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GOVERNMENT OF INDIA

REPORT ON ACCIDENT TO
M/s PAWAN HANS DAUPHIN N3 HELICOPTER
VT-PWF
AT BOMBAY HIGH
ON 04/11/2015

AIRCRAFT ACCIDENT INVESTIGATION BUREAU
MINISTRY OF CIVIL AVIATION
NEW DELHI

Foreword

This document has been prepared based on the evidences collected during the investigation, discussions held with the post holders and involved personnel, replay of recorders and opinion from the experts.

The investigation has been carried out in accordance with Annex 13 to the convention on International Civil Aviation and under Rule 11 of the Aircraft (Investigation of Accidents and Incidents) Rules 2012 of India

This investigation is conducted not to apportion blame or to assess individual or collective responsibility. The sole objective is to draw lessons from this accident which may help to prevent such accidents in future.

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GLOSSARY

AIP	Aeronautical Information Publication
AME	Aircraft Maintenance Engineer
AMM	Aircraft Maintenance Manual
ATC	Air Traffic Control
BEA	Bureau ďenquêtes et ďAnalysis
CAP	Civil Aviation Publication
CAR	Civil Aviation Requirement
CPL	Commercial Pilot License
CVR	Cockpit Voice Recorder
DGCA	Directorate General of Civil Aviation
EASA	European Aviation Safety Agency
ELT	Emergency Locator Transmitter
FDR	Flight Data Recorder
FIR	Flight Information Region
GPS	Global Positioning System
HUMS	Health and Usage Monitoring System
IFR	Instrument Flying Rules
ISO	International Organisation for Standardisation
MGB	Main Gear Box
NDB	Non Directional Beacon
NTSB	National Transport Safety Board
NSOP	Non-Schedule Operator Permit
ONGC	Oil and Natural Gas Corporation
PIC	Pilot In Command
QNH	Query: Nautical Height
QHSE	Quality Health Safety and Environment
OHSAS	Occupational Health and Safety Assessment Series
ROC	Rate of Climb
ROD	Rate of Descent
SOP	Standard Operating Procedures
TRE	Type Rated Examiner
TRI	Type Rated Instructor

UTC	Co-ordinated Universal Time
VFR	Visual Flight Rules
VHF	Very High Frequency
VOR	VHF Omnidirectional Range

Synopsis

Pawan Hans Limited Dauphin AS 365 N3 helicopter VT-PWF was involved in an accident while operating a night training flight on 4th November 2015 from WIS platform to a rig (RonTappmeyer). The pilot flying was a CHPL holder occupying the right hand seat and undergoing night off-shore training with an instructor PIC occupying the left hand seat. There were no passengers on board.

The helicopter departed from Juhu at 1703 IST with 05 persons and 700 kgs of fuel on board and was to be designated as standby for Casualty Evacuation (Night Ambulance). It was supposed to be parked in Bombay high (WIS platform) for the night.

The flight from Juhu to WIS platform was uneventful and the helicopter landed at 1804 IST. No snag was reported by the flight crew to the engineering person (AME). As planned the crew after landing discussed among themselves and decided for the training flight (night training) at 1900 hrs IST.

The helicopter took off from WIS helipad at 1910 hrs.The helicopter was planned to land first at Ron Tappmeyer Rig attached to EE platform in South Field and then to floating platform Sewak. The helicopter made an approach to land on Ron Tappmeyer but as the helicopter was high on approach, it made a go around and banked to the left. Simultaneously it descended and few seconds later the helicopter crashed into the sea and was destroyed. Both the flight crew members received fatal injuries.

Government of India vide notification no AV-15029/115/2015-DG ordered investigation of the subject accident by a Committee of Inquiry. (The intimation of the accident was provided to ICAO, TSB Canada, BEA France and NTSB USA as per the requirements of ICAO Annexure 13).

1.0 FACTUAL INFORMATION

1.1 History of Flight

Pawan Hans Limited Dauphin AS 365 N3 helicopter VT-PWF was involved in an accident while operating a night training flight on 4th November 2015 from WIS platform to a rig (Ron Tappmeyer). The pilot flying was a CHPL holder occupying the right hand seat and undergoing night off-shore training with an instructor PIC occupying the left hand seat. There were no passengers on board. The helicopter crashed into sea and was destroyed. Both the flight crew members received fatal injuries.

On 3rd November 2015, the involved flight crew was informed about roster of the flight which was as per the published flight schedule. The flight crew prior to operating the flight from Juhu had undergone Pre-Flight Medical Examination (PFME) including the breath analyser test at the PHL facilities. The weather at Juhu at the time of departure was, visibility 3 km in haze and at offshore location visibility of 5000 m, temperature 29 degree centigrade, wind direction 250°, wind speed 28 knots & QNH as 1005.

The flight plan from Juhu was filed to fly the route under VFR conditions at 3000 feet AGL with endurance of 02.15 hours. The helicopter departed from Juhu at 1703 IST with 05 persons and 700 kgs of fuel on board. The helicopter was flown from Juhu helipad (ONGC base) to the offshore WIS platform SLQ and the helicopter was designated as standby for Casualty Evacuation (Night Ambulance). It was parked in Bombay high (WIS platform) for the night.

The route followed by the helicopter was VAJJ – SCA – ICD – WIS. The flight from Juhu to WIS platform was uneventful and the helicopter landed at 1804 IST. No snag was reported by the flight crew to the engineering person (AME).

PHL had requested ONGC for permission regarding carrying out night training flight (recency) of one of the crew members on the night of 4th of

November 2015. The crew after landing discussed among themselves and decided for the training flight at 1900 hrs IST.

Refueling was carried out after landing at WIS platform and total fuel on board prior to the training flight was 790 kgs as per the gauge. Fuel sample was also taken and checked. There was no abnormality. Both the flight crew members after carrying out check and obtaining clearance from the SLQ radio officer started the engines. The clearance to start the engines was also given by the AME. However as per the AME he was not having any flight plan/ schedule of the night flying to be carried out. The AME was verbally informed by the flight crew that they will be landing back at WIS within 30-45 minutes. No flight acceptance certificate is given/ taken or retained at platforms or offshore.

Radio Officer (ONGC), SLQ platform on duty was aware that medevac helicopter will do night flying and practice landings. Accordingly he had informed vessel Samudra-Sevak (location east of SCA) and rig Ron Tappmeyer (location EE platform) that the helicopter will carry out night practice landings. Samudra Sevak was in open location and without any obstructions for landing. The flight crew was also informed about readiness of SEVAK and Ron Tappmeyer.

The helicopter took off from WIS helipad at 1910 hrs. At the time of take-off, the weather information (winds) communicated to the flight crew was 015°/10 knots. The information was copied by the flight crew.

The helicopter was planned to land first at Ron Tappmeyer Rig attached to EE platform in South Field and then to Sewak. While clearing the helicopter to land at Ron Tappmeyer, winds communicated to the flight crew were 10 to 12 knots with a direction of 020°.

The helicopter made an approach to land on Ron Tappmeyer but as the helicopter was high on approach, it made a go around and banked to the left. Simultaneously it descended and few seconds later the helicopter crashed into the sea.

Search and Rescue operation was launched under the control of Coast Guard. The debris of the helicopter was located on 09^{th} of November 2015. While body of trainee flight crew was found strapped up with the Captain seat when the helicopter was winched out of the Sea, body of the instructor was missing and is yet to be located. His seat belt was found to be in locked position and the shoulder straps were free.

Government of India vide notification no AV-15029/115/2015-DG ordered investigation of the subject accident by a Committee of Inquiry. (The intimation of the accident was provided to ICAO, TSB Canada, BEA France and NTSB USA by AAIB India as per the requirements of ICAO Annexure 13).

1.2 Injuries to Persons

INJURIES	**CREW**	**PASSENGERS**	**OTHERS**
FATAL	2	Nil	Nil
SERIOUS	Nil	Nil	Nil
MINOR/ NONE	Nil	Nil	

1.3 Damage to Helicopter

The helicopter was totally destroyed as a result of the impact with the water. The wreckage was self contained & the main parts/ components were recovered in one go from deep sea on 9th November 2015.

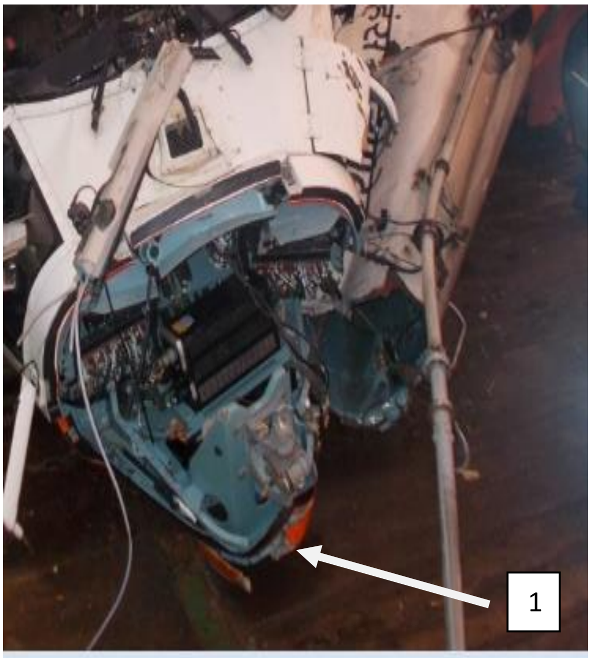
The retrieved wreckage contained front lower structure including the instrument panel and the centre console; Main Rotor Hub (MRH) and Main Gear Box (MGB) installed on the transmission deck; the engines; aft structure including tail boom assembly; and tail rotor with fenestron. The wreckage after retrieval was transported to Juhu by road. It was laid down at the PHL facility for analysis of damages in detail. The wreckage was examined at Juhu and a team of experts through BEA France who has appointed an accredited representative to associate with the investigation as per ICAO Annex 13 was requested to associate in the wreckage examination from the investigation point of view. Committee along with BEA carried out examination of the wreckage. Experts from the Manufacturer were also associated to pin point the pattern of breakage of the structure and analyse tell tale signs if any from the wreckage.

BEA had submitted a wreckage examination report which has been used in this report and extracts have been incorporated. Observations received from BEA on main rotor drive system, main rotor including blades, tail rotor drive system, tail rotor, tail rotor controls, flight control, engines including magnetic plugs, filters and BSI etc. are detailed in additional information.

MAIN ROTOR BLADES

Observations from wreckage at Juhu

In the area of the front lower structure, the components like Radome and lower panels are destroyed. Nose landing gear, co-pilot's door and passenger’s doors are disconnected. The maximum damage occurred on the left side indicating impact from outside. The structure behind the centre console is totally destroyed with floor totally broken and deformed.



1. DAMAGED RADOME
2. INSTRUMENT PANEL (REAR)
3. DAMAGED PILOT DOOR

The instrument panel had shifted backwards during impact though complete console is in position. The co-pilot’s door is totally destroyed and the damage matches with that on the left side of the structure. The front right passenger’s door is though available in full with some deformations but its window is missing. Both the rear passenger’s doors are available with left passenger’s door broken in its lower part.

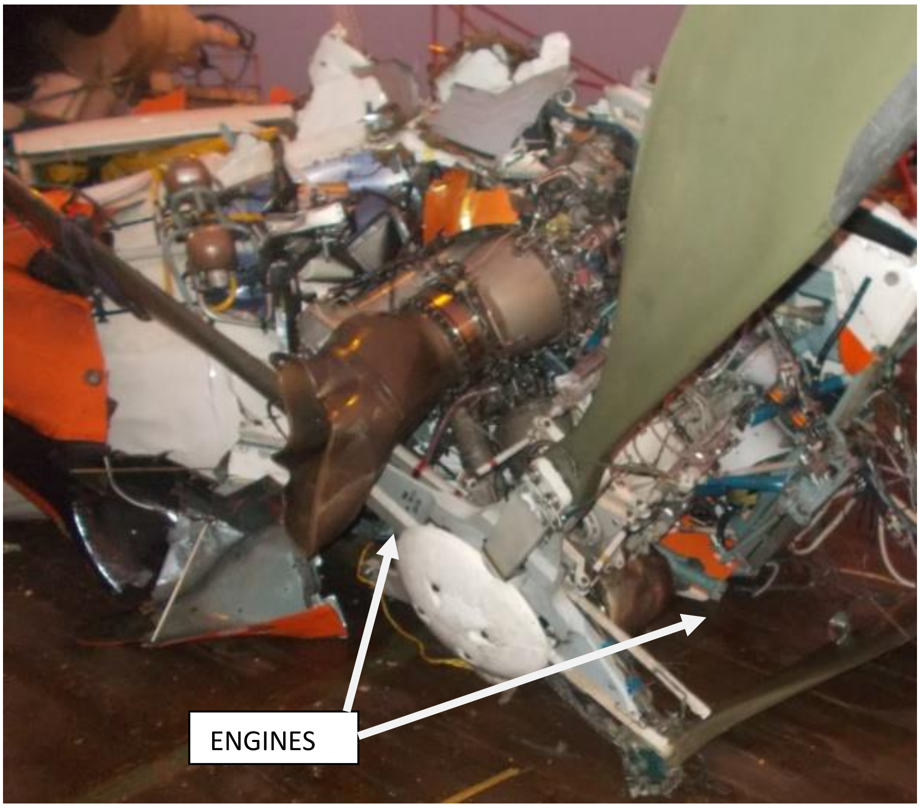
When the wreckage was recovered from the sea, the main rotor was connected to the main gear box. All the four blade root ends were connected though only portion of blades were available. Three blades (red, blue and yellow blades) had almost similar length available and the fourth blade (black blade) portion available was of shorter length. The main gear box was attached to the transmission deck with all the linkages in place.

The rear area of the aft structure and the tail boom is complete though has deformations whereas the lower part of front area of the aft structure is totally destroyed and deformed. The upper fairings are complete with little deformation. The tail rotor drive shaft is connected to the aft structure by its bearing supports. The shaft is complete though with a little bending deformation. The front part of the tail rotor control shaft is not in position on the tail boom. The flight recorder is in position in the tail boom. The area of the tail boom located in front of the recorder was cut for removing the flight data recorder.

The “left side of the horizontal stabilizer and left outboard fin” assembly is broken. On the right side, the lower outboard fin is broken. The right horizontal stabilizer and the rest of the outboard fin are in position without deformation. The rear part of the fenestron housing is broken. The rest of the fenestron is complete with the blades in position without visible deformation. The rear part of the tail rotor control shaft is connected at its rear end.

- The right horizontal stabilizer in Position
- The left horizontal stabilizer was broken

The two engines were near the main gear box (on retrieval of wreckage from sea).



1.4 Other Damage

Nil

1.5 Personnel Information

The flight was a training flight with an examiner occupying the left hand side seat and the trainee (pilot under check) was occupying the right hand side seat.

1.5.1 Pilot-in-Command

AGE	:	59 years
License	:	CHPL
Date of issue	:	11th April 1988
Valid upto	:	8th June 2017
Class	:	Multi engine land
Endorsements as PIC (on N3)	:	11th Nov. 2002
Medical valid upto	:	28th April 2016
Total flying experience	:	19588 hrs
Total flying experience -		
during last 180 days	:	375:49 Hrs
during last 90 days	:	210:44 Hrs
during last 30 days	:	56:14 Hrs
during last 07 Days	:	15:46 Hrs
during last 24 Hours	:	01:35 Hrs

1.5.2 Co-Pilot

AGE	:	59 years
License	:	CHPL
Date of Issue	:	10th May 2012
Valid upto	:	9th May 2017
Class	:	Multi engine land
Endorsements as PIC	:	25th June 2012
Date of Med. Exam	:	20th August 2015
Med. Exam valid upto	:	19th February 2016
Total flying experience	:	6700 hrs
Experience on type	:	4115:25 hrs
Experience as PIC on type	:	862 hrs
Total flying experience -		
during last 180 days	:	251:50 Hrs.
during last 90 days	:	155:55 Hrs.
during last 30 days	:	67:47 Hrs.
during last 07 Days	:	14:15 Hrs.
during last 24 Hours	:	1:35 Hrs.

1.6 Aircraft Information

The helicopter was operated under Non scheduled operator’s Permit No. 02/1998 which is valid up to 15th March 2017. Dauphin N3 helicopter is a twin engine helicopter and the involved helicopter bearing serial number 6946 was manufactured by Euro copter in the year 2011. It is ONGC AS4 compliant helicopter and has flown about 3255 hrs (approx) since new. The helicopter was fitted with all the equipment required for IFR and offshore flying as per DGCA requirements e.g. CVR/FDR, ELT, autopilot, weather radar, automatic flotation gear inflation mechanism etc. It was also fully equipped for night ambulance task.

The helicopter has undergone 5T (3000 hours/ 06 years) inspection at Mumbai on 14-09-2015 at 3057.50 airframe hours. Subsequent to 5T inspection there was no major defect reported on the helicopter. Subsequently all lower inspections, after last flight inspection and pre-flight checks were carried out as and when due before the accident. It is approved in the "Normal" category under Sub-division "Passenger Aircraft" and there is no restriction of service life.

Certificate of Registration No. 4310, under Category "A" was issued on 26.03.2012. The certificate of Airworthiness Number 6419 was issued by DGCA on 26.03.2012 specifying minimum number of flight crew as two. The helicopter was issued an Airworthiness Review Certificate by the DGCA on 19-03-2015 at Mumbai.

In Medevac configuration, the middle rows of seats and RH forward twin seats are removed to facilitate installation of medical equipment comprising of oxygen cylinder, suction unit, multipurpose monitor, emergency ventilator, infusion pump, de-fibrillator, housekeeping kit, accessary kit and a stretcher.

The maximum operating height under IFR conditions is 15000 feet and maximum takeoff weight is 4300 kgs. Fuselage length is 12.808 meter. Width of the helicopter is 3.255 meter and height is 3.808 meters (fin).

The helicopter and the engines were being maintained under continuous maintenance program consisting of calendar period based maintenance and Flying Hours/Cycles based maintenance.

The helicopter was last weighed on 03.10.2011 at Eurocopter, France by manufacturers and was recomputed at Mumbai on 30/03/2012. As per the approved weight schedule the Empty weight is 2808.31 kgs. Maximum Fuel capacity is 915 kgs. Maximum permissible load with 2 Pilots, Fuel and Oil tank full is 425.69 kgs.

Empty weight CG is 4.127 meters aft of reference in off-shore configuration. As there has not been any major modification affecting weight & balance since last weighing, hence the next weighing would have fallen due on 02.10.2016.

Turn around Inspections are carried out as per approved “Turn Around Inspection schedules” and all the higher inspection including checks/ inspection as per the manufacturer’s guidelines as specified in “MSM” (Master Servicing Manual). The last fuel microbiological test was done on 17.08.2015 at DGCA approved facility and the colony count was within acceptable limits.

LH Engine S.No. 24524 had logged 4325:50 Engine Hrs, 6944.10 Ng cycles and 2202.50 FT cycles respectively. The RH Engine S. No. 24540 had logged 4100:25 Hrs with 7188.70 Ng cycles and 2057.90 FT cycles respectively.

Details of four main rotor blades are

S/No.	PART NO	SERIAL NO	COMPONENT HOURS
1.	365A11-0050-09	11483	3384:14
2.	365A11-0050-08	9932	5191:35
3.	365A11-0050-08	9111	6311:12
4.	365A11-0050-08	9565	6418:37

The emergency floatation gear used for ditching purposes includes four inflatable floats forming two assemblies located on each side of the helicopter. Each assembly consists of one spherical float and one cylindrical float. There is one inflation system for each assembly, including one cylinder fitted with a pressure gauge visible from outside of the helicopter, a two frangible disks electrical head and two flexible hoses connected to the floats.

There is an immersion detection system that provides the automatic percussion of the floating when the helicopter is laid down on water. For inflation of the float system, emergency float switch should be in ARM position.

1.7 Meteorological Information

Weather at Mumbai and crash site was reported ‘good’ with good visibility. The winds were 10 knots / 020 degrees. QNH was 1010. There was no clouding in the area.

1.8 Aids to Navigation

The helicopter was equipped with VHF, VOR, NDB, ATC transponder, Radio altimeter, weather radar and GPS. There was no snag reported on any of the above equipments and were serviceable. In addition the helicopter was equipped with AIS for monitoring purposes as per the requirements of ONGC.

The rig ron tappmeyer, SLQ and vessel Sevak are having NDB with 317 Khz, 348 Khz and 350 Khz respectively. All these beacons were functioning satisfactorily.

1.9 Communications

There was always two way communications between the helicopter and ground station(s). Neither the CVR replay nor the AIS replay has indicated any problems faced by the flight crew regarding communication.

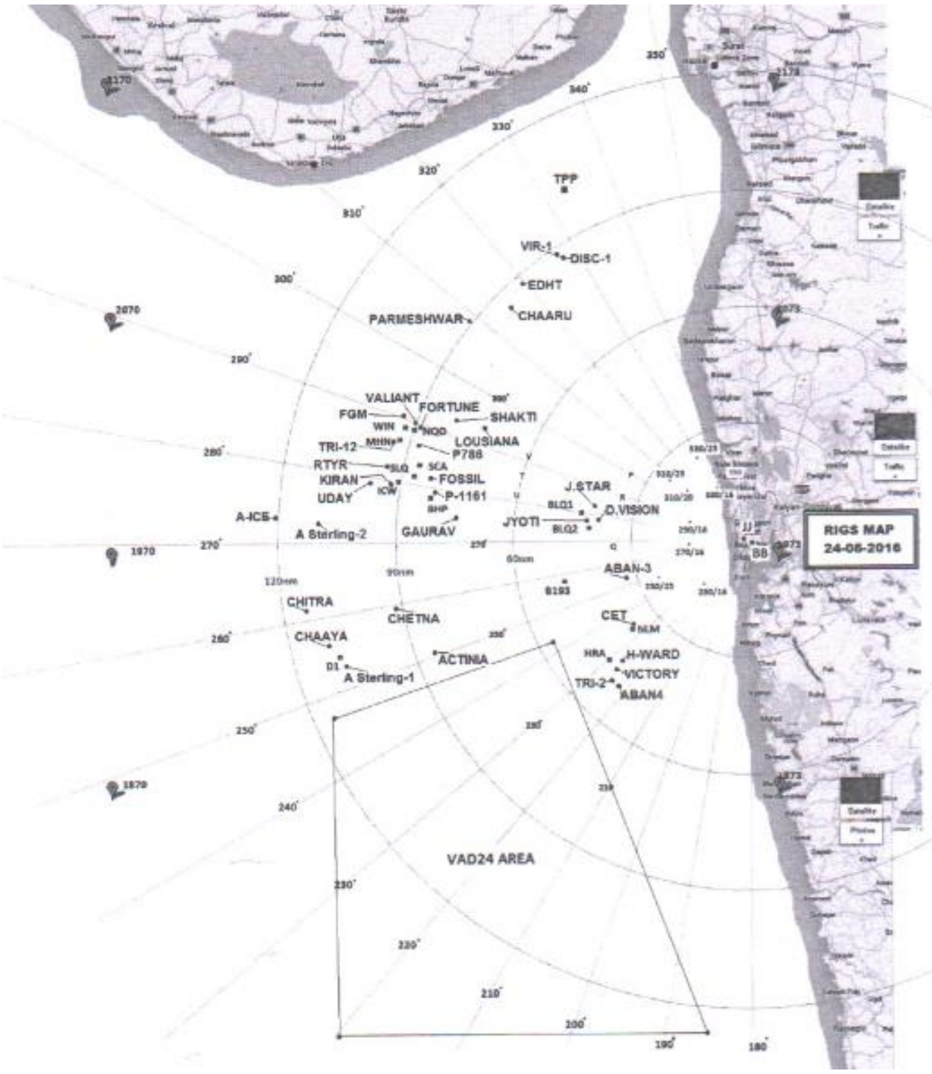
1.10 Aerodrome Information

The helicopter had crashed into sea in the Mumbai offshore area where ONGC oil platforms are located.

These fields are located 180 kms from Mumbai in the direction of about 285 degrees approx. In South Field there are four major processing plants SCA, SLQ, ICD and SHQ. There are various small unmanned oil platforms and four to five rigs are stationed on these platforms for repair of oil wells.

The helicopter was tasked to carry out five practice circuit and landings on Ron Tappmeyer rig which is stationed on oil platform EE adjacent to SHQ.

The particular area is called the South Field area and the chart depiction of the various platforms is given below:

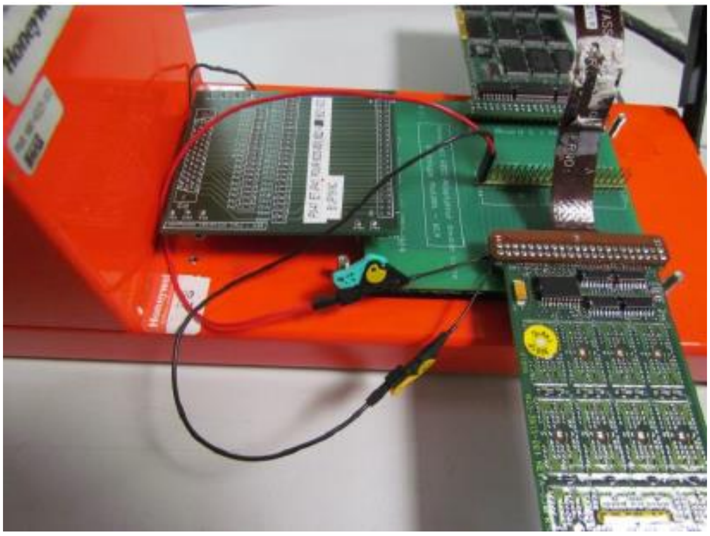


1.11 Flight Recorders

The helicopter was equipped with a Honeywell 6021 combined flight recorder bearing part number as 980-6021-066 & Serial Number 706. As the recorder was in sea for a prolonged period it was decided to take the opinion of BEA France regarding its readout. In association with the experts from BEA France, it was decided to make an attempt to first open the unit at DGCA India, CVR/FDR lab.

On external examination, no damage was observed on the unit. It was decided to remove the CSMU from the chassis and to extract the memory support. On opening CSMU, the white thermal protective powder inside the unit was found wet. The electronic boards were separated to check the status of the memory components between the boards. The memory support was found exposed to water. The memory components were in a good physical condition but were also exposed to water. As the connector was broken (two pins), it was decided to explore the further options in BEA laboratory to perform the download of the data.

The further actions were taken at BEA avionics laboratory and BEA has submitted a report to the Committee. As per the report, the memory boards were first cleaned with demineralized water and then with alcohol. The boards were dried in an oven. After drying, electrical tests were performed to check the electrical continuity of the boards. The tests values were consistent with reference values provided by the manufacturer.



A download was attempted on a golden chassis with the manufacturer ground station (RPGSE), using BEA interconnection board and BEA customizable connector. The connection of the two broken pins was made by using two micro clips on the base of the pins. Four CVR files and a .dlu file was downloaded containing FDR data.

CVR tape transcript was prepared for the relevant portion of the recording. The information was used for investigation and has been discussed in the analysis portion.

Spectrum analysis of the recording was carried out by BEA to evaluate the condition of the VT-PWF propulsion system and identify any acoustic anomalies that might have been recorded. The gist of the report of BEA is given at “1.18 Additional Information”.

The .dru file containing the parameters was synchronized to have the engineering values. As the time parameter was not available on the FDR data, in order to establish the flight chronology, the end of the recording T_0 was taken as reference time and events described compared to that reference T_0. The findings of the report are at “1.18 Additional Information”.

1.11.1 Health & Usage Monitoring System (HUMS)

The helicopter was installed with the HUMS to monitor the health of the engines. The system gathers USAGE and HEALTH data of the engines including MGB over torque, engines exceedance (T4, NG, NF…), NR exceedance for different flight configurations which is stored on PCMCIA cards. Recording of flight starts when either NG1 or NG2 increase over 11% and ends when both NG1 & NG2 decreases below 11% and NR decreases below 30%. However, if the flight is not closed properly, the data of the flight is not transferred and recorded in the HUMS card.

Externally, the three HUMS cards appeared to be in good condition. They were heavily exposed to salty water following the accident. The Committee decided to explore the possibility of extracting data from these cards at BEA facilities.

BEA after drying the three HUMS cards for more than 48 hours connected these to a manufacturer Ground Station (Computer) using a PCMCIA card reader. None of them was detected by the computer. On Linux and Windows OS, attempts to retrieve the data were also unsuccessful.

1.12 Wreckage and Impact Information

When the wreckage was recovered from the sea, the main rotor was connected to the main gear box and was equipped with four blade fragments. The main gear box was complete with the rods and the servo-controls in position. The suspension bars and the two laminated elastomer stops were destroyed. The four blades were broken with several fragments missing especially the end of each blade. The main rotor controls were continuous before the impact.

1.13 Medical and Pathological Information

Pre-flight Medical examination of both the cockpit crew members alongwith the breath-analyzer test was carried out. They were found fit to fly and the breath-analyzer test was negative.

One of the bodies was retrieved and post mortem examination was carried out. As per the report, “most probable opinion as to cause of death is asphyxia due to drowning”.

The other body is still not traceable.

1.14 Fire

There was no fire.

1.15 Survival Aspects

The accident was not survivable.

1.16 Tests and Research

Nil

1.17 Organizational and Management Information

1.17.1 Pawan Hans Limited

PHL was incorporated in October, 1985. It is a non-scheduled air transport operator with valid NSOP and is engaged in helicopter charter operations. It gives support to petroleum sector mainly ONGC, connecting difficult areas in the North and North East, travel tourism and intra city transportation. The company carries out operations and maintenance contract of helicopters across the country. The Board of Directors is the apex body and its normal operations are overseen by the CMD. The Accountable Manager of PHL as per the various Manuals and documents is a person with finance background and is positioned in Delhi.

The helicopters based at Juhu, Mumbai undertake crew change service of ONGC and production sorties in Mumbai off-shore. In addition, PHL also provides helicopter for medical causality evacuation for which one helicopter is parked at SLQ processing plant as Night Ambulance.

- **Chief pilot:**

PHL, being a large organization, is working with three Regions namely western Region (WR, Juhu), Northern Region (NR, Safdarjung Airport) and Eastern Region (ER, Guwahati). In the approved organization of WR and NR, (ER is under raising), there is a JGM (joint General Manager) level appointee who is a senior (Supervisor) pilot of at least one of the helicopters of the fleet and performs all the duties of HOD (operations). He is responsible for the overall operations related aspects of the Region. He is assisted by other Managerial level pilots who are appointed for training, safety, planning and Co-ordinations etc.

The HOD Operations of the region is looking after all the aspects that are looked after by the Chief pilot.

- **Training Manual**

PHL (WR) has provided a photocopy of the training Manual (volume 4 of the operations Manual, old format) which was not having any date of issue and as per PHL the Manual was approved by the DGCA in as it is condition. This was the only version available with them. It was also informed that there were no amendments made to the Manual but a revised Operations Manual (part IV – Training Manual) in the new format has been submitted to DGCA for approval. Northern and Western region has training captains.

As per the existing training manual on the date of accident, the DGM (trg) / DGM (ops) of WR & NR respectively would be responsible for their respective type training. As a general instruction to the training personnel it is mentioned that they must,

> "Ensure that where weakness is identified these are concentrated upon. The purpose is not to fail a candidate

but to teach and correct him, avoiding over criticism and the undermining his self confidence. However where serious weaknesses are revealed and the candidate's ability is in doubt, then there must be no hesitation in recording a fail. "

- **Training Records**

PHL pilots undergo recurrent training at HATSOFF Training (P) Limited as per the service agreement dated July 2014. Last night flying was carried out by the co-pilot on 30.11.2014 and by the PIC on 31.8.2015. Total night flying by the co-pilot was 190 hrs approximately.

- **Flight Safety Department & Safety Management System**

The Flight Safety Manual and the Safety Management System Manuals have been prepared as per the DGCA requirements. The SMS Manual has been accepted by DGCA in October 2014. The Safety Policy has been signed and issued by the Accountable Manager.

- **Attrition of flight crew**

In one of the regulatory audits, it has been noted that there has been an attrition of 46 pilots since 1st January 2014 in PHL. This is over 30% of the average strength of pilots in the company. As on 21.12.2015, the company also has a shortfall of 34 pilots as per their internal planning parameters of the company with a shortfall of 21 pilots in the western region alone. The operations management staff at both the Northern & Western regions has also undergone major turnover in the period.

During discussions, it was informed that probable cause for attrition of pilots is better opportunities/ emoluments being offered by other Operators. In order to curtail attrition and bench-mark emoluments with industry, several measures are being introduced. These cover proposed increase in the license related allowances, narrowing the gap in emoluments between regular and contract Pilots through regularisation of contract Pilots after completion of 5 years with overall good performance, proposed increase in the minimum assured flying to cater to pilots with lower flying hours task, review of the promotion policy of pilots, increased insurance coverage and review of the overall emoluments structure comprising of fixed salary and variable allowances.

1.17.2 Oil & Natural Gas Commission (ONGC)

ONGC is the largest producer of crude oil and natural gas in India. It has an in-house service capability in all areas of Exploration and Production of oil & gas and related oil-field services. The Company operates with 27 Seismic crews, manages 250 onshore production installations, 215 offshore installations, 77 drilling (plus 31 hired) and 57 work-over rigs (plus 25 hired), owns and operates more than 28,139 kilometers of pipeline in India, including 4,500 kilometers of sub-sea pipelines.

As per their website, ONGC has implemented globally recognized QHSE management systems conforming to requirements of ISO 9001, OHSAS 18001 and ISO 14001 at ONGC facilities and certified by reputed certification agencies at all its operational units. Further website also claims that corporate guidelines on incident reporting, investigation and monitoring of recommendations has been developed and implemented for maintaining uniformity throughout the organization in line with international practice.

Coming to helicopter operations and aviation safety, ONGC had appointed DGM (AS) to look after Aviation Safety. Besides, aviation Safety, he is also responsible as HSE incharge at helibase. As per the organogram he reports to the Head (Air Logistics), helibase. He is not involved with day to day Operations and ONGC has a DGM (operations) who controls helicopter operation and interacts with operations (including pilot) of operator. Though he is not trained on any of the helicopters or on helidecks inspection, he is carrying out the following functions:

- Ensuring that pilots/ helicopters deployed by operators are as per ONGC AS 4 standard.
- Monitoring helicopter performance standards.
- Inspecting and auditing document of helicopter and carrying out physical check when helicopters are offered to ONGC for operation.

- Carrying out investigations whenever any incident/accident takes place.
- Ensuring continuous airworthiness of helicopters whenever helicopters are offered to ONGC after snags.
- To ensure compliance of instructions of DGCA India.
- To audit the documents of pilots and verify the suitability of pilots for adherence to ONGC Aviation policy and DGCA.
- To monitor and liaise with various Assets & Services and operators for implementations of observations received through Hazard Alert Cards.
- Inspect helidecks for its condition and safe operation of helicopters.

Another person who is acting as CM (logistics) has joined safety section recently (after the crash). In addition he is also responsible to DGM (ops.) for certain tasks and Head air logistics for additional tasks. There is nobody else in the Aviation Safety.

Helicopter operation between ONGC and helicopter operator is governed by terms and condition of written contract signed between them. ONGC has aviation standard AS4 for offshore helicopter operation and safety. Medevac is though defined in the contract signed between ONGC and PHL and PHL is also providing the helicopter for medevac purposes but is not one of the explicit requirements of the contract.

It was given to understand that ONGC has a system where in helicopter operators forward Hazard Alert cards (HAC) regarding the environment pertaining to safe helicopter operations. HACs and internal helideck inspection reports are then forwarded to various Asset Managers/ Installation Managers for complying those observations. HACs are forwarded to ONGC installation managers, compliance reports are received and then forwarded to respective operators.

ONGC had engaged a third party for carrying out audit of helicopter auditors (after the accident) which was completed in Mar 2016.

1.17.2.1 ONGC Radio Officer (Marine)

Duties of marine radio officer concerning aviation are not defined in any of the documents. Helicopter programme is made for in field flying (VFR). Traffic advisory is given when asked and also as and when required. If the helicopters are in the conflicting path, they are cautioned. Radio Officer is not in a position to ensure separation. No specific training for handling communication and traffic of helicopters is given to the radio officers.

There is no document indicating procedure of taking weather (off shore) and transmitting the same to flight crew. Instantaneous weather condition is displayed in the weather monitor which includes wind speed in knots, direction in degrees, barometric pressure in mili-bars and temperature in degree Celsius. Visibility and Cloud base are not included in the existing system.

Display from the weather monitor is read and as a practice is transmitted on the VHF radio to pilots. All the radio transmission and receptions are automatically recorded in the VOX computer with date and time stamp.

1.18 Additional Information

1.18.1 Offshore Operating Environment

In comparison to the operations from onshore airfields, offshore flight operations are a highly complex and specialised process. It requires high levels of training, competence and skill to plan a flight, to land and take off from an offshore installation and to consistently execute the task safely and efficiently under ‘normal’, good weather flying conditions. The skills of flight crew can be stretched, when an operation is carried out in adverse weather (e.g. poor visibility), during night flying or when any other predictable and/or unpredictable factor exists in and around the offshore installation or vessel.

Despite the many advances in aircraft technology, navigation, landing and communications aids in recent years, offshore helicopter crew have relatively little ground-based technology and fairly limited information to assist them as they commence their final approach for landing on an offshore helidecks. Similar is the situation when the helicopter is taking off.

Therefore, offshore helicopter crew has to rely heavily on their acquired skills and experience. Besides adherence to SOP is a must, when approaching, landing and taking off from offshore Installations.

1.18.1.1 Standard Operating Procedures

The offshore helicopter operate under non-scheduled operations and flies passengers and freight to a variety of fixed and mobile installations and vessels that are normally anchored on station or are moving. Normally standard procedures are to be followed by flight crew when approaching, landing and taking off from offshore helidecks/ platforms/ vessels. These procedures vary from helicopter to helicopter taking into consideration the handling characteristics, performance etc. The standard procedures should be finalized with the approval of chief Pilot of an organisation and it is to be seen during the Pilot's routine checks that these procedures are followed and are used for everyday operational flying.

In practice due to the large number of environmental variables likely to be encountered around offshore installations and vessels, individual Pilots tend to fly the approach, execute a landing and take-off, by slightly deviating from standard procedures. These deviations to standard procedures occur in response to sometimes extremely difficult flying conditions and are required to control the risks. For normal operations, such deviations are accepted practice and fall within the ultimate responsibility of flying crew for ensuring the safety of his helicopter and passengers.

Pawan Hans has issued an SOP for night ambulance operation wherein the aspects of requirements of helicopter, crew, training requirements for first officer and PIC and Medevac operations are as follows:

- **Co-pilot training and Clearance**

a) A total of 4 sorties of one hour each on fixed deck, rigs, floaters and Night let down, cross country, followed by one clearance sortie of one hr (total 05:00hrs).

b) After this training, a pilot is to be cleared for co-pilot duties for Night Ambulance.

Requirements for PIC training

a) He should have flown for one year/monsoon as a co-pilot.
b) He should have done at least 4 actual/simulated night med evac from Bombay High to Juhu.

Training Night Flying at Bombay High

Night flying for training and night currency including dark phase may be carried out on as required basis. However, it is to be planned in advance by including it in flying programme and ONGC informed accordingly, before the departure of the flight from Juhu.

Special points during Night Flying

In addition to the standard Night Flying Procedures the following points are to be kept in mind while carrying out night ambulance sortie:

a) Before landing on a Rig/Floater, a dummy circuit must be carried out.
b) During approach, pilot should not hesitate to go around, should he feel that speed/ROD in high.
c) Co-pilot must call out bank during turns and speed and ROD during approach for proceeding to pick up a casualty.
d) The Minimum aid, i.e. NDB must be available on the destination.
e) Any time during night flying if Captain feels disoriented. He should call it out and co-pilot to take over and bring the helicopter to the nearest landing place.

On the previous day i.e. 3rd Nov. 2015, night ambulance flight was operated by an instructor/ examiner as PIC. After reaching WIS at around 1745 hrs IST, night currency sortie for the co-pilot was carried out. The helicopter took off from WIS at 1850 hrs and proceeded to North field. Instrument flying was practiced for 15 minutes. The helicopter thereafter proceeded to rig Ron Tappmeyer (located at unmanned platform EE) and carried out 3 circuits / landings including one go around. Thereafter course was set for WIS and after carrying out 2 circuits the helicopter landed at WIS.

1.18.1.2 Helideck Safety - world-wide

CAP 437 re-named Standards for Offshore Helicopter Landing Areas has become an accepted world-wide source of reference on the subject. As per this periodic surveys are to be carried out during which minimum safety issues should be examined to confirm that there has been no deterioration in the condition of helicopter landing area.

In UK, guided by CAP 437, the helicopter operators have chosen to discharge the legal responsibility placed on them by accepting Helicopter Landing Area Certificates (HLACs) as a product of helideck inspections completed by the Helideck Certification Agency (HCA) in UK.

1.18.2 Helicopter Night VFR Operations (Effect of Lighting (on Seeing)) in Night VFR Helicopter Operations

The principles of lighting and seeing conditions are useful in any night VFR operation. While ceiling and visibility significantly affect safety in night VFR operations, lighting conditions also have a profound effect on safety. Even in conditions in which visibility and ceiling are determined to be visual meteorological conditions, the ability to discern unlighted or low contrast objects and terrain at night may be compromised. The ability to discern these objects and terrain is the seeing condition, and is related to the amount of natural and manmade lighting available.

In order to conduct operations safely, seeing conditions must be accounted for in the planning and execution of night VFR operations. Night VFR seeing conditions can be described by identifying “high lighting conditions” and “low lighting conditions.”

Some areas may be considered a high lighting environment only in specific circumstances. As a general good aviation practice and with the accumulation of night flying experience in a particular area, the crew/ operator develops the ability to determine, prior to departure, that which areas can be considered supporting high or low lighting conditions. Without that operational experience, low lighting considerations should be applied by operators for both pre-flight planning and operations until high lighting conditions are observed or determined to be regularly available.

1.18.3 DGCA Civil Aviation Requirements (CAR) on the subject

The DGCA CAR Section 8 Series H Part I dated 28 July 2014 on helicopter Operations covers Offshore Operations. It states the following (relevant to the subject accident):-

a) Offshore flying is undertaken in all weather conditions – by day as well as by night.
b) Offshore operations shall normally be restricted to VFR only.
c) Casualty evacuation operations from offshore facilities may be undertaken by night provided the helicopter is IFR cleared and the crew is specially cleared to undertake these operations.
d) The SOPs should clearly lay down entry and exit procedure, routing, RT / communications procedures.
e) Helideck information.
f) Sources for Weather Information.
g) Emergency Procedures.
h) Crew composition, qualification and currency.
i) The requirements for Offshore (Co-pilot and Command) training.

- The operator shall ensure that the pilot engaged in offshore operations has a thorough knowledge of the operating procedures and peculiarities concerning off shore operations.
- The Crew.
  - Qualification

  The crew should have successfully completed training and flown the release check as specified in Part 4 Subpart B for Offshore Operations (of the same CAR).

  - Currency

  All pilots, in addition to the currency requirements for flying commensurate with their experience, have completed in the last six months at least five hours of offshore flying including minimum three helideck landings. In case the currency has lapsed, the pilot will need to undergo a check sortie with a check pilot/ instructor/ examiner on type.

- Night Currency Check (General)

Pilots engaged in carriage of passengers by night shall carry out at least one route-flying check sortie by night including five take offs and landings in the preceding six months with an Examiner on type. The Performa for the check and guidelines to examiner are given in Part 5 of the said CAR.

- REFRESHER TRAINING

Helicopter Underwater Escape Training (HUET). All aircrew undertaking offshore operations shall undergo HUET once every three years.

- Night Flying Break Period More Than 180 Days But Less Than One Year (for pilots undertaking night casualty evacuation/ training/ regular passenger flying)
    - Undertake a sortie to include three take-offs and landings with TRE/ TRI before flying with passengers on board. OR Undertake one FFS sessions of not less than 0:45hrs successfully.
    - Applicable for pilots current on type by day but not current for night flying. If not current by day, he/ she would be required to undergo recency by 'day' first.
    - Should hold current IR on type for night casualty evacuation and passenger flying.

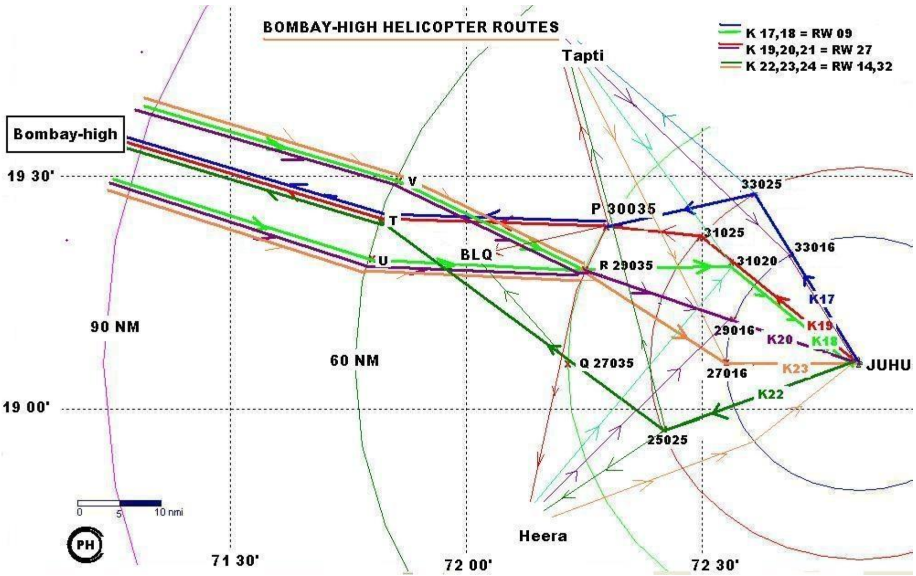
1.18.4 Helicopter Routing Mumbai/Juhu

The helicopter operators flying in the offshore as per the CAR Section 8, Series H, Part I should meet the following requirements:

- Offshore operations are normally restricted to VFR only. In addition, casualty evacuation operations from offshore facilities may be undertaken by night provided the helicopter is IFR cleared and the crew is specially cleared to undertake these operations.

- All helicopter operators wishing to operate in any offshore sector will liaise with other existing operators regularly operating in that sector, to formulate Sector SOPs in consonance with the SOPs being followed by these other operators. These SOPs should clearly lay down the following: -
    - Entry/ exit procedures;
    - Routing;
    - RT/ communications procedures;
    - Details of all helidecks/ landing platforms in the sector including dimensions, obstructions, facilities etc;
    - Sources for weather information;
    - Procedures to be followed in an emergency including communications failure; and
    - Any other relevant information.

AAI has issued an AIP Supplement 09/2010 regarding helicopter routing Mumbai/Juhu. In this AIP, helicopter VFR rules were established to streamline the flow of helicopter movement within Mumbai control zone to various helipads and Bombay High.



Bombay High helicopter routes

As per the available documents it appears that procedures for offshore flying (beyond 30 nm in the offshore and in the uncontrolled airspace), were formulated in April 2010, after mutual agreement by the helicopter operators at Juhu and operating offshore. These procedures covered the altitude, radial, ROC, ROD etc. to be followed while flying inter/intra field traffic (north, south field). These procedures were integrated with the routings given in AIP from Juhu.

1.18.5 AIS (Automatic Identification System) – tracking

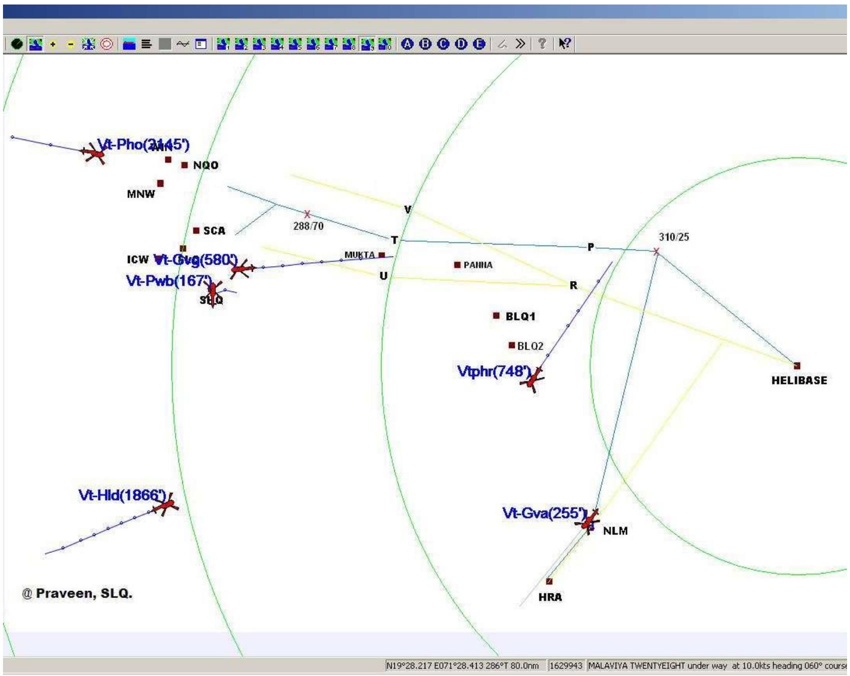
Automatic Identification System (AIS) is used by ONGC for tracking of ships in real time. ONGC has made it mandatory to have the equipments on helicopters serving offshore oilfield. The same system is also incorporated on helicopter flying over oceans engaged in search & rescue operations.

The system normally called AIS vessel tracking works in conjunction with radar and is the most significant from mariner's navigation safety point of view. It was originally used as a collision avoidance tool as it enables commercial ships to 'see' each other more clearly in any conditions and to improve the helmsman's information about the surrounding environment. AIS does this by continuously transmitting vessels' position, identity, speed and course, along with other relevant information, to all other AIS equipped vessels within range. Combined with a shore station, this system also offers port authorities and maritime safety bodies the ability to manage maritime traffic and reduce the hazards of marine navigation.

An AIS transceiver normally works in an autonomous and continuous mode, regardless of whether it is operating in the open seas or coastal or inland areas. AIS transceivers use two different frequencies, VHF maritime channels 87B (161.975 MHz) and 88B (162.025 MHz), and use 9.6 kbit/s Gaussian minimum shift keying (GMSK) modulation over 25 or 12.5 kHz channels using the High-level Data Link Control (HDLC) packet protocol.

Although only one radio channel is necessary, each station transmits and receives over two radio channels to avoid interference problems, and to allow channels to be shifted without communications loss from other ships. The system provides for automatic contention resolution between itself and other stations, and communications integrity is maintained even in overload situations.

Using suitable AIS receiver and plotting software it is possible to monitor & track all ships and helicopter equipped with AIS system in real time. Presently, ONGC is using software “Ship Plotter”. It displays Ships & helicopters operating in the oil field on a 2-dimensional map on the screen of computer. A screenshot showing the pictorial output is shown below:



1.18.6 Spatial Disorientation

Spatial orientation is defined as our natural ability to maintain our body orientation and/or posture in relation to the surrounding environment (physical space in three dimensions) at rest and during motion. Spatial disorientation or spatial unawareness is the inability of a person to correctly determine his/her body position in space. The three dimensional environment of flight is unfamiliar to the human body, creating sensory conflicts and illusions that causes spatial disorientation. Statistic shows that 5 to 10% of all general aviation accidents can be attributed to spatial disorientation, 90% of which are fatal.

Vicious spiral is a dangerous spiral dive entered into accidentally by a pilot who is in instrument flight when flying in instrument meteorological conditions (IMC). Such spirals are most common during night time or poor weather conditions where no horizon exists to provide visual correction for misleading inner-ear cues. This type of spiral consists of both physiological and physical components. Mechanical failure is often a result but generally not a causal factor, as it is the pilot’s sense of equilibrium which leads to the spiral dive.

Another type of illusion is repeating pattern illusion. This occurs when an aircraft is moving at very low altitude over a surface that has a regular repeating pattern, for example ripples on water. The pilot's eyes can misinterpret the altitude if each eye lines up different parts of the pattern rather than both eyes lining up on the same part. This leads to a large error in altitude perception, and any descent can result in impact with the surface. This illusion is of particular danger to helicopter pilots operating at a few metres altitude over calm water.

The vicious spiral is more common than the spin and it is associated with the return to the level flight following an intentional or unintentional prolonged bank turn. A pilot who enters the banking turn to the left will initially have a sensation of turn in the same direction. If the left turn continues for more than 20 seconds or more, the pilot will experience the sensation that the helicopter is turning and banking in the opposite direction (to the right). If the pilot believes the illusion of right turn (which can be very compelling), he will re-enter the original left turn in an attempt to counter act the sensation of a right turn. Unfortunately while this is happening the helicopter is still turning to the left and losing altitude. Pulling the control stick and applying the power while turning will make the left turn tighter. If the pilot fails to recognize this illusion and does not level the horizon the helicopter will continue turning left and losing altitude until it impacts the ground/sea.

1.18.7 Black Hole Illusion.

A Black-Hole Approach Illusion can happen during a final approach at night (no stars or moonlight) over water beyond which the horizon is not visible. When peripheral visual cues are not available to orient oneself relative to the earth, one may have the illusion of being upright and may perceive the surface to be tilted and upsloping. However, with the horizon visible one can easily orient correctly using ones central vision.

A particularly hazardous black-hole illusion involves approaching under conditions with no lights before the landing surface and with city lights or rising terrain beyond. Those conditions may produce the visual illusion of a high-approach perspective. If one believes this illusion he may respond by lowering the approach slope. One of the most difficult things to do under instrument conditions is to maintain a constant turn rate. One has to stop the disbelief and disregard what the brain is telling and focus on the instrument panel as what you see and feel is in conflict.

1.18.8 Salient Observations from Wreckage Examination (reference BEA report)

Committee along with BEA carried out examination of the wreckage. Experts from the Manufacturer were also associated to pin point the pattern of breakage of the structure and analyse tell tale signs if any from the wreckage. Observations received from BEA on main rotor drive system, main rotor including blades, tail rotor drive system, tail rotor, tail rotor controls, flight control, engines including magnetic plugs, filters and BSI etc. are as follows:

Main Rotor Drive System

The main gearbox was complete without perforation.

Note: This gearbox was not dismantled in the context of the investigation because of the findings made at the end of the wreckage initial examination and the flight data analysis.

The two “engine to main gearbox” couplings were broken:

- The left coupling was broken in the intermediate part of the coupling shaft. The fracture was static without damage prior to the accident. This was a consequence of the accident.

Rotational interference was identified on the outer surface of the coupling shaft. This observation showed that the left engine was running during the fracture sequence. This observation is consistent with parameters recorded on the FDR.

Part of the coupling linked with the main gearbox

Part of the coupling linked with the engine

Right "engine to gearbox" coupling

Joint at the intermediate flange

Joint at the output on the main gearbox

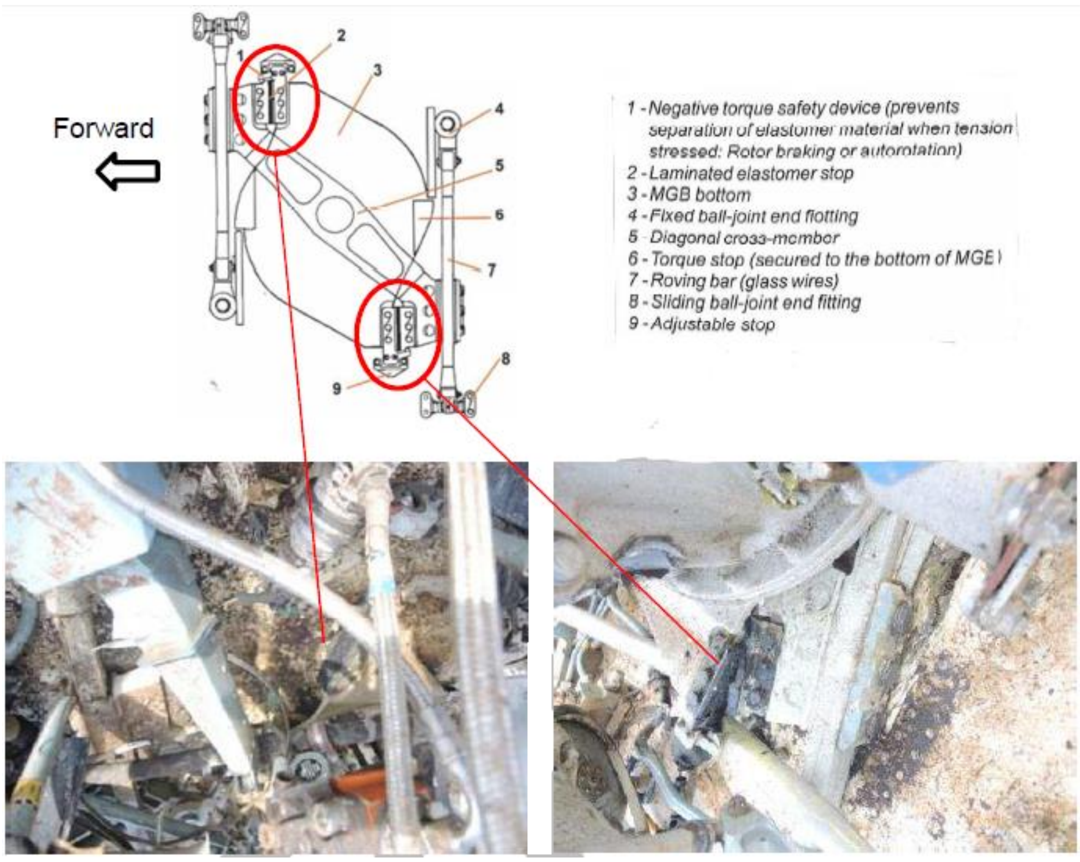
- The right coupling was broken at the MGB input flexible coupling and at the intermediate coupling flange. The fractures were static without damage prior to the accident.

Rotational interference was observed on the inner surface of the front fairing. This shows that the right engine was running during the fracture of the coupling. This observation is consistent with parameters recorded on the FDR.

The front left suspension bar was complete without distortion. The three other suspension bars were fractured statically without damage prior to the accident. This damage was a consequence of the accident.

Each suspension bar had its lower and upper joints in position.

The two laminated elastomer stops were fractured and the main gearbox had turned clockwise in relation to the structure. This damage was a consequence of the crash when the powered main rotor stopped suddenly due to impact with water.



Front laminated elastomer stop **Rear laminated elastomer stop**

Mast rotor

Main rotor

The components of the mast rotor were in position. The rotating and non-rotating swash-plates were in the lower position with a tilt to the right.

The star arm attached to the fractured black blade

The star arm associated to the black blade was fractured with an angle representative of load in the inertia direction.

The three other star arms were externally complete.

The star was nominally attached to the mast.

The outer ends of the blue blade attach beams were destroyed and the frequency adapter was separated but attached to the blade root.

On the other blades, the attach beams were complete but the frequency adapter flanges were distorted which was consistent with load resulting from the rotational energy during the blades impact with the water.

The pitch change rods, the rotating and fixed scissors, the servo controls were in position and correctly connected.

During the examination performed by the BEA, only one fragment of the black blade was in position on the main rotor head. The other fragments had been removed previously.

Outer ends of the blue blade attach beam

- The root of the black blade was in position on the main rotor head. The fragment still attached to the main rotor head was about 1 metre long.

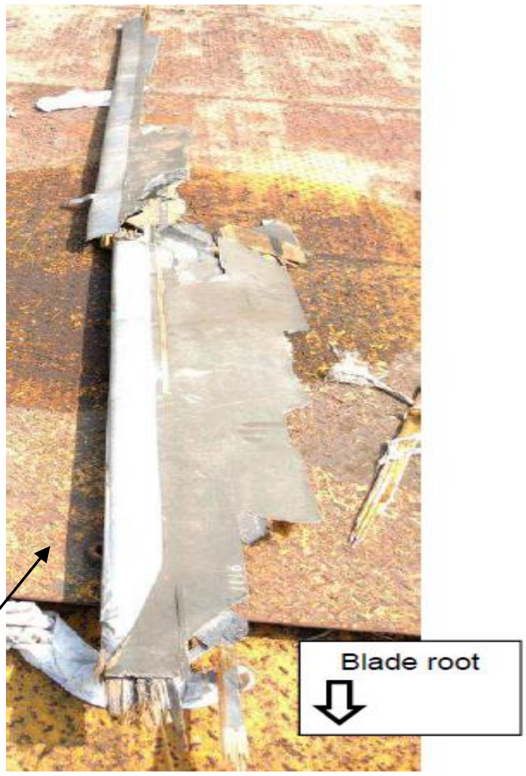
Two other fragments were identified among the debris.

The end of the black blade was missing.

On these fragments of the black blade, no impact was identified on the leading edge. The profile of this blade was destroyed from the root toward the end.

The fragment of the black blade attached to the rotor head

Others fragments of the black blade



Only one fragment of the blue blade was identified. This fragment was composed of the root of the blade and was about 2.4-2.5 metres long. On this fragment, the profile was complete and no impact marks were identified on the leading edge.

Blue blade – lower surface

- Only one fragment of the yellow blade was identified. This fragment was composed of the root of the blade and was about 2.6-2.7 metres long. On this fragment, the profile was complete and no impact marks were identified on the leading edge.

On the upper side, several cracks and several yellow marks were identified. The cracks were parallel to the leading edge and located at the centre of the profile and close to the leading edge.

The yellow marks were at about 1.2 metres from root of the blade.

Yellow blade - Lower surface

Yellow blade - Upper surface

Yellow marks identified on the upper surface

- Two fragments of the red blade were identified. The main fragment was composed of the blade root and was about 2.4-2.5 metres long. The other fragment was about 1.2 metres long.

  On the main fragment, the profile was complete and no impact was identified on the leading edge.

  On the other fragment, the profile was destroyed but no impact was identified on the rest of the leading edge.

Red blade - Lower surface

Red blade - Upper surface

Yellow marks identified on the upper surface

On the upper side, several cracks and several yellow marks were identified. The cracks were parallel to the leading edge and located at the centre of the profile and close to the leading edge.
The yellow traces were located about 1.6 metres from the blade root.

Note: On one picture taken by the Indian Authority, several yellow deposits are visible on a leading edge. During examinations made by the BEA, these deposits were not identified.

The condition of the blade fragments shows that the main rotor had significant energy (rotation and torque) during the impact with the sea.

Tail rotor drive system

The flexible coupling located at the tail rotor drive shaft output flange on the main gearbox was complete. The internal splines were not damaged.

Exit of the main gearbox toward the tail rotor drive

Internal splines

The front drive shaft was broken and its front part was missing. The shaft fracture was static without damage prior to the accident.

FORWARD

Broken front drive shaft

The flexible coupling between the front drive shaft and the centre drive shaft was destroyed by overload.

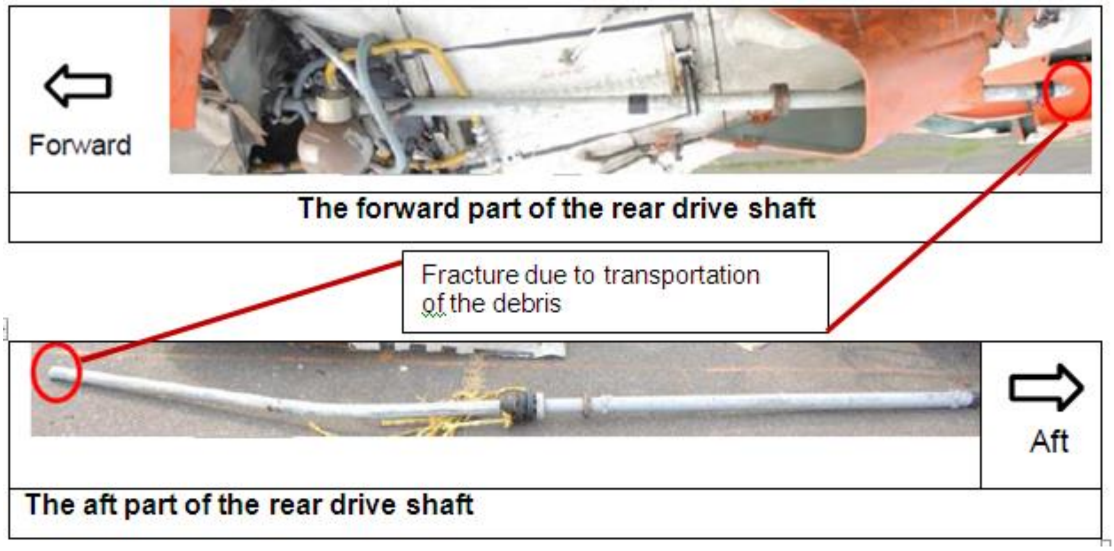
Forward

Flexible coupling between the front drive shaft and the centre drive shaft

The rear drive shaft was broken in its centre area and bent. The fact that the shaft was complete on recovery from the sea indicated that the shaft fracture identified by the BEA was a consequence of transportation of the debris.

The splined end fitting was either not damaged or only superficially.

All bearings were extracted from their clamps. The bearings were corroded due to contact with salt water.



Splined end fitting

The TGB forward attachment coupling shaft was in position and complete.

The input housing of the TGB was disconnected from the main housing and had been pushed toward the rear.

Tail rotor

All of the tail rotor blades were in position on the hub. One blade was fractured by bending close to its root.

Left side of the tail rotor Picture **The rear side of the tail rotor**

Scuffing identified on the fenestron duct **Scuffing identified on the fenestron duct**

Several rotational interferences were identified on the fenestron duct due to contact with the blades. This observation showed that the fenestron was rotating when the structure of the tail rotor began to be damaged and deformed.

Flight controls

Main rotor controls

For easier understanding, the rods and the bellcranks are identified arbitrarily in the diagram below (rods identified from R1 to R18 / bellcranks identified from B1 to B10) with the position of damage.

The pilot's and copilot's cyclic pitch control sticks were in position and complete. These sticks were connected to each other.

The pilot's collective pitch lever was in position and complete whereas the copilot's lever on the left was disconnected from the structure.

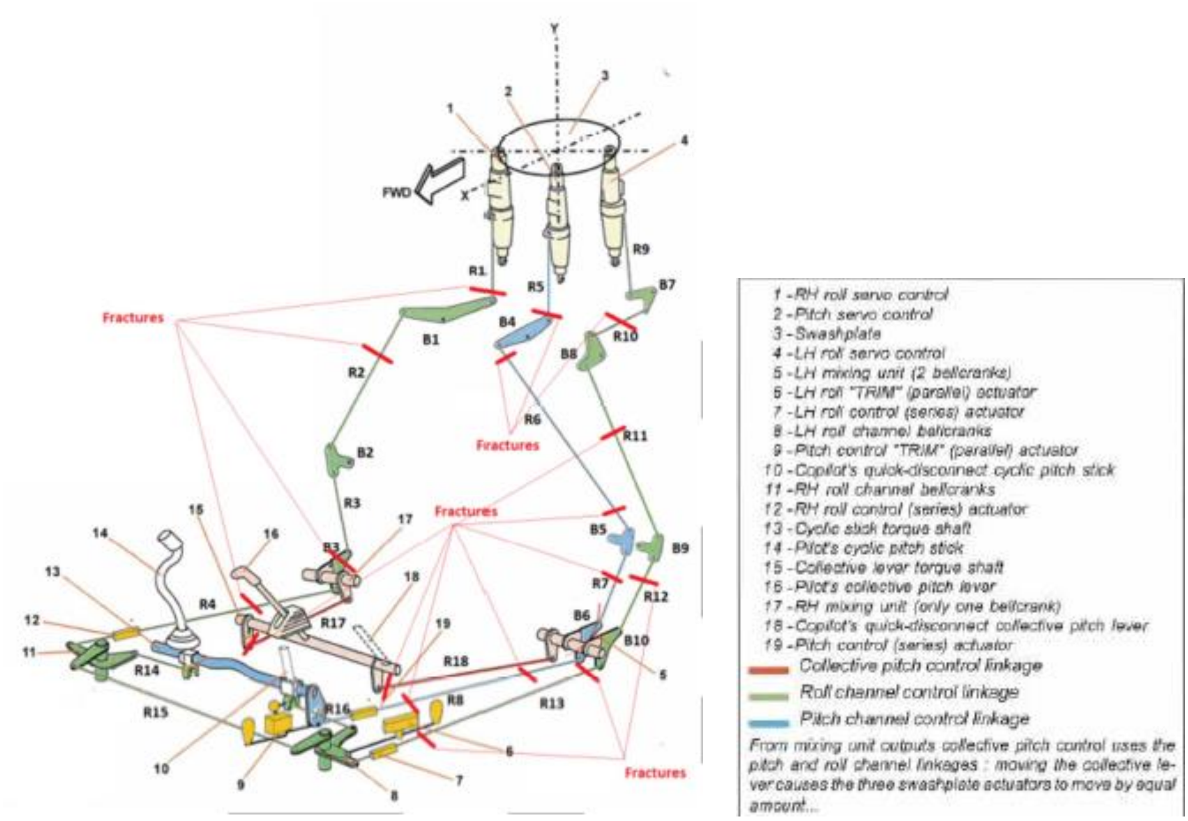


Diagram of the flight controls

In the right side, damage identified was as follows; the other components were complete and connected to the structure. All fractures identified were the consequence of an overload (static fractures) without damage prior to the accident.

- rod R4 broken
- RH mixing unit disconnected from the structure and the bellcrank was broken
- rod R2 broken;
- rod R1 broken close to the rod end and the bellcrank B1;
- rod end R17 broken on the collective lever torque shaft

FRACTURE

Broken rod R4

Broken bellcrank B3

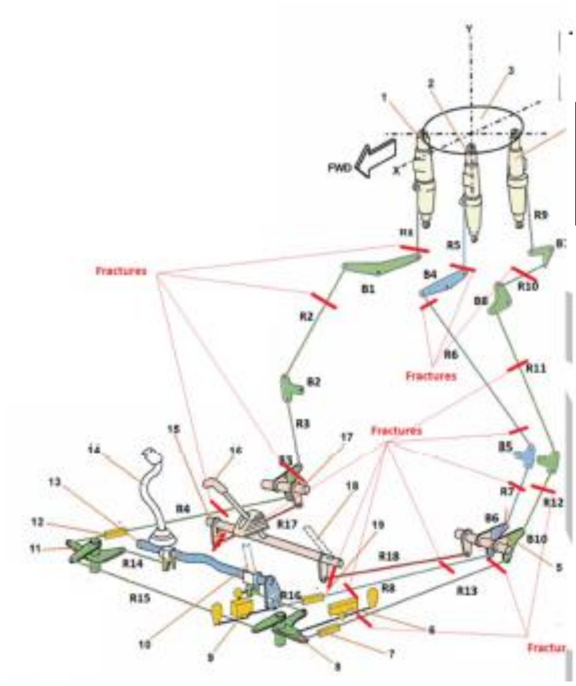
Broken rod R17 and RH mixing unit disconnected from the structure

On the left side, damage identified was as follows, the other components were complete and connected to the structure. All fractures identified were the consequence of overload (static fractures) without damage prior to the accident.

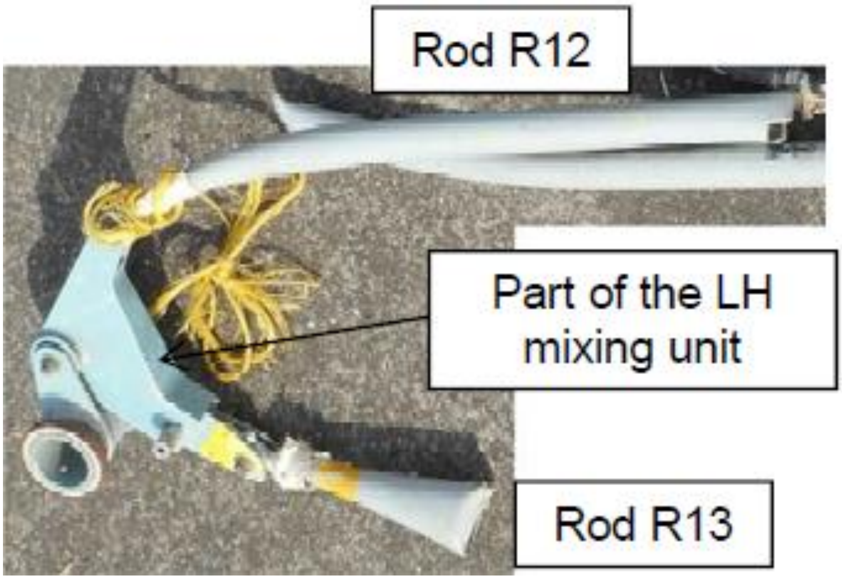
- rod R13 broken twice after the LH roll control actuator and close to the bellcrank B10;
- rod R8 broken twice after the pitch control actuator and close to the bellcrank B6;

- LH mixing unit totally destroyed and disconnected from the structure;
- Bellcranks B5 and B9 connected to a fragment of the structure.
  (On each bellcrank, two fragments of rod were connected; R7, R8, R12 and R13.)
- rod R6 broken twice;
- rod R5 broken close to the lower rod end;
- rods R10 and R11 broken.

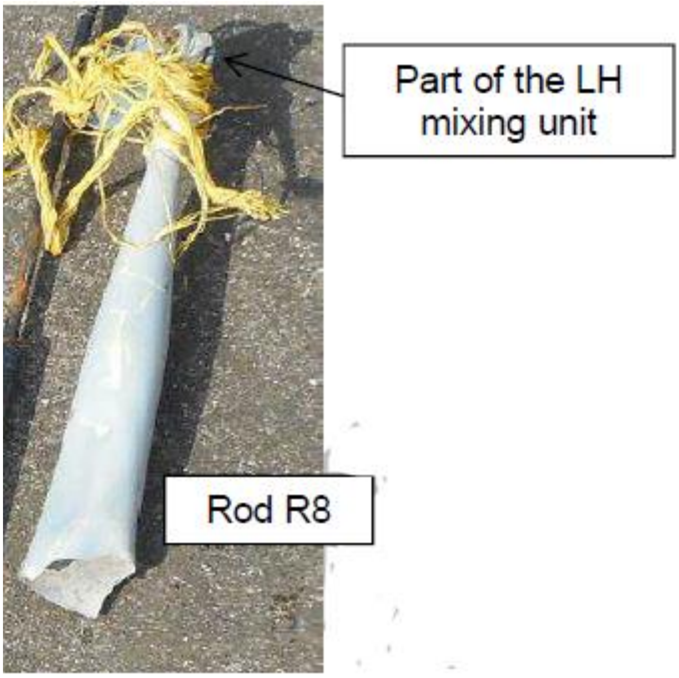
Fragments of rods R6, R8 and R13 were missing.



Front controls on the left side



Parts of controls probably on the left side



Part of controls on the left side

To conclude, the main rotor controls were clearly continuous before the impact. This observation was consistent with parameters recorded on the FDR.

Tail rotor controls

The parts of the tail rotor controls checked in the wreckage are indicated on the diagram below. The other parts were not examined because access was too difficult or the area had been totally destroyed during the accident.

Several fractures were identified on the controls. All fractures observed were the consequence of overload (static fractures) without damage prior to the accident.

The end of the tail rotor control was cut previously by the Indian Authority.

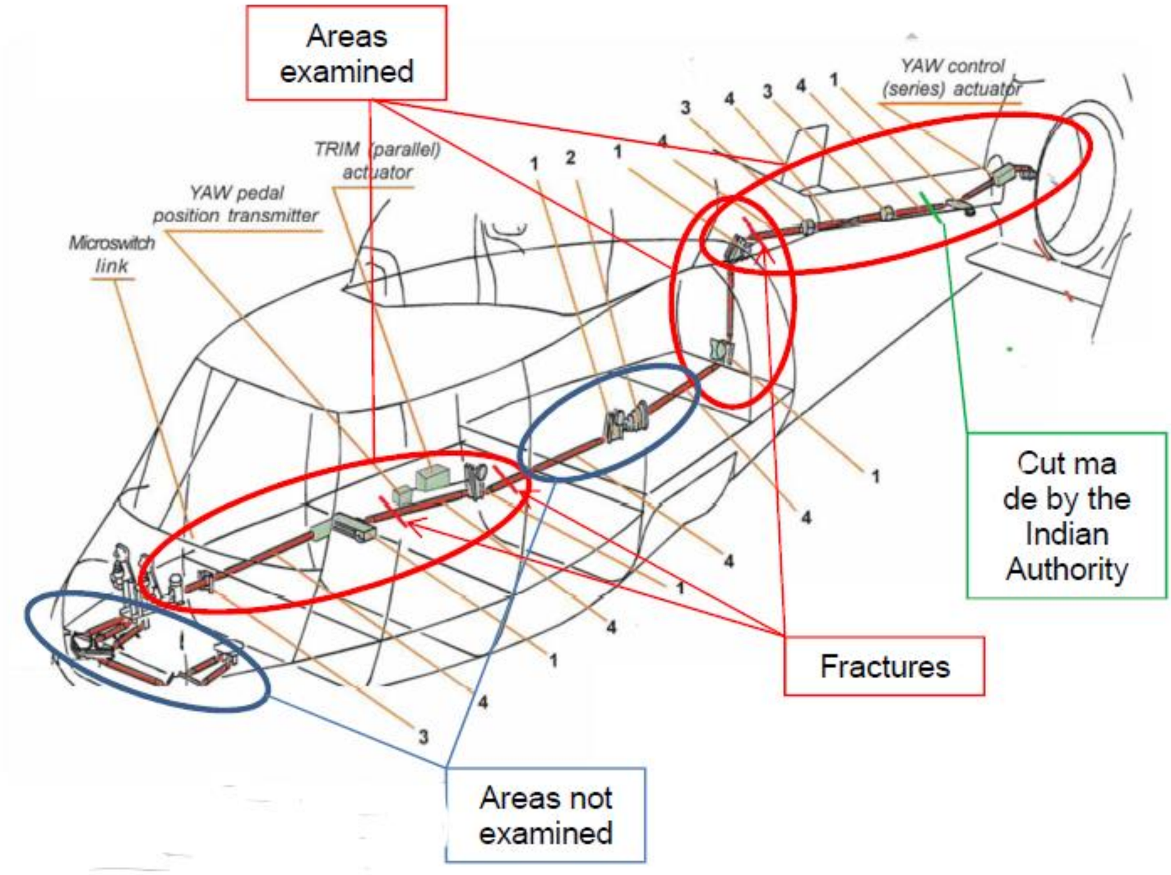
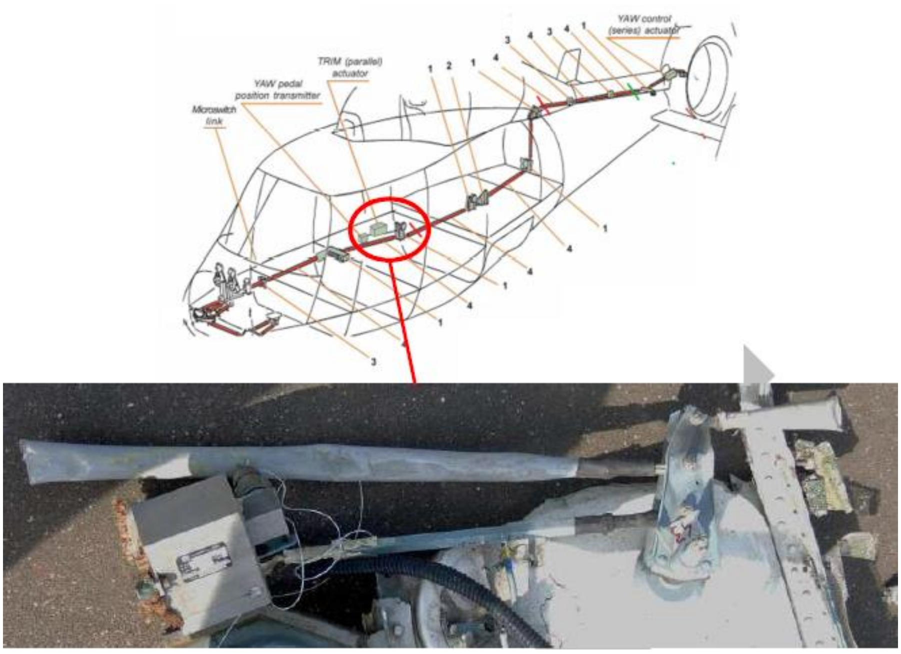
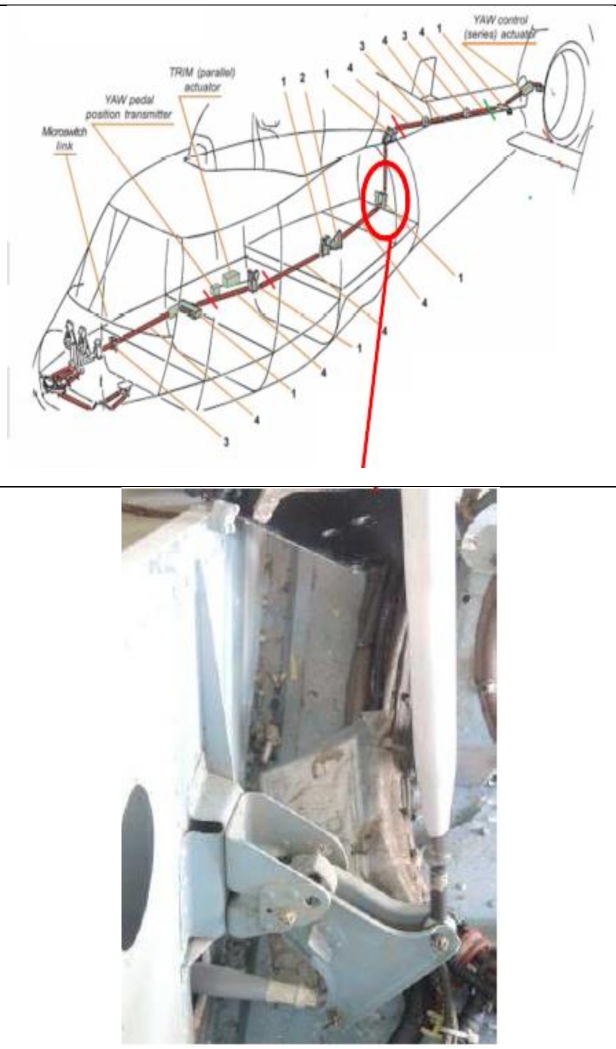


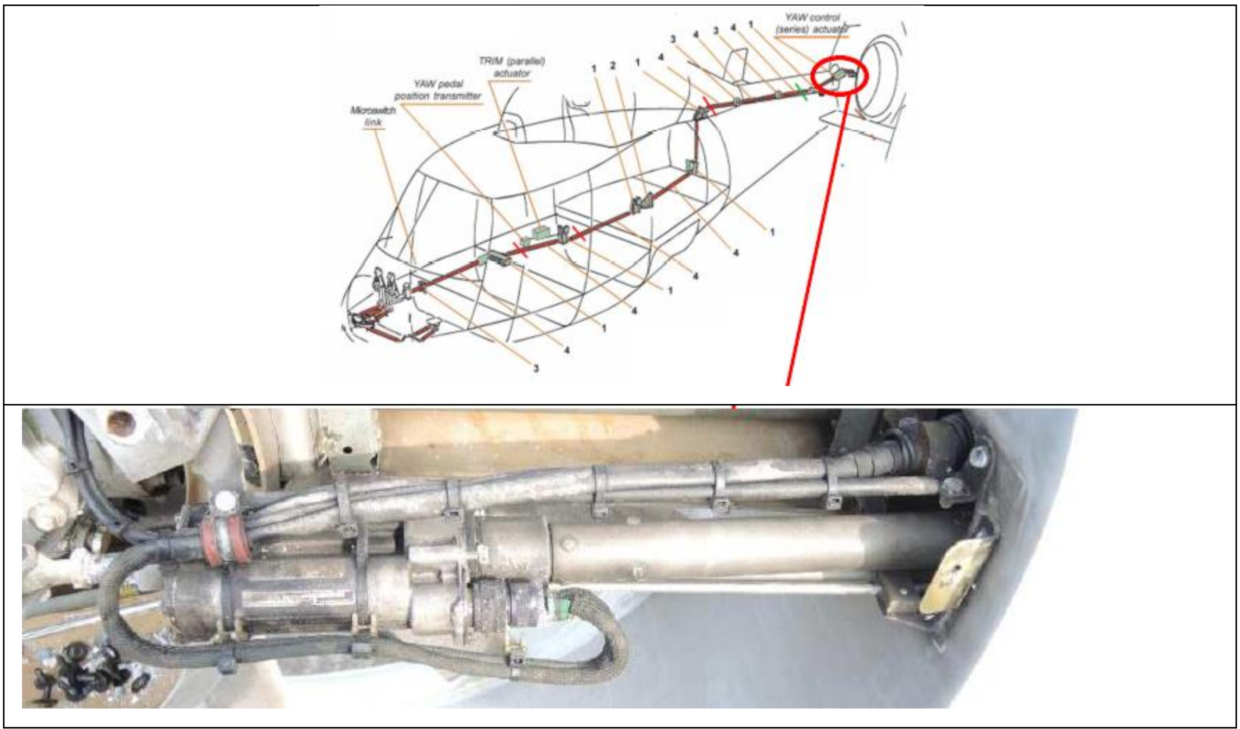
Diagram of the tail rotor controls



Part of the tail rotor control



Part of the tail rotor control



Engines

The helicopter was equipped with two Turbomeca Arriel 2C engines identified below:

Left engine : S/N 24524;

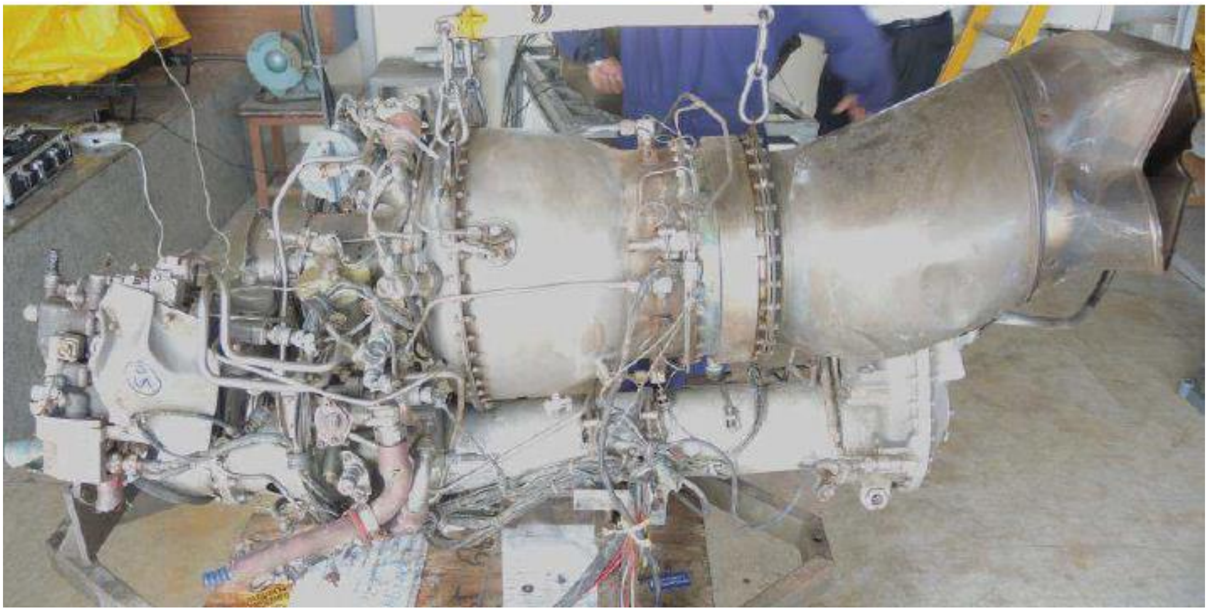
Right engine : S/N 24540.

The examinations consisted of an external review, a check on the magnetic plugs and filters and a boroscopic examination. These investigations were performed with the manufacturer's expert. The manufacturer's technical document is referenced RA2015-300. Turned by hand, the engines could not rotate. This blockage was due to seizing of the bearings after being in the sea.

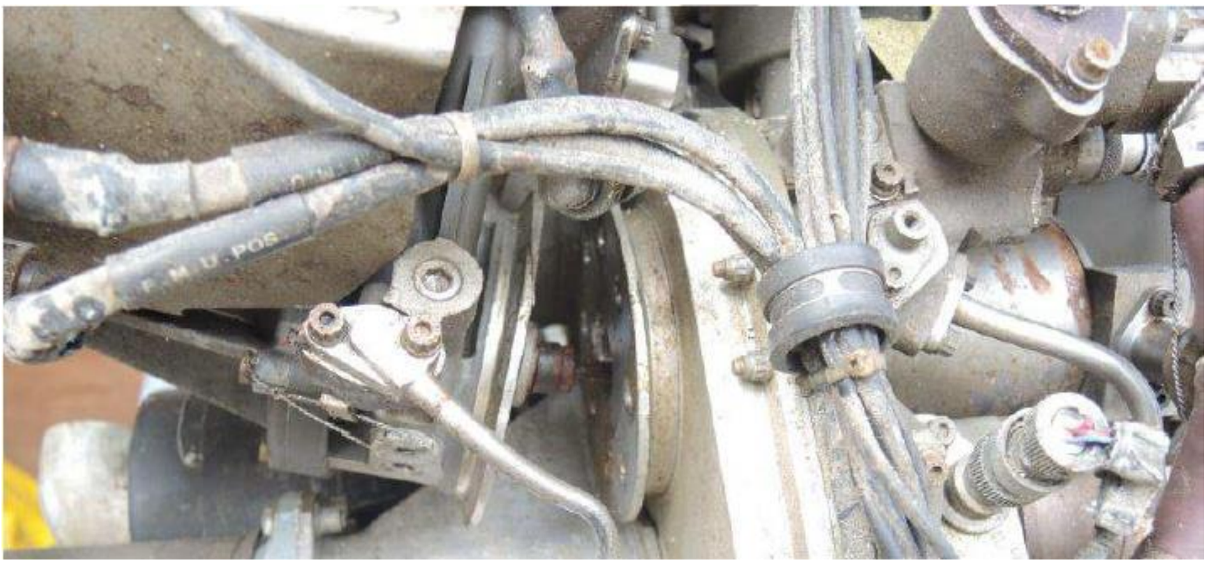
External review:

Left engine	**Right engine**
The front support: see under "main rotor drive system" The rear engine support was deformed with the elastomer shock	The front support: see under "main rotor drive system" The rear engine support was deformed with the elastomer shock mounts

mounts broken. The air intake was attached to the engine. The air intake was deformed during the impact. The engine casings and the transmission shaft casing were neither deformed nor perforated. The exhaust pipe was deformed but it kept its initial form. On the front of the engine, the starter generator was in position and connected to the engine. The shaft of the pump and metering unit assembly was outside of the engine. The clamp of this shaft was found deformed and was found under the joint area. On the top of the engine, the fuel valves assembly and the bleed valve unit were in position. The bleed valve was open, this position is normal with the engine stopped. On the pump and metering unit assembly, the fuel supply pipe was connected but broken about 0.1 metres from the engine. The external pipes were connected and complete. Some deformations were identified; these deformations were a consequence of the impact.	broken. The air intake was attached to the engine. The air intake was deformed during the impact. The engine casings and the transmission shaft casing were neither deformed nor perforated. The exhaust pipe was deformed but it kept its initial form. On the front of the engine, the pump and metering unit assembly and the starter generator were in position and connected to the engine. On the top of the engine, the fuel valves assembly and the bleed valve unit were in position. The link was broken at the entry to the start electro-valve. The fracture was a consequence of the impact during the accident. The bleed valve was open, this position is normal with the engine stopped. On the pump and metering unit assembly, the fuel supply pipe was connected but broken about 0.4 metres from the engine. The external pipes were connected and complete. Some deformations were identified, these deformations were a consequence of the impact.



The left side of the left engine



Pump shaft of the and metering unit assembly disconnected from the engine

Magnetic plugs

The electrical magnetic plugs and the front mechanical magnetic plugs were checked. The rear mechanical magnetic plugs had been ripped off from the engines and checks were impossible.

One metallic chip was identified on the front mechanical magnetic plug of the right engine. This chip is not representative of an internal mechanical damage. No metallic chip was identified on the other plugs. There were just oil residues mixed with water.

LEFT ENGINE	RIGHT ENGINE
	
Front mechanical magnetic plug	**Front mechanical magnetic plug**
	
Electrical magnetic plug	**Electrical magnetic plug**

Filters:

On the oil filter covers and the fuel filter covers, the blockage indicators were not activated. The filters were clean.

Boroscopic examinations:

Both engines had a similar internal condition. The description below is valid for both engines.

The axial compressor blades were damaged on the leading edge. This observation shows that some debris passed through the compressor whilst the engines were rotating, most probably due to the consequences of the impact with the water.

Left engine **Right engine**

Axial compressor **Axial compressor**

The centrifugal compressor blades also showed some damage on the leading edge.

No damage was identified in the combustion chamber and on the turbine blades.

Some residues were identified on the leading edge of the gas generator turbine blades.

These residues probably came from the damaged compressor blades. Inview of this, we can say that there was combustion in the combustion chamber and so fuel was being supplied to the engine at the moment of the impact.

Samples chemical analyses

Various traces of paint have been identified on the items listed below:

- upper side of yellow blade;
- forward structure;
- upper side of the aft structure;
- rope used to recover the wreckage;
- rope used to recover the wreckage and attached to the aft structure.

Upper side of the yellow blade

Forward structure

Upper side of the aft structure

Rope used to recover the wreckage

During the examination of the wreckage by the BEA, samples were taken on these elements.

The analyses carried out on these samples have been limited by the very small amount of material. It has not been possible to identify precisely all the chemical components of these samples. Nevertheless analyses show that these various samples are composed of an epoxy resin, commonly used in paint composition.

Concerning the traces identified on the upper side of the yellow blade, we note that there is neither modification of the helicopter vibration nor main rotor behavior on the FDR parameters. In addition, no damage was identified below these traces.

Under these conditions, the yellow traces cannot be associated with the accident.

1.18.9 Human Factor and CRM

Human Factors include human behaviour and performance; decision-making and other cognitive processes; communication and documentation; as well as the refinement of staff selection and training. Each of these aspects demands skilled and effective human performance.

Human Error is, by far, the most pervasive cause of accidents and incidents in aviation. Also, what could be considered perfect performance in one set of circumstances might well be unacceptable in another. Studies of worldwide aviation accidents indicates that for the approach and landing phase of flights, which accounts for 4 per cent of total flight exposure time and 49 per cent of all accidents, flight crew error is cited in 80 per cent as a factor. Similar studies indicate that between 80 and 90 per cent of all aviation accidents are attributable to human error in one form or another. It is abundantly clear from such data that human performance is critical to preventing accidents.

CRM training encompasses a wide range of knowledge, skills, and attitudes including communications, situational awareness, problem solving, decision-making, and teamwork; together with all the attendant sub-disciplines which each of these areas entails. CRM can be defined as a management system, which makes optimum use of all available resources—equipment, procedures and people—to promote safety and enhance the efficiency of operations. CRM is concerned with the cognitive and interpersonal skills for making decisions.

1.19 Useful or Effective Investigation Techniques

Nil

2.0 ANALYSIS

2.1 Helicopter & Its Maintenance

The Helicopter had flown for 3255 airframe hrs before the date of accident flight. The Certificate of Airworthiness of helicopter remains valid until or unless it is suspended/ cancelled subject to valid Airworthiness Review Certificate (ARC) and the last was ARC issued on 19.3.2015.

The last major inspection done on helicopter was 3000 hrs/ 6 year inspection at 3057.50 Airframe Hours in September 2015. Subsequently all lower inspections and pre-flight checks were carried out as and when due before the accident. The helicopter was loaded within the limit and C.G was within approved range.

The helicopter was equipped with two Turboshaft Arriel 2C engines manufactured by Turbomeca, France. The helicopter and the engines were being maintained under continuous maintenance program consisting of calendar period based maintenance and Flying Hours/Cycles based maintenance. LH Engine had logged 4325:50 Engine Hrs, 6944.10 Ng cycles and 2202.50 FT cycles. The RH Engine had logged 4100:25 Hrs with 7188.70 Ng cycles and 2057.90 FT cycles.

All modifications and Service Bulletins were complied with before undertaking the flight. No snag was pending for rectification before the accident flight. The emergency floatation gear switch was not armed as the crew was not planning to carry out ditching so the floatation gears have not inflated.

It can be concluded that the helicopter was maintained properly and it was airworthy to take the flight. Maintenance aspects of the helicopter have not contributed as cause of the accident.

2.2 Crew Qualifications

Both the crew held valid licenses and were qualified on type. Their ratings were current. The PIC had a total flying experience of 19588 hrs and the co-pilot had a total flying experience of around 6700 hrs. Last night flying was carried out by the co-pilot on 30.11.2014 and by the PIC on 31.8.2015. Total night flying by the co-pilot was 190 hrs approximately.

Both had valid class I medical and have undergone proficiency checks as per the requirements. The crew had undergone pre flight medical including breath-analyser test before taking off for the first flight of the day and they were not under influence of alcohol.

2.3 Training

In any operational organisation training records are very vital and is one of the indicator to provide the health of operations. Earlier investigation reports have emphasized on the issue and gave recommendations not only on the conduct of training but also on upkeep of documentation.

The training of Dauphin N3 pilots is under the head of training, Western Region which is under the overall control of GM (WR). From last one and a half year, an officer (Capt.) is holding the post of both head of training as well as the head of operations. Both the crew fulfills the training and currency requirements for flying in the six months including offshore currency.

One of the crew was cleared for night offshore as co-pilot and as per records provided his night currency had lapsed as he had last flown offshore by night on 30 Nov 2014. The night training flight was undertaken to enable him to regain his currency

For clearance as PIC the SOP only stipulates the followings:-

a) Pilot should have flown for one year/monsoon as a co-pilot.
b) Pilot should have at least 4 actual / simulated night medevac from Bombay high to Juhu. The SOP does not specify the aspects such as the detailed sortie profile, phase of moon for ambient lighting or the selection of deck for night training.

All flying by day and night within offshore fields and landing back at offshore helidecks is conducted under ONGC radio officer without prior intimation to Mumbai FIC or the operator.

Offshore training is being carried out without a written programme. There is no procedure or control on conduct of training and PIC is left to decide all aspects of the flight. In this particular flight the marine radio officer/ AME were not aware of the flight profile. As per the CVR the radio officer enquired about the flight profile when flight crew was preparing to start up. Further as one of the crew had a break in night currency it would have been prudent to carry out some amount (0:15 minutes) of dusk flying prior to night flying including a few approach/ landing at WIS platform before proceeding to Ron tappmeyer.

As per the CVR, the helidecks selected for night training were rig Ron tappmeyer and floater vessel Samudra Sevak. These were not ideal platform for initial night training due to poor surrounding ambient lighting and Sevak being a floater is an unstable deck.

Review of the files of the individual revealed that there is no system of review of the training report/ record received for the pilot and nor is there any procedure through which the progress of the pilot on any weak areas indicated in the simulator training can be monitored. It is more of a filing the records in a file with index.

2.4 Helideck Safety

ONGC has more than 300 helidecks in entire Mumbai flight field extending from 40 nm to 120 nm on the west coast. Some of these decks are living platforms with refueling facilities while others are production platforms or floating vessel or drilling rigs.

As per para 8 of ONGC Aviation standard 4 (AS: 4) inspection of helidecks should be carried out prior to conducting passenger operations to any offshore facility operated by ONGC. Further para 8.4 of CAR Section 4 Series B Part V on minimum safety requirements for helicopter landing areas used on regular basis stipulates that “ operator shall carry out periodic audit/ inspections to ensure compliance of minimum facility during the period of operation as part of SMS.

In practice only prior to starting operations to any helidecks, the operator satisfies himself on the minimum operating and safety facilities through a trial landing report.

The committee was not provided any other requirement either from DGCA or from ONGC wherein requirement of helidecks safety audit/ surveillance/ inspection are laid down. The committee during course of investigation visited SLQ and EE production platform to which Ron tappmeyer was attached on the night of accident. The condition of the both the helidecks surfaces were found rusted with rust flakes coming out at a number of places. The matter was discussed with DGM (Aviation safety) who, as per him carries out inspection of helidecks for their condition and safe operation of helicopters, though there is no system/ procedure developed for the purpose.

Pawan Hans also have not carried out any inspection/ audit of the helidecks, though it should have been carried out under SMS. The system of HAC is not effective as there was no close loop mechanism for taking action on the hazards raised.

From the regulatory point of view there are no laid down requirements of periodicity of the safety audits of helidecks or system of action taken reports to ensure compliance on the deterioration observed on the safety standards. There is an urgent need to have formal regulation on the subject, similar to CAP 437 with inbuilt check & balance provisions between the helicopter operators and the installation (rigs etc.) owners.

2.5 Weather - Obtaining & transmission procedure/ documentation

Helidecks are regarded as ‘unlicensed landing areas’ and offshore helicopter operators are required to satisfy themselves that each helideck to which they operate is fit for purpose. Up-to-date, accurate meteorological information is critical for helicopter operators for flight planning purposes and by crew to facilitate the safe operation of helicopters in the take-off and landing phases of flight. Meteorological reports of the concerned platform are desirable than those of the neighbouring platforms.

The criteria have to be described for such operations including the meteorological requirements and these requirements should be accounted for in the Operations Manuals of the operators. In the present case though the QNH, wind direction and velocity was provided to the flight crew, the cloud base and visibility was neither available with the marine radio officer nor it could be ascertained.

2.6 Wreckage Examination

The condition of the wreckage and the deformations indicated that the helicopter impacted water with significant energy level. The area in front left side has taken maximum loads indicating that helicopter hit the water in a left bank and pitch down attitude. These observations are consistent with the airspeed and attitude parameters recorded on the FDR during the impact. On the tail rotor, the blades of the fenestron were in position without visible deformation. There were rubbing marks on the fenestron duct from blade. The rear drive shaft was continuous and complete on recovery from the sea but bent. The splines were not damaged.

As mentioned earlier, the wreckage was examined at Juhu followed by further analysis by investigators in association with BEA France. Following have been concluded:

The helicopter was destroyed and five main fragments were identified:

- front lower structure including the instrument panel and the centre console;
- main rotor installed on the transmission desk;
- both engines;
- assembly with the aft structure and the tail boom;
- tail rotor.

When the wreckage was recovered from the sea, the main rotor was connected to the main gear box and was equipped with four blade fragments. The main gear box was complete with the rods and the servo-controls in position.

The suspension bars and the two laminated elastomer stops were destroyed and show that there was energy (rotation and torque) when the blades impacted the sea.

The four blades were broken with several fragments missing especially the end of each blade. On the fragments analysed, no impact was identified on the leading edge.

The main rotor controls were obviously complete before the impact. This observation is consistent with parameters recorded on the FDR which showed that the helicopter was most probably controllable until the end.

On the tail rotor, the blades of the fenestron were in position without visible deformation.

Several rotational interferences were identified on the fenestron duct due to contact with the blades which shows that the fenestron was turning when the structure of the tail rotor began to be damaged and deformed.

The rear drive shaft was complete on recovery from the sea and bent. At the forward and the rear, the splines were not damaged.

The tail rotor controls were fractured in several areas during the impact with associated deformations. Fractures located at each end of the control system were all static and due to the accident. The tail rotor control was obviously complete before the impact.

The two engines had a similar internal condition. The only damage was to the axial compressors with grabbing, which showed that wreckages were passed through the compressor whilst the engines were rotating. The engines were running at the moment of impact which is consistent with FDR recorded parameters.

2.7 Flight Recorders & Spectrum Analysis

2.7.1 CVR

The flight time between the take off and the end of the recording was 05 min & 19 secs. The audio data analysis of the period did not show any abnormality in the cockpit. The transmissions with ground were loud and clear. It was observed that normal check list was not carried out by following challenge and response procedure.

No audio warnings were recorded on the audio data except the “Decision Height” warning which triggered 4 seconds before the end of the recording and is consistent with the height of the helicopter at that moment (200 ft).

2.7.2 Spectral Analysis

A spectral analysis was performed to evaluate the condition of the propulsion system and identify any acoustic anomalies that might have been recorded. The spectrum view showed acoustic signatures (harmonic families) typical of the helicopter propulsion system spectrum, i.e. Main Rotor blade rotation with a fundamental frequency of 23.66 Hz (BR – Blade Rate), Tail Rotor drive shaft with a fundamental frequency of 1083 Hz and MGB input meshing rotation with a fundamental frequency of 2740 Hz.

The signatures were consistent with nominal acoustic signature normally observed on AS365 family of helicopters. These fundamental frequency values indicate that the propulsion system was at 100% of its nominal rate and is in consonance with FDR data.

No abnormality was observed from beginning until the end as per the recording. Two acoustic events were detected as given below:

(a) Blades-Vortex Interaction (BVI) occurrences before the end of the flight

48 secs before the end of recordings, a “flapping” sound related to the blades was recorded on the audio file. This sound is typical of a blades-vortex interaction (BVI) phenomenon and is generated by the interaction between blades and vortex. The BVI phenomenon occurs

when a blade strikes on or passes closely to the shed tip vortices of preceding blades. It mainly occurs during descent flight or sharp turn.

(b) Unknown unstable frequency

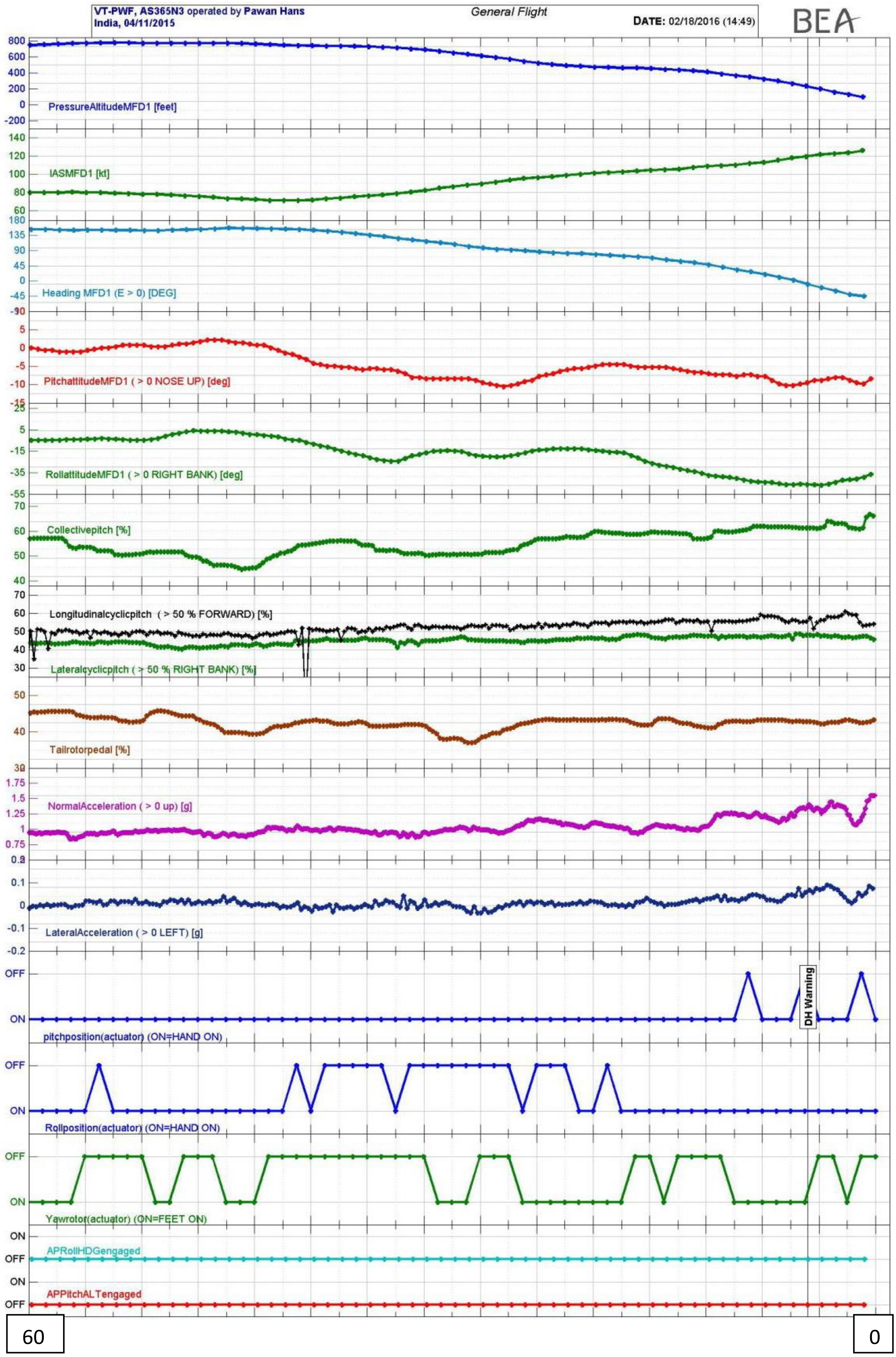
An unknown unstable frequency was present in the spectrum. This frequency can be found on other DAUPHIN's CAM recordings. Its sharp value changes are usual on this helicopter family. The origin of this frequency has not been identified yet but is not related to a failure in the propulsion system.

Neither the audio data analysis nor the spectrum analysis showed any sound of blades contacting with an external object.

2.7.3 FDR (END of the Recording is depicted as time T_0)

The flight was a night training flight. 56 secs after takeoff from SLQ platform, the autopilot was engaged in ALT and HDG modes. In these modes, the pilot adjust power by the movement of collective stick. The helicopter was in cruise for about 3 minutes. The cruise altitude was between 550ft and 650ft AMSL with Auto-Pilot engaged. About 98 secs prior to the crash, the autopilot (upper modes ALT and HDG) was disengaged.

At that point the pilot slightly moved the cyclic stick backward and the collective stick downward. Consequently, the pitch increased and the power decreased. This maneuver looks like a standard approach procedure to decrease the speed. Thereafter, the pilot moved the cyclic stick slightly to the left and began a left turn. For about 38 seconds from T_0, the roll attitude was always more than 12° left and the altitude continued to decrease. The collective pitch was slightly moving upward. At 34 seconds from T_0, the roll attitude was 24.26° left. At 4 seconds from T_0, the FDR recorded a maximum left roll of 46.76 °.The pitch attitude was 8.79 ° down.



FLIGHT PARAMETERS FOR LAST 60 SECONDS

During the last ½ to 1 second the collective pitch significantly increased from 61.25% to 66.84%. At that moment, when the recording stopped, the recorded attitude of the helicopter was 8.44° pitch down and 36.58° left for the roll. The lateral cyclic stick was 4.41% left.

2.8 CRM

The primary goal of CRM is enhanced situational awareness, leadership, assertiveness, decision making, flexibility, adaptability, and communication. Having decided to go around, the flying pilot needed to get on to instruments and if he was disoriented, should call out so that the non-flying pilot can take over. This aspect is also emphasised in special points in the Medevac SOP.

The CVR readout brings out a lack of adherence to standardized checks and procedures and communication protocol between the crew. While the pilot on controls decided to go around, both pilots, perhaps, continued to fly VFR. Pilot monitoring displayed lack of situational awareness by not taking over controls. The crew thereby failed to engage in the important process of CRM.

2.9 Safety Management System (PHL & ONGC)

The SMS manual has not been revised since initial issue in 2014, inspite of the fact that various changes in organisation setup have taken place. Neither there was any Risk Assessment carried out for any of these changes. Safety Communication through meetings, seminars and bulletin etc along with Safety Training has been stated as a major way to achieve the goal of Safety Promotion. No safety circular or bulletin has however been issued during last 2 years.

Safety training is required to be provided to all staff with refresher each year, but it was found that even initial training has not been completed for all the employees as mentioned in the Manual.

Pawan Hans has defined 18 key performance indicators as part of Safety Assurance, though no values were indicated for any year to assess the level of safety. Data pertaining to Safety Performance Parameters are also required to be communicated to all concerned, but in absence of any monitoring system, no such data is shared. There is no record to indicate that consultation with all personnel regarding changes in work environment, procedures, practices etc. is being carried out.

The SMS Manual further requires that the Flight Safety Document system shall be reviewed at least once a year but it was not carried out even once. It was informed that for a period of almost a year prior to the accident, actions such as review of Flight Safety Manual, Safety Management System Manual and record keeping on key performance indicators, training of PHL executives, pilots, AMEs and other staff were not conducted though it was required as per regulations. There was no key performance indicator specific to the offshore operations.

2.10 Circumstances Leading to the Accident

In the present case the helicopter started up and took off from SLQ platform and turned right towards Ron Tappmeyer Rig stationed on oil Platform EE. Once it reached in the vicinity of Rig it started reducing speed. There after it has initiated a left turn as seen in the AIS recordings on the platform. The helicopter had turned towards the Rig but did not land and crossed helideck. Simultaneously it started losing height while turning left.

As discussed earlier, disorientation or black hole approach Illusion can happen during a final approach at dark night over water beyond which the horizon is not visible. These conditions may produce the visual illusion of a high-approach perspective.

The position of Ron tappmeyer was to the south extremity of the South field with no other rigs nearby to provide ambient lighting. As per the AIS and FDR the tail wind approach was made with speed of approximately 79 kts. This high speed approach would have caused an abrupt loss of visual reference.

The pilot on controls was flying during night after break of nearly a year. The fact that it was a dark phase of moon made this even more challenging. Some amount of dusk flying on instruments would have prepared the pilot flying for undertaking the night flying profile/ maneuvers. As soon as he got airborne and set course for Ron tappmeyer, the pilot flying has probably entered conditions ideal for black hole phenomenon because of loss of horizon as is corroborated by CVR replay. Under such conditions he was not aware about the direction he was proceeding to i.e. up or down / turning right or left.

The pilot flying probably continued to fly visually instead of getting on to instruments. Therefore on initiating the go around after realizing that he was high he entered into spatial disorientation extremely quickly.

The instructor was not disoriented and was aware that the helicopter was low. He had cautioned, (though delayed), the pilot flying twice. He however did not realize that the pilot flying was in total state of spatial disorientation and was unable to react to his caution. Nor did he take over controls. The helicopter as a result crashed into the sea with a speed of approximately 116 kts. The high impact velocity caused substantial damage to the helicopter and fatal; injuries to the occupants.

3. Conclusion

3.1 Findings

3.1.1 General

- The operator was carrying out operation of helicopter under NSOP and the maintenance of helicopter under CAR 145.
- The Certificate of Airworthiness, Certificate of Registration and Certificate of Release to Service of the helicopter was valid on the date of the accident.
- The defect records were scrutinized and there was no defect pending on the helicopter prior to the flight which could have contributed to the accident.
- All major modifications and Service Bulletins were complied with. There was no snag pending for rectification before the accident flight.
- There was no abnormality reported on the navigational or communication equipments prior to the accident.
- The PIC & the co-pilot were holding a valid license on the type of helicopter. Both the crew members held valid medical certificates as per the requirement.
- The crew had undergone pre-flight medical examination and nothing abnormal was observed. The BA test was negative.
- The quantum of training as required by the relevant regulations on the subject was imparted to both the flight crew members.
- The Helicopter Underwater Escape Training (HUET) for the PIC was not current on the date of accident.
- As per the existing SOP, in addition to the standard Night Flying Procedures, before landing on a Rig/Floater, a dummy circuit must be carried out and pilot monitoring must call out bank during turns; and speed & ROD during approach.
- The emergency floatation gear switch was not armed as the crew was not planning to carry out ditching so the floatation gears have not inflated.

3.1.2 Organizational influences

- The training manual available with the WR was not having any date of issue though it was approved by the DGCA in as it is condition.
- In WR the same flight crew personnel (DGM Level) was holding the posts of DGM Training and DGM Ops.
- The SMS manual though accepted by DGCA does not contain 'How to do' the various functions mentioned therein. The Manual just remains a document without performance of any function at working level.
- There is no SOP for carrying out night offshore training. There are some references in the SOP issued for Night Ambulance Operation.
- There is no document indicating procedure of taking weather (off shore) and transmitting the same to flight crew. The flight crew operating in offshore is not provided with accurate information on the visibility, cloud ceiling and cloud base.
- Earlier Committees of Inquiry have recommended "establishment of strong safety department" but it was observed that the operator has not established the safety department in true letter and spirit. It is still continuing on ad-hoc basis and full fledged department is yet to be established.
- There is a shortage of pilots and situation is aggravated due higher attrition rate of flight crew.
- Paras 3 & 4 of Subpart D – Special Helicopter Operations under PART 2 - OPERATIONS of CAR - Section 8, Series 'H' Part I on Commercial Helicopter Operations regarding flight rules, night offshore operations and corresponding training / recency requirements are ambiguous.
- The cross-country requirement of "route flying check sortie by night" in para 4.5 (Page 4-B-3) of DGCA CAR Section 8, Series H, Part I is not being complied by offshore operators as required.
- Last night flying was carried out by the co-pilot on 30.11.2014 and by the PIC on 31.8.2015. Total night flying by the co-pilot was 190 hrs approximately.

- Aviation Safety aspects covering systems and procedures of operations have not been covered in the ONGC QHSE Implementation though the off shore installation are with ONGC.
- There is no documented safety system or procedure with ONGC to ensure Safety Assurance particularly for helidecks audits, certification and periodic inspections.
- Medevac is defined in the contract signed between ONGC and PHL, and PHL is providing the helicopter for medevac purposes but, it is not one of the explicit requirements of the contract.
- System of HACs is not a formal one and devoid of transparency and closed loop procedures.
- No specific training for handling communication and traffic of helicopters is given to the marine radio officers.

3.1.3 Unsafe Supervision

- The decision to undertake the flights in offshore field rested with the pilot. There was no monitoring/ supervision to check if unsafe decisions were not taken.
- The training records of the flight crew is just a record keeping exercise without any system or procedure in place to review the observation of the instructor / examiner for monitoring the progress of the flight crew. There is no system to identify the observations made by the SFIs in their reports and depute the crew members accordingly for the various special operations being conducted by PHL.
- Flight Plans are filed with Bombay FIC only for flights taking off/landing back at Juhu from Bombay High. The major portion of Bombay High Oil field is class G airspace and no flight plans are filed for flights within this region.
- The Marine Radio officers provide information of position of Helicopters and Transmit wind direction/velocity to the flight crew. They are neither authorised nor competent to ensure requisite separation between the helicopters

- The deficiency existing on the Helidecks were reported by the operator however no closed loop system exists to make these good in a timely effective manner.
- DGM (AS) ONGC is supposed to carry out all the proactive safety oversight activities including inspection of flight decks and physical inspection of helicopters but is not trained on any of the aspects.

3.1.4 Preconditions for Unsafe Acts

- Many recommendations made by the earlier courts / committees of inquiry having operational safety implications are yet to be implemented by PHL in true spirit. Even the actions taken on the recommendations have withered away with passage of time due complacency and non supervision.
- Due to non availability of senior level operational personnel and adhocism, there is no supervision of operational activity.
- Since the promulgation of the air routes in Bombay High in year 2010 new installations have been erected by ONGC wherein helicopter land resulting in criss-crossing the existing routes.
- Routine Cockpit Checks (Challenge and Response) for various phases of flight were not thoroughly carried out. While the pilot on controls decided to go around, both pilots, perhaps, continued to fly VFR. Pilot monitoring displayed lack of situational awareness by not taking over controls.
- PHL is positioning a helicopter in Bombay High for the purposes of night medevac, however no SOP has been developed for undertaking night offshore operations at helidecks, particularly in the absence of night landing aids.
- Marine Radio Officer is not in a position to ensure separation.

3.1.5 The Accident Sequence

- The pilot on controls was flying during dark phase of moon at night after break of nearly a year.

- Some amount of dusk flying on instruments would have prepared the pilot flying for undertaking the night flying profile/ manoeuvres.

- Before the descent and until the autopilot disconnection, the recorded parameters were nominal.

- The helicopter made a tail wind approach with speed of approximately 79 kts for Ron tappmeyer which is to the south extremity of the South field with no other rigs nearby to provide ambient lighting which caused an abrupt loss of visual reference.

- During the descent and before the helicopter started to turn left, the parameters were consistent with a standard approach procedure associated with a speed decrease by pushing slightly down the collective stick and nose up the helicopter

- The left turn was 50 seconds long with slight variations in roll attitude. The lateral acceleration remains between -0.03 and +0.09. The corrections did not lead to a roll attitude less than 12° to left

- After the Autopilot disconnection, the pilot was "hands on" and the attitude of the helicopter was consistent with the inputs on the flight commands.

- No specific pilot inputs were recorded, except actions on the collective pitch in the last second of the recording.

- The pilot flying has probably entered conditions ideal for black hole phenomenon because of loss of horizon wherein he was not aware about the direction he was proceeding to i.e. up or down / turning right or left.

- The pilot flying probably continued to fly visually instead of getting on to instruments, therefore on initiating the go around after realizing that he was high he entered into spatial disorientation extremely quickly.

- The engines were delivering power until the end of the recording. The engines parameters NG, NR, TRQ and T4 were consistent with each other and with the power demand on the collective pitch.

- The instructor cautioned, (though delayed), the pilot flying twice but did not realize that the pilot flying was in total state of spatial disorientation and was unable to react to his caution.
- The PIC did not take over controls when the helicopter descended below critical height.

- No warnings were recorded in the flight data during the flight of the event.

3.2. Probable Cause

The helicopter impacted into the sea at high velocity, as

- The pilot on controls, who had a long break in night offshore flying, got into complete spatial disorientation, as a result of black hole phenomenon, while approaching a helideck at high speed in tail winds on a dark night, and
- The PIC did not take over controls when the helicopter descended below critical height

4. Recommendations

For Offshore Flying

- The Helidecks from where night currency training are to be carried out may be identified by ONGC in association with the Helicopter operators and these helidecks should be provided with minimum landing aids for night offshore operations. DGCA may develop procedures for landing and takeoff utilizing these aids.
- As far as practicable night flying to/from the floating vessels should not be carried out.
- The existing SOP on off shore departure and arrival for Bombay High should be immediately reviewed covering following aspects.

- Existing routing and separation
- Planning, Authorisation, Post Flight documentation of the flying undertaken within off shore fields including intimation to FIC
- Duties and responsibilities of a competent person to ensure separation.
- Accurate weather information including visibility, cloud base and ceiling. The procedure of obtaining and transmitting this information to the flight crew should be developed.

- DGCA may review the requirements regarding flight rules for off shore night operations and corresponding training and recency requirement.
- ONGC should develop system and procedure for carrying out periodic audit of the helidecks from safety point of view. This audit should be linked to continued certification of the helidecks for operational purposes. A copy of audit report should be provided to the operator for verification and continuance of operations.
- In addition to the automated means of ascertaining the meteorological information, a manual means of verifying and updating the visual elements of observation, i.e. cloud amount and height of base, visibility and present weather, may be developed. The latest weather report from each installation should be made available to the helicopter operator one hour before take-off.

General - PHL

- Documentation is a weak area throughout the organisation be it operations or safety including SMS. The importance of timely updation of documents and the dissemination of information needs no emphasis. As one time exercise all the Manuals, procedures, processes be reviewed and amended to have cohesion of content. System of periodic review should be put in place and strictly followed.
- PHL should immediately undertake the implementation of safety management system across the whole organisation by completion of training, reviewing the manual by including the procedures for the actions to be carried out under SMS, appointing key safety personnel

at all regions and Corporate Office, establishing values of the safety indicators, etc.

- In order to curtail higher rate of attrition of pilots, PHL must introduce some long term effective remedial measures and must ensure that the pilot should not have any type of allurement to fly more number of hours, which at times may be at the cost of safety.
- PHL needs to ensure that their flight crew is sensitized and indoctrinated regarding CRM, with particular emphasis on the merits of adherence to SOPs, good aviation practices, communication and assertiveness.

25/10/16

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25.10.2016