

**FINAL INVESTIGATION REPORT ON ACCIDENT TO M/S ARYAN AVIATION  
AGUSTA 109 C HELICOPTER VT-VKS AT RANCHI AIRPORT ON 09.05.2012**

1	Aircraft		
		Type	Agusta A109C Helicopter
		Nationality	Indian
		Registration	VT-VKS
2	Owner		M/s Aryan Aviation Private Limited, Mumbai-99.
3	Operator		M/s Aryan Aviation Private Limited, Mumbai-99.
4	Pilot – in –Command	CHPL	
	Extent of injuries	Serious	
5	Co-Pilot	CHPL	
	Extent of Injuries	Serious	
6	No. of Passengers on board	04	
	Extent of Injuries	03 – Serious: 01 – Minor	
7	Last point of Departure	Birsa Munda Airport, Ranchi	
8	Intended landing place	Kuchai HeliPad	
9	Place of Accident	Birsa Munda Airport, Ranchi (231851.3N; 0851915.8E)	
10	Date & Time of Accident	9 <sup>th</sup> May 2012, 0654 UTC	

## **SYNOPSIS**

1. On 9<sup>th</sup> May 2012, Aryan Aviation Agusta A109C helicopter VT-VKS, met with an accident during emergency landing at Ranchi Aerodrome at 0654 UTC. The helicopter was airborne from Ranchi for Kuchai helipad under Special VFR conditions at 0546 UTC with six persons on board, including the Chief Minister of Jharkhand and two pilots. The flight was uneventful till its arrival overhead Kuchai. While turning for finals the pilot felt loss in left rudder control. On checking the Tail Rotor (TR) effectiveness, left rudder control was found completely ineffective. The helicopter nose had offset to the right and the pilots were unable to align it with flight path. The PIC decided to return to Ranchi Aerodrome for an emergency landing on the runway. He attempted a forward speed landing after trying out several approaches wherein the helicopter started yawing to the right on short finals. It turned through 180 degrees, and continued turning further. The helicopter toppled to its left after impacting the runway surface. It was substantially damaged. The occupants received serious injuries. There was no fire. The accident occurred during daylight.
2. Airport Emergency Services were appropriately activated. The occupants were extricated promptly and evacuated to the hospital.
3. The Ministry of Civil Aviation, Government of India ordered the investigation by appointing Committee of Inquiry under Rule 74 of the Aircraft Rules 1937 vide Order No. AV.15018/07/2012-DG dated 18.05.2012 to determine the causes and the contributory factors leading to the accident.
4. The most probable cause of the accident was perfunctory maintenance wherein Ring Nut of Duplex Bearing got unwound from its support sleeve due absence of safety locking wire. This obstructed axial movement of Pitch Change Slider resulting in loss of TR control. Retention of negative TR blade pitch made pilot handling difficult during landing.
5. PIC's decision to divert for emergency forward speed landing was prudent and in consonance with 'Loss of TR Control' emergency listed in the Flight Manual. Delay

in cutting off the engines, however, negated the efforts to control the yaw before touch down and resulted in toppling of the helicopter.

## **1. FACTUAL INFORMATION**

### **1.1 History of The Flight**

**1.1.1.** Agusta A109C Helicopter VT-VKS owned and operated by M/s Aryan Aviation Private Limited Mumbai, met with an accident at Ranchi Aerodrome on 9<sup>th</sup> May 2012 at 0654 UTC. The helicopter was on operational contract with Government of Jharkhand and had been planned to fly from Ranchi to Kuchai, Goddadih and Chaibasa helipads. This was a VIP flight with Chief Minister Jharkhand on board for which a Special VFR flight plan was filed with Ranchi ATC at 0410 UTC. The first intended landing was at Kuchai helipad after about 20 minutes of flying time.

**1.1.2.** The helicopter was prepared for the flight and released by the AME. It was checked and accepted by the PIC. Start up and take off was normal. The helicopter departed Ranchi at 0546 UTC after obtaining Special VFR clearance from ATC. The flight was uneventful till arrival overhead Kuchai. While turning for finals, the PIC noticed significant loss in left rudder. On checking the controls subsequently, left rudder control was found completely ineffective and right one partially effective. The pilots were unable to align the nose that had developed an offset to the right. The situation was assessed and a decision was taken to divert for an emergency roller landing. At 0622 UTC, the helicopter transmitted its plan to land back at Ranchi. Details however, could not be understood/ acknowledged by the ATC and had to be re-iterated once the helicopter was in clear VHF range.

**1.1.3.** At 0626 UTC, the helicopter reported 14 miles inbound and intimated its requirement for full runway. The PIC conveyed his intention to carry out a roller landing due to insufficient rudder control. At 0627 UTC, Jet Airways flight was made to discontinue the approach and climb up to facilitate emergency landing.

**1.1.4.** The helicopter approached Rwy 31 for a low pass and went around at 0635 UTC. Two more approaches were made on Rwy 31 before changing to Rwy 13.

**1.1.5.** An attempt to land was made during sixth approach wherein the helicopter started yawing to the right. It veered through 540 deg approximately and toppled to the left after hitting the runway. Persons on board received serious injuries. They were promptly extricated by Airport Emergency Services and were rushed to the hospital for medical care. There was no fire. The helicopter was substantially damaged.

## **1.2 Injuries to Persons**

Injuries	Crew	Passengers	Others
Fatal	Nil	Nil	Nil
Serious	02	03	Nil
Minor/None	Nil	01	

## **1.3 Damage to Helicopter**

The helicopter was substantially damaged due impact and post impact rotor striking the runway surface.

## **1.4 Other Damage**

Minor damage was observed to the runway surface.



**Figure 1. Final position of the crashed helicopter**

## **1.5. Personnel Information**

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

**1.5.1.1.** An ex-Army Aviation helicopter pilot whose initial helicopter training was conducted at Helicopter Training School, Air Force Station Hakimpet, Hyderabad in 1987. He obtained CHPL in 1992 and started his commercial flying in 1993. He joined Pawan Hans Helicopters Ltd in 1994 and continued there for about eight years. He was endorsed on A109C in December 2011.

### **1.5.1.2. Licence Details**

Age	52 years
Licence	CHPL
Date of Issue	20.10.1992
Valid up to	11.11.2012
Endorsements as Pilot in Command (PIC)	Chetak, Cheetah, R-44, AS 365N, A 109C
Date of last Med. Exam	03.05.2012
Med. Exam valid up to	02.11.2012
FRTD Date of issue	16.3.1992

Valid up to	15.3.2032
IR test done	23.12.2011
IR test due	22.12.2012
Total flying experience	3873:35 hrs
Experience on type	401 hrs PIC, 200 hrs Co-pilot
Total flying during last 90 days	55:30 hrs
Total flying experience during last 30 days	16:45 hrs
Total flying experience during last 07 Days	06:25 hrs
Total flying experience during last 24 Hours	00:15 hrs

### 1.5.2. Co-Pilot

1.5.2.1. A former military aviator, the Co-pilot underwent initial helicopter training at Helicopter Training School, Air Force Station Hakimpet in 1984. He remained with Army Aviation till 2011 and joined Aryan Aviation in Aug 2011. He obtained his CHPL endorsed in Chetak/ Cheetah helicopters in 2002. He completed his conversion training on A109C in March 2012.

### 1.5.2.2. License Details

Age	54 Yrs
Licence	CHPL
Date of Issue	16-9-2002
Valid up to	15-9-2012
Endorsements as PIC	A 109C,Cheetah, Chetak
Date of last Med. Exam	08.2.2012
Med. Exam valid up to	07.8.2012
FRTD Date of issue	16.9.2002
Valid up to	15.9.2012

Total flying experience	3475 Hrs
Experience on type	23:35 Hrs
Total flying during last 90 days	23:35 Hrs
Total flying during last 30 days	08:25 Hrs
Total flying during last 07 Days	06:25 Hrs
Total flying experience during last 24 Hours	00:15 hrs

**1.5.3. Aircraft Maintenance Engineer** The AME is holding Cat 'A & C' license endorsed on A109C helicopter fitted with Rolls Royce 250C-20R/1 engines. Validity of his licence is till 03.2.2014. He has been issued organisational approval by the Quality Manager Aryan Aviation under the authority of CAR 145 Para 145.A.35. The scope of approval is to carryout, certify and issue CRS of the below mentioned inspections on the helicopter:

- Up to 600 hrs inspection (Airframe & Engine)
- 12 monthls inspection

## 1.6 Aircraft Information

**1.6.1 General Information** Agusta A109C Helicopter VT-VKS was designed and manufactured by M/s Agusta SPA Italy, now Agusta Westland. It is powered by two turbo shaft engines. It has an anti-clockwise rotating main rotor (MR) system comprising four composite articulated blades. It has twin blade teetering TR and a retractable Tricycle Landing Gear. The helicopter is certified in transport category, under single pilot VFR and IFR, day and night land operations under non icing conditions. It has a service ceiling of 15,000 feet and its maximum All Up Weight is 2720 Kg.

## 1.6.2 Basic Details

Helicopter Model	Agusta109 C
Helicopter Serial No	7648
Year of Manufacture	1991
Certificate of Registration Issue Date	17.03.2009
C of A Issue Date	25.03.2009
C of A Valid Up to	15.03.2013

Total Hrs Since New	3139:10
Engine Make / Model	RR 250 C-20 R/1
Engine Serial Numbers	CAE 295511 CAE 295185
Last Major Schedule	600 hrs/ 4 Years Carried on 16.01.12
TSN	Left Engine 3139:10 Hrs Right Engine 3139:10 hrs
Last Inspection	200 Hrs Inspection carried out at 3083:40 Hrs.
Repetitive Snags ( Last 15 Days)	NIL
Major Snags Reported	NIL

### **1.6.3. Scrutiny of Maintenance Records**

**1.6.3.1.** The scrutiny of Aircraft Logbook and other technical records revealed that the helicopter had its C of A valid on the day of accident. It had completed 3139:10 A/F hrs since new. On 09.05.2012, the AME reported for work with two technicians at approx 0730 hrs IST to prepare the helicopter for flying. Before First Flight (BFF) inspection was carried out as per approved schedule and the helicopter was refuelled with 160 Kg of fuel to bring the total to 240 Kg.

**1.6.3.2.** Last major maintenance inspection/600 hrs schedule inspection including lower inspection schedules, 600hrs/04 yrs “out of phase” inspection, 600hrs/24 months MRH lubrication, 900 hrs/03 yrs “out of phase” inspection had been carried out at 3022 A/F hrs on 16.01.2012.

**1.6.3.3.** Last 50hrs out of phase inspection, 50hrs/03 months Main Rotor Swash Plate lubrication was carried out at 3037:30 A/F hrs on 07.02.2012 followed by 75 hrs “out of phase” inspection carried out at 3044:40 A/F hrs on 12.02.2012.

**1.6.3.4.** A 200hrs/06 month “out of phase” inspection was carried out at 3083:40 on 07.03.2012.

**1.6.3.5.** Inspection of hydraulic pipes and TR control rod was carried out after removal of oil tank at 3083:40 A/F hrs on 21.3.2012 to comply with Service Bulletin (SB) 109.128.

**1.6.3.6.** The next 75 hrs “out of phase” inspection had been carried out at 3117:25 A/F hrs on 19.04.2012.

**1.6.3.7.** After completion of 600 hrs Scheduled maintenance on 22.01.2012. Following major maintenance was carried out by the AME on Tail Rotor Pitch Change Mechanism in order to rectify the snag of Rudder stickiness:

- Tail rotor Duplex Bearing P/N 109-0133-05-101 was observed to have roughness and was replaced with new set received vide Agusta release NOTE NO- AUG 2011 IT20 39852. Duplicate inspection was carried out by appropriately authorized AME on 22.01.2012.
- Further, the Terminal assembly of pitch change links of main rotor blades P/N 709-0101-18-111, S/N- 614, 600, 615, 605 were replaced with new ones having S/N: 718, 704, 717,709 respectively. Duplicate inspection was carried out by appropriately authorized AME on 22.01.2012.

**1.6.3.8.** Scrutiny of right engine logbook revealed that 600 hrs schedule inspection including lower inspection schedule was carried out at 3022 A/F hrs on 16.01.2012. Engine oil drained and replenished with engine oil at 3083:40 A/F hrs on 21.03.2012.

**1.6.3.9.** Scrutiny of left engine logbook revealed that 600 hrs schedule inspection including lower inspection schedules, carried out at 3022 A/F hrs on 16.01.2012. Engine oil drained and replenished with engine oil at 3083:40 A/F hrs on 21.03.2012.

**1.6.3.10.** All Maintenance Inspection Schedules, Modifications, Service Bulletins etc were observed to have been complied with and no reported snag was due before operating the accident flight.

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

**1.6.4.1.** Scrutiny of the Weight Schedule revealed that the same was approved based on the last weighing of the helicopter done on 19.01.2009 in Italy. The approved weight schedule revealed that maximum all up weight of the helicopter was 2720 Kgs. The position of the movement of the Centre of Gravity was established between 3.168m aft of the forward limit and 3.500m aft of the aft limit.

**1.6.4.2** The load and trim sheet of the accident flight was duly filled before origination of flight. Total AUW was 2665.5 Kg and the moment of CG was calculated and found within given limits.

### **1.7 Meteorological Information**

The helicopter took off from Ranchi Airport for Kuchai at 0526 UTC. The details of meteorological reports issued are given below:

Time (UTC)	0430	0500	0530	0600
Winds	260/ 02 Kt	2000/ 02 Kts	330/05 Kts	320/06
Visibility	4000 m	4000 m	4000 m	4500 m
Clouds	NSC	NSC	FEW 1800 ft	SCT 1800 ft
Temp	34 deg C	34 deg C	34 deg C	37 deg C
QNH	1011 hPa	1011 hPa	1011 hPa	1011 hPa
QFE	935 hPA	935 hPA	935 hPA	935 hPA

## **1.8 Aids to Navigation**

**1.8.1** The aerodrome is equipped with following Radio Navigation and Landing Aids:

Sl. No.	Type of Aid installed	Operating Frequency
1.	DVOR	116.9 MHz
2.	VOR DME	1140/1203 MHz
3.	NDB	285 kHz
4.	LLZ 31 (ILS CAT-I)	110.5 MHz
5.	GP31	329.6 MHz
6.	ILS DME (LP)	1066/1003 MHz

**1.8.2** The helicopter VT-VKS was equipped with following Navigation Equipment:

Sl. No.	Type of Aid installed	Operating Frequency
1.	ELT	121.5/406 MHz
2.	Instrument Landing System	
	Localiser Receiver	108-117.95M Hz
	Glide Path Receiver	329.15-335 M Hz
	VOR Receiver (02 no.)	108.00 to 117.95 M Hz
3.	Automatic Direction Finder (ADF)	190 KHz to 1749. KHz
4.	Marker Receiver	75 Hz

## **1.9 Communication**

**1.9.1** Ranchi Aerodrome is equipped with VHF communication. Its working frequency is 118.05 MHz. The channel has recording facilities.

**1.9.2** The helicopter was equipped with VHF main and standby transmitter and receiver. Replay of the stored communication at ATC indicates that the helicopter had maintained VHF contact up to 25 NM on the outbound and had reported the position at 0602 UTC. The next call was given at 0622 UTC wherein it reported its return to Ranchi due to no response from rudder. ETA Ranchi given was 0631 UTC.

## **1.10 Aerodrome Information**

Birsa Munda Airport, Ranchi is fully managed and controlled by Airports Authority of India. Aerodrome information is given below:

Aerodrome Reference Point	:	231851.3N 0851915.8E
Elevation/Reference temperature	:	654.53 m(2148 ft)/38°C
Types of traffic permitted	:	VFR/IFR
Category for fire fighting	:	CAT-7 between 0340 UTC to 1410 UTC
Runway designation	:	13 / 31
Strip dimension	:	2833m x150 m
ATS Air space lateral limits	:	25 NM; centred at 231901.3N, 0851918.8E NDB “RC”.
Vertical limits	:	6000 ft MSL
ATS communication facilities	:	VHF “TWR” & DATIS
Navigation and landing Aids	:	DVOR, VOR DME, NDB, ILS CAT-I LLZ31, GP 31& ILS DME (LP)

## **1.11 Flight Recorders**

**1.11.1** A109C helicopter VT-VKS was not fitted with CVR/FDR as per extant provision.

**1.11.2** A low resolution video of about 37 sec duration was recorded on the accident. The video was analysed by the investigating team and also discussed with other experts, including OEM representatives. The helicopter is seen making a shallow approach on Rwy 13 in the first 25 sec of the video. Directional control is maintained despite helicopter nose offset to the right. Onset of right yaw can be seen in the next 02 sec, and the helicopter turns rapidly through 90 deg and beyond. A leftward tilt in the rotor disc is discernible which could be associated with lateral cyclic stick input to counter the right yaw. The helicopter continues to loose height during the manoeuvre and at 10-15 ft, its view gets blocked by Safety Vehicles lined up ahead. The camera is

relocated and the helicopter starts re-appearing in the frame after 3-4 sec. The helicopter is envisaged to have rotated more than 360 deg and is facing in a direction reciprocal to the approach at the time of impacting the runway. The helicopter keeled over to the left after taking an impact on its left wheel and rotates viciously on its side. The video recording ends abruptly thereafter. Noise generated by MR blades impacting the runway surface is distinctly heard over and above engine noise that remains discernible till the end of recording.

## **1.12 Wreckage and Impact Information**

**1.12.1** The helicopter crashed on active runway while attempting a low forward speed emergency landing. It turned through 540 deg approx on short finals and impacted the runway. Left undercarriage hit the surface and the helicopter topple on the same side. The helicopter thereafter rotated viciously through 360 deg approx and came to rest. The MR blades impacted the runway while in rotation and broke into pieces that got scattered around the main wreckage. The wreckage remained localised within the width of the runway.

**1.12.2** The detailed examination of the wreckage revealed following:

- The Main Rotor blades impacted runway surface several times and broke into pieces that got scattered around the main wreckage.
- Tail Rotor blades got shredded & delaminated.
- Tail Boom skin got damaged at a few places.
- The Left Main landing gear got pierced through the body structure.
- The left side of the cockpit got deformed.
- The Pilot & Co-pilot seats had come off their attachment points in the cabin floor.
- The cabin window Plexiglass panels were broken.
- Right side Passenger door jettisoned.
- Co-pilot side door damaged and seized.
- Tail fin damaged.
- LH horizontal stabilizer broken at mid-section.
- MGB fairing broken.

- Pilot skylight broken.
- Pitch link horn of Red MRB broken.
- The drag dampers of Red, Blue & Yellow MR blades sheared off.
- Tail drive shaft fairing cut at three places.
- Tail Rotor blades badly damaged. Safety Locking Wires of the Duplex Bearing Support Sleeve / Ring Nut missing from both sides.
- A wide hole in the lower side of the tail boom.



Fig.2 Crash/Impact point and location of wreckage on Runway



Fig. 3 MR blade marks, scattered pieces of blades & other broken parts.



Fig.4 Failed Tail Rotor Pitch Change slider



Fig.5 Unscrewed Duplex Bearing Nut & its locking holes without Locking wire

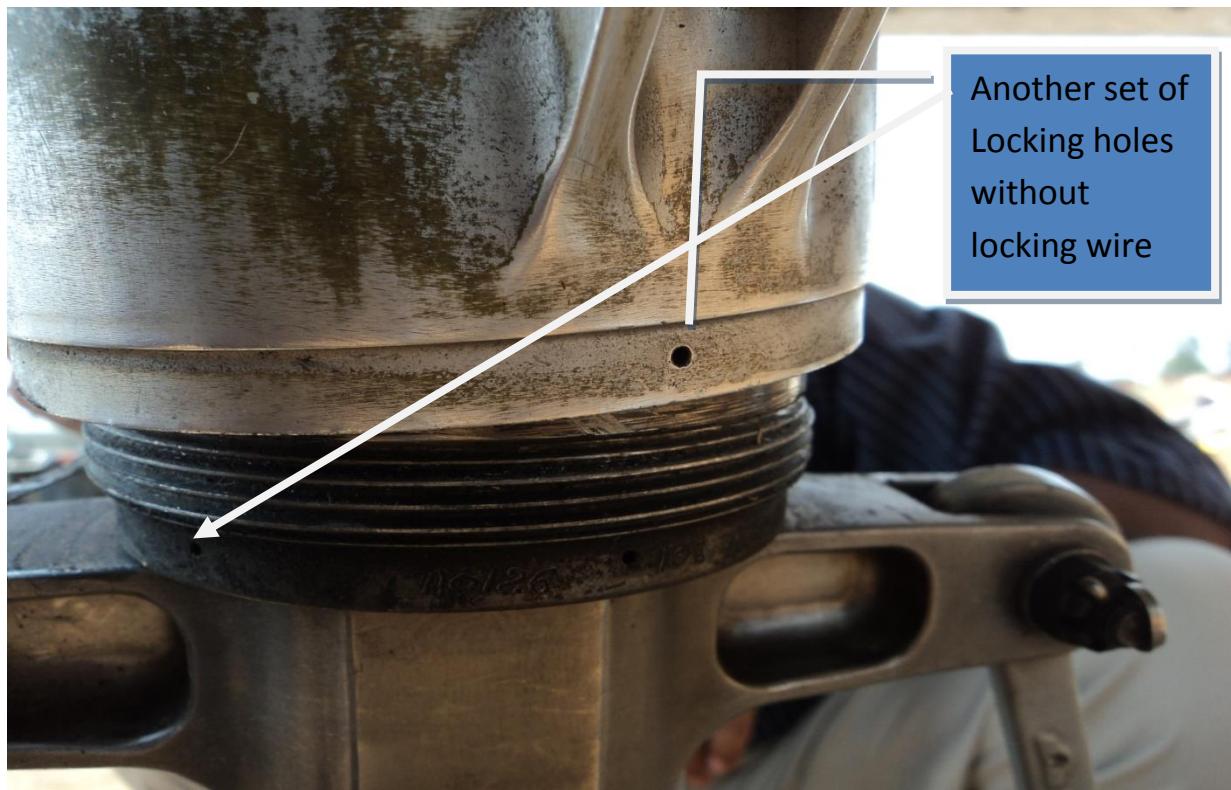


Fig. 6 Second pair of holes without locking wire.

### **1.13 Medical and Pathological Information**

**1.13.1** The helicopter VT-VKS took off with two operating crew and four passengers on board. All six persons on board survived with injuries due crash landing impact.

**1.13.2** Pathological examination of all the persons on board was carried out at Apollo Hospital Ranchi. The report did not reveal information of relevance to accident investigation.

**1.13.3** The operating crew had undergone Pre Flight Medical Examination before operating the flight as per regulation and found fit to operate the flight.

### **1.14 Fire**

There was no evidence of pre or post-accident fire.

### **1.15 Survival Aspects**

**1.15.1** The helicopter VT-VKS crash landed on active runway at Birsa Munda Airport Ranchi while attempting a low speed emergency landing with impaired TR Control.

Since the situation had been communicated to the ATC in advance, the emergency response group was ready and positioned appropriately to meet eventuality.

**1.15.2** Personnel on board were promptly extricated from the wreckage and administered primary aid before taking to hospital for further treatment.

**1.15.3** All the occupants survived the accident.

## **1.16 Tests and Research**

**1.16.1** TR Pitch Control Mechanism assembly of the helicopter was stripped down systematically and was examined component wise for possible defects/failures. Representative experts of the manufacturer, M/s Agusta Westland Italy and Type Trained & experienced engineers from a Delhi based Agusta Westland helicopter fleet Operator, were also present during this part of defect investigation and analysis. It was found that:

- a) The Tail Gear Box and Tail Drive Shaft were undamaged.
- b) Both Tail Rotor Blades had shredded (delaminated) due to impact.



Figs.7 Dislodged Ring Nut.

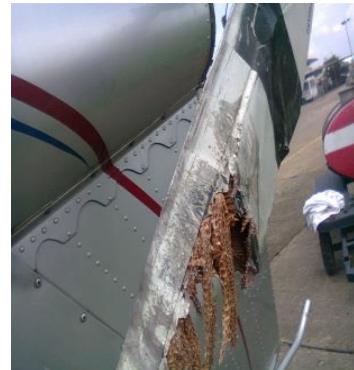


Fig. 8 Shattered TR Blade

- c) Fasteners and linkages were intact;
- d) Ring Nut of Duplex Bearing P/N 109-0133-05-101 had got fully dislodged from the support sleeve. One of the Outer Races of Duplex Bearing had also come out, which prevented free and full movement of Slider Sleeve for effective positive TR blade pitch change application.

- e) There was no trace of the Safety locking wires on either side of the Duplex Bearing Support Sleeve for securing and preventing Ring Nut from loosening/ threading out.
- f) Position of Inner Races of the bearings indicated that the Duplex Bearings had been assembled correctly during last 600hr/6month servicing conducted on 22.01.2012.



Fig. 9 Direction of inner races of Duplex Bearings

- g) Outer Race of one half of the Duplex bearing was found stuck obliquely inside the Support Sleeve.
- h) There were no signs of rubbing, pitting, corrosion or over heating on steel ball bearings.



Fig. 10. Condition of Ball Bearing Holders

- i) No grease was available inside the bearing support Sleeve.
- j) All pitch change links and their bush bearings were intact.
- k) The Teflon sleeve inside the pitch change slider had burnt down to fine black powder.

### **1.17 Organizational and Management Information**

The Agusta A109C Helicopter VT-VKS was owned and operated by M/s Aryan Aviation Pvt Ltd, Mumbai. The owner holds a valid Non Scheduled Operators Permit bearing NSOP No. 13/2009 issued by Director General of Civil Aviation and valid up to 07.04.2013. The operator has one Bell 407 helicopter endorsed on the permit besides the accident helicopter.

### **1.18 Additional Information**

**1.18.1** Emergency actions in case of Tail Rotor Malfunction as given in the Agusta A 109C Flight Manual (FM) is as appended below:

The vertical stabiliser produces an anti-torque component which is a function of forward speed. This permits controlled flight at low power; **however the landing should be made with the power levers set to OFF.**

Two possible types of TR failures and subsequent actions are described in the following paragraphs.

### **COMPLETE LOSS OF TAIL ROTOR CONTROL IN HOVERING FLIGHT 4 to 10 ft**

Power Levers : OFF (if height permits)

Collective: As necessary and at about 2 ft above ground increase to cushion the touch down

A rotation to the left on touch down is obtained when both power levers are off, otherwise a rotation to the right is obtained.

### **COMPLETE LOSS OF TAIL ROTOR CONTROL IN CRUISE FLIGHT**

Collective: Lower as necessary to eliminate yaw to the right.

Airspeed/Power: As necessary in order to reach a suitable landing site.

**NOTE:** Increased power will allow an extension of the flight path, however an increase in power necessitates an increase in speed to prevent a helicopter from turning.

Landing gear lever: DOWN

Nose wheel lock : ON

Parking Brake: OFF (In)

### **On reaching the point of intended landing**

Collective : As needed for autorotation

Power Levers : OFF (full aft)

All Fuel Panel Switches : OFF

Generators 1 & 2 : OFF

Battery : OFF (except as needed in night flight)

Perform an auto-rotative landing with forward touch down (if terrain permits.)

**Collective :** Lower as necessary to eliminate yaw to the right.

**Airspeed/power:** As necessary in order to reach a suitable landing site.

**NOTE:** Increased power will allow an extension of the flight path, however an increase in power necessitates an increase in speed to prevent the helicopter from turning.

**Landing Gear Lever:** DOWN.

**Nose wheel lock:** ON.

**Parking Brake:** OFF (in).

**On reaching the point of intended landing:**

- Collective: As needed for autorotation.
- Power levers: OFF (full aft).
- All fuel panel switches: OFF.
- Generators 1 and 2: OFF.

**Perform an auto-rotative landing with forward speed touch-down (if terrain permits).**

**1.18.2** The pilots' account of circumstances preceding the accident brings out following:

- PIC's RT conversation with AME did not provide any information to mitigate the situation.
- Helicopter did not encounter any abnormal behaviour other than loss of TR control.
- Several approaches were made on runway to assess handling characteristics during landing without rudder control.
- In the first attempt, helicopter approached Rwy 31 with speeds varying between 60-90 kts. It made a low pass at about 20 ft. Nose offset to the right could not be eliminated by the crew. In the next two approaches, efforts were made to align the nose with flight path without success. Subsequent attempts were made on the reciprocal runway, due to change in winds.
- After fifth attempt, the helicopter climbed up and continued to burn fuel.
- Various options to reduce the offset, including reduction in fuel control levers were tried out.

- Auto-rotation option was considered but ruled out due to envisaged directional control problem on account of negative TR pitch.
- The crew decided to land in the sixth approach.
- PIC's stated direction of approach from 131 direction is negated by other evidence. The available video and other inputs indicate that the last approach was made for Rwy 13 and not Rwy 31.
- The helicopter approached the centre line at about 10 ft, with approx 20 kts of speed.
- Before reaching transition speed, the PIC asked the Co-pilot to pull back on the fuel control levers to remove engine torque. However before the levers could be pulled back, the helicopter started turning right, developing rapidly into a vicious turn. It impacted the ground and rolled over.
- The pilots appeared to be hazy about recounting details of last few seconds of the accident due to rapidity of events.

### **1.19 Useful or Effective Investigation Techniques**

N/A

## **2. ANALYSIS**

### **2.1 Maintenance Aspect**

**2.1.1** Agusta A109C helicopter serial number 7648 manufactured in 1991 has been entered in the register of India with effect from 17.03.2009 and allotted with registration VT-VKS endorsed in the C of R No. 3921. The operator of the aircraft is Aryan Aviation Pvt Ltd, Mumbai as recorded in the C of R. The C of A of the helicopter was valid up to 15.03.2013. The aircraft was last weighed on 19.01.2009 was not due for reweighing the accident flight. The analysis of Load & Trim Performa in association with the Passenger Manifest revealed that total Take off weight including Basic Empty Weight of the helicopter, weight of two operating crew, four passengers and total fuel on board was within the limit of maximum authorized take-off and landing weight .

**2.1.2** The helicopter was observed to have been operated within the provisions of C of A and C of R. The loading of helicopter and movement of its C of G being in limits, do not appear to be the contributory factors for the accident.

**2.1.3** Analysis of the maintenance revealed that the helicopter had completed 3139:10 A/F hrs since new and BFF inspection had been carried out as per DGCA Approved Schedule on 09.05.2012.

**2.1.4** Inspection of hydraulic pipes and TR control rod was carried out at 3083:40 A/F hrs on 21.3.2012 to comply with Service Bulletin (SB) 109.128.

**2.1.5** The scrutiny of both RH and LH engine logbooks revealed that 600 hrs schedule inspection was carried out at 3022 A/F hrs on 16.01.2012. Engine oil was drained and replenished at 3083:40 on 21.03.2012.

**2.1.6** Major maintenance on TR Pitch Change Mechanism was carried out for rectification of rudder stickiness snag wherein TR Duplex Bearing P/N 109-0133-05-101 (observed to have roughness) was replaced with new set received vide Agusta release NOTE NO- AUG 2011 IT20 39852 dated 22.01.2012.

**2.1.7** It was established from the foregone that all Maintenance Inspection Schedules, Modifications, Service Bulletins etc had been complied with and no reported snag was due before operating the accident flight.

**2.1.8** The Ring Nut of the Duplex Bearing P/N 109-0133-05-101 Support Sleeve had got fully dislodged from the Support Sleeve (housing) along with one of the Outer Races of the Duplex Bearing, thereby preventing free and full movement of the Slider Sleeve for effective left rudder application.

**2.1.9** There were no visible signs at the locking wire holes of the Duplex Support Sleeve (housing) and the Ring Nut to suggest the presence of locking wire before originating the accident flight. It is evident that the Ring Nut had not been wire locked during last servicing and remained undetected till the post accident inspection. The AME who signed the Duplicate

Inspection too had failed to observe and prevent the deficiency in the maintenance carried out by the AME.

**2.1.10** Approved BFF does specifically mention about inspection point “to check security of locking of the Duplex Bearing Ring Nut”. The above deliberations imply that perfunctory maintenance carried out by the AMEs, was contributory factor to the accident.

**2.1.11** In order to prevent reoccurrence of such accidents, the manufacturer, after the accident, has also advised through Revision No.15 to Temporary Revision MM 64-2, of A109C, dated 14.07.2010 that the value of torque applied to the Ring Nut be increased from 500-600 kg.cm to 1200-1300 kg.cm. Further a special “clearance checks” on Duplex Bearing and technique for applying Primer LCM-34 or 35 and Sealing compound LCM-19 during the tightening of the Ring Nut have been advised. The Safety Locking wire LCM-24 too has been replaced by LCM-36 vide the above Temporary Revision.

## **2.2 Operational Aspects**

**2.2.1 Flight Planning** Planning and preparation of the flight was appropriate and the Flight Crew was qualified for the planned VIP flight. The All Up Weight (AUW) was within the prescribed limits. Reported visibility was 4.0 km for which a Special VFR Flight Plan was filed with Ranchi ATC at 0410UTC. There was no significant weather in the area to have any bearing on emergency handling.

**2.2.2 Checks & Procedures** No abnormality was observed during start up and pre-take off checks. A normal hover take off was executed from Ranchi aerodrome.

### **2.2.3 Piloting and Handling of Emergency**

**2.2.3.1** The emergency procedure however, does not cover specifics to deal with retention of negative pitch condition which is akin to rudder pedals getting stuck to the right. This condition is difficult to handle in helicopters with anti-clockwise rotating rotors as in case of Agusta A 109 C.

**2.2.3.2** Flight Crew report highlights right nose offset in cruise settings which could have resulted from retention of negative TR blade pitch due to dislodged Ring Nut and Outer Race interference with Slider Shaft.

**2.2.3.3** Decision to return back to Ranchi for an emergency forward speed landing on runway was consistent with emergency stipulated procedure. The essence of generic emergency listed in the FM for 'Complete Loss of TR Control Emergency' is to perform a landing with Engine Levers OFF, which, however, was not done in the instant case. Even though, PIC's predicament and hesitation for an autorotative landing in the given circumstances and with VIP on board is considered pertinent; adoption of a theoretical technique without requisite training/ expertise was not prudent.

**2.2.3.4** Various power/ speed combinations were tried out to work out an approach/ landing configuration for safe touch down and finally an approach was made to land on Rwy 13. Intention was to retard the engine levers before hitting the transition speed. This would have negated additional left rudder requirement at lower speed but the speed was allowed to drop without manipulating engine levers. The helicopter yawed and started turning right. It turned through 90 deg and continued turning further. Even though the crew was not able to recollect complete details of last few seconds of the flight due to rapidity of events, analysis of other available inputs indicate that the helicopter had made one and a half rotation, before impacting the ground. The helicopter lost height during this manoeuvre and hit the ground. It rolled over to the left, with MR blades in rotation under power which induced a vicious rotation of the fuselage in the keeled position.

**2.2.3.5** Inadvertent reduction in helicopter speed below transition, with engines operative, led to the helicopter toppling during attempted landing. The PIC evidently did not possess requisite training/skills to handle the emergency in the intended manner.

## **2.2.4 Cockpit Resource Management**

**2.2.4.1** The two pilots have comparable total flying hours on rotary wing. The PIC has about 600 hrs of experience on type and has also flown AS-365 N Dauphine and

Robinson R-44. The Co-pilot's experience is mainly on Chetak/Cheetah helicopters with just 23 hrs (apprx.) on Agusta109 C.

**2.2.4.2** The CRM was found to be sub-optimal during the critical phase of handling during the landing attempt. The emergency being generic in nature, the Co-pilot could have assisted/ advised the PIC in maintaining the requisite speed through prompting till retarding of Engine fuel flow levers.

## **2.3 Human Factors**

**2.3.1 Pre-flight Medical** The pilots underwent Pre-flight medical before the VIP flight and were found fit. Nothing adverse was reported to indicate any stress or fatigue.

**2.3.2 Flying Conversion Training** The PIC had undergone type conversion at OEM facility in Italy while the Co-pilot had been trained in India. The training was conducted in accordance with DGCA CAR Section 7- Flight Crew Standards Training and Licensing Series 'B' Part X dated 28<sup>th</sup> June 2005 except for use of full motion simulators. There being no simulator for A-109C, training for the pilots was carried out only on the helicopter. A total of 10 hrs of flying by the PIC and 15:10 hrs by the Co-pilot including skill test by day and night, were flown.

**2.3.3 Training Records** Training records were analysed and are covered in succeeding paragraphs.

**2.3.3.1 Recurrent Training.** DGCA CAR Section 7 Series 'B' Part XIV dated 8<sup>th</sup> July 2005 postulates recurrent training requirements for helicopter pilots. Training records of the pilots were scrutinised to check for compliance. The Captain and Co-pilot had completed conversion training on 20.2.2009 and 27.03.2012, respectively. Competency Checks were presented for perusal of requisite certificates/ records and were in order.

**2.3.3.2 Simulator Training for Critical Emergencies** Simulator training of 05 hrs for critical emergencies, which cannot be practiced on the aircraft needs to be undertaken once in two years. The crew had not undertaken the same. New models of A 109 full motion flight simulator, now allow practising representative critical emergency

conditions as per manufacture's communiqué. The use of same would increase the pilot training proficiency.

**2.3.3.3 Proficiency & Other Checks** The PIC had undergone required checks including Night check and IR check. The Flight Crew were appropriately licensed and qualified to undertake the flight .

**2.3.3.4 CRM and Dangerous Good Training.** Both Pilots had undergone CRM and dangerous Good Training in accordance with CAR.

### **3 CONCLUSIONS**

#### **3.1 Findings**

**3.1.1** The helicopter was operated within the provisions of valid C of A and C of R.

**3.1.2** Loading of the helicopter and the movement of CG is not a contributory factor.

**3.1.3** The operating crew was appropriately licensed to operate the flight.

**3.1.4** All Maintenance Inspection Schedules, Modifications, Service Bulletins etc had been complied with and no reported snag was due before operating the accident flight.

**3.1.5** The Duplex Bearing was replaced on 22.01.2012.

**3.1.6** The AME had carried out the Before First Flight (BFF) inspection as per approved schedule before the accident flight.

**3.1.7** The Ring Nut and one Outer Race of Duplex Bearing were fully dislodged from its housing. This prevented Slider Sleeve movement required for requisite TR control.

**3.1.8** Safety locking wires on either side of the Duplex Support Sleeve (housing) were found missing in TR Pitch Change Mechanism. These were not noticed till post accident inspection.

**3.1.9** Approved BFF did not specifically mention about inspection point “to check the security of locking of the Duplex Bearing Ring Nut”.

**3.1.10** Post accident, the OEM has issued Temporary Revision No 15 to Maintenance Manual on 25.5.2012 and advised following as preventive measures:

- increment in torque application from 500-500 Kgcm to 1200-1300 Kgcm
- Special technique for applying Primer LCM-34 or 35 & Sealing compound LCM-19 during tightening of the Ring Nut
- Use of Safety Locking wire of higher thickness viz. replacement of LCM-24 by LCM-36.

**3.1.11** The flight was operated in Special VFR condition. The operating crew and the helicopter met the requirement of special VFR conditions.

**3.1.12** The flight was uneventful till arrival overhead Kuchai. Loss of TR control was experienced during the turn for helipad finals.

**3.1.13** The helicopter diverted to Ranchi for an emergency forward speed landing on the runway. This was in consonance with actions stipulated in the Flight Manual.

**3.1.14** The pilot attempted a low forward speed landing with impaired TR control. His intention to pre-empt right yaw did not fructify due delay in retarding the Engine fuel levers. The helicopter yawed and veered through 540 deg approx and toppled after hitting the runway surface.

**3.1.15** There was no evidence of pre or post impact fire.

**3.1.16** The helicopter was substantially damaged.

**3.1.17** The persons on board escaped with serious injuries.

**3.1.18** Weather was not a contributory factor to the accident.

**3.1.19** Simulator training was not imparted to the pilots during Conversion Training and for Critical Emergency Training due non availability of type simulator. New models of Full Motion Flight simulator of A 109 now allow practising representative

critical emergency conditions as per manufacturer's communiqué. The use of same would increase the pilot training proficiency.

### **3.2 Probable Causes and Contributing Factors**

**3.2.1** The accident was caused due to the malfunction of TR Pitch Control Mechanism due to unwinding of Ring Nut from Duplex Bearing Support Sleeve in absence of the locking wires.

**3.2.2** Retention of negative TR blade pitch made pilot handling difficult during the landing.

**3.2.3** Improper handling of the emergency by the pilot was a contributed factor.

## **4 SAFETY RECOMMENDATIONS**

**4.1** The Service Bulletin No. 109-134 dtd 21 Sep 2012 (issued by Agusta Westland post accident (VT-VKS) be meticulously followed by all operators, as it covers even the daily checks needed to ensure the availability of Safety locking wires to secure the Ring Nut of the Duplex Bearing.

**4.2** The Duplicate Inspection of all Flying Controls required to be carried out and signed by the senior AME, should be conducted in presence of Technician / AME performing the Scheduled task and not independent of each other.

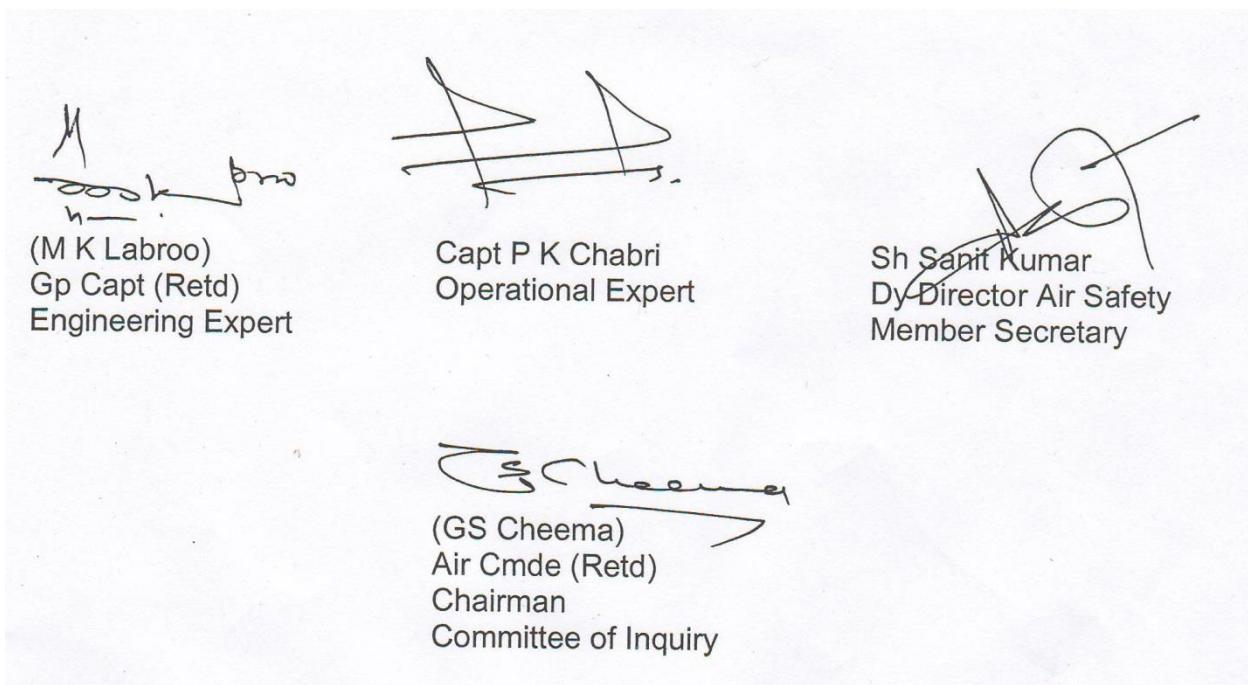
**4.3** Optional Information Letter No.A109-10-023 dtd 18 Oct 2010 by Agusta Westland on the subject " Tail Rotor Pitch Change Mechanism Duplex Bearing Improvement", should be made mandatory to ensure the greasing of the Duplex Bearings at short intervals through grease nipples provided in the Support Sleeve and thereby, avoid opening of the Duplex Bearing Assembly periodically for greasing.

**4.4** Agusta 109 series helicopter operators be advised to include Part I & II Instructions contained in Tech Bulletin No.109-134 dtd 21 Sep 2012 (pertaining to the availability of both safety Locking wires securing the Ring Nut with Support Sleeve) in the respective checklists.

**4.5** Approved Before First Flight Schedule (BFF) does not specifically mention about inspection point "to check the security of locking of the Duplex Bearing Ring Nut". Since post accident deliberations established its importance to be so vital; inclusion of the point of inspection of the presence of locking wire in the BFF schedule could prevent such future occurrences.

**4.6** Helicopters in use for VIP airlifts, irrespective of the weight category may be fitted with CVR.

**4.7** Use of Full Motion Simulators is recommended for practicing representative critical emergencies on A 109 series.



<b><u>Glossary</u></b>	
AAI	Airports Authority of India
approx	Approximately
AME	Aircraft Maintenance Engineer
ATC	Air Traffic Control
BFF	Before First Flight
BKN	Broken
C of A	Certificate of Airworthiness
C of R	Certificate of Registration
C.G	Centre of Gravity
CAR	Civil Aviation Requirement
CHPL	Commercial Helicopter Pilot License
CRM	Cockpit Resource Management
CVR	Cockpit Voice Recorder
DVOR	DME VOR
DGCA	Director General of Civil Aviation
DME	Distance Measuring Equipment
FDR	Flight Data Recorder
FIC	Flight Information Clearance
FLT	Flight
Ft	Feet
HPA	Hecta Pascal
Hrs.	Hours
IF	Instrument Flying
IFR	Instrument Flight Rules
IGE	In Ground Effect
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IR	Instrument Rating
IST	Indian Standard Time
kg	Kilogram

kHz	Kilo Hertz
km/h	Kilometer per hour
kts	Knots
LH	Left Hand
LLZ	Localizer
m	Meter
mb	Milli Bar
MR	Main Rotor
MGB	Main Gear Box
Met	Meteorology
MHz	Mega Hertz
MRB	Main Rotor Blade
NDB	Non Directional Beacon
NSOP	Non Schedule Operators Permit
PIC	Pilot in Command
RH	Right Hand
RWY	Runway
UTC	Universal Coordinated Time
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
Vne	Velocity Never Exceed
VOR	VHF Omni Directional Range
wt	Weight
yrs	Years