AIRCRAFT ACCIDENT FINAL REPORT NUMBER A05/2016

ACCIDENT INVOLVING EUROCOPTER AS350 B3e REGISTRATION RP-C6828
AT BATANG LUPAR, SARAWAK
05 MAY 2016

AIR ACCIDENT INVESTIGATION BUREAU

MINISTRY OF TRANSPORT

MALAYSIA

AIR ACCIDENT INVESTIGATION BUREAU

ACCIDENT REPORT NO.: A05/2016

OPERATOR	**:**	**GCA SKYLINE AVIATION**
AIRCRAFT TYPE	**:**	**EUROCOPTER AS350 B3e (ECUREUIL)**
NATIONALITY	**:**	**PHILIPPINES**
REGISTRATION	**:**	**RP-C6828**
PLACE OF ACCIDENT	**:**	**BATANG LUPAR, SARAWAK (1º 2' 30.5" N, 111º 13' 28.2" E)**
DATE AND TIME	**:**	**05 MAY 2016 AT APPROX 1630 HOURS (LT)**

All times in this report are Local Time (LT) (UTC + 8 hours).

This investigation was carried out for the prevention of accidents and incidents in the future and not for the purpose of apportioning blame or liability (Civil Aviation Regulations 2016).

TABLE OF CONTENTS

Appendices

ABBREVIATION

‘G’	Gravity
AAIB	Air Accident Investigation Bureau
ALERFA	Alert Phase
APMM	Malaysian Maritime Enforcement Agency
ATC	Air Traffic Control
BOMBA	Fire and Rescue Services
CAA	Civil Aviation Authority
CPL	Commercial Pilot Licence
DCA	Department of Civil Aviation
DETRESFA	Distress Phase
DVI	Disaster Victim Identification
ETA	Estimate Time of Arrival
FIR	Flight Information Region
GIRN	Government Integrated Radio Network
HS	Hornbill Skyways
ICAO	International Civil Aviation Organisation
INCERFA	Uncertainty Phase
KLIA	Kuala Lumpur International Airport
LSS	Lembaga Sungai Sarawak
LT	Local Time
MATS	Manual of Air Traffic Services
METAR	Met Aerodrome Report Requirement
RH	Rumah
SAR	Search and Rescue
SEM	Scanning Electron Microscope
SK	Sekolah
STRIDE	Science and Technology Research Institute for defence
VHF	Very High Frequency

INTRODUCTION

The Air Accident Investigation Bureau of Malaysia

The Air Accident Investigation Bureau (AAIB) is the air accident and serious incident investigation authority in Malaysia and is responsible to the Minister of Transport. Its mission is to promote aviation safety through the conduct of independent and objective investigations into air accidents and serious incidents.

The AAIB conducts investigations in accordance with Annex 13 to the Convention of the International Civil Aviation and the Civil Aviation Regulations 2016 of Malaysia.

In carrying out these investigations, the AAIB will adhere to ICAO's stated objective, which is as follows:

"The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability."

Accordingly, it is appropriate that the AAIB's reports should not be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose

SYNOPSIS

On the 05 May 2016, a Philippines registered helicopter bearing registration RP-C6828 departed Kuching, Sarawak at 0930 LT with six (6) persons on board. After landing at three (3) locations, it landed Betong at 1602 LT. After several minutes on ground, with the engine and rotors running, five (5) passengers who have been waiting at Betong boarded the helicopter and departed for Kuching at 1612 LT. The fuel endurance reported was one hour thirty two minutes. At 1615 LT, it made a radio call on operating frequency that gave the estimated time abeam Triso at 1630 LT and Simunjan in 20 minutes". According to witnesses flying during that time, the weather en-route from Betong to Kuching was observed to be raining with thunderstorm. There was no more communication with RP-C6828 even though several attempts were made to communicate with the helicopter. Search and Rescue (SAR) was activated at 1926 LT and declared missing. SAR was carried out along Batang Lupar but there was no sighting of any helicopter. There was no distress call made or received in any of the operating radio frequencies. A body of one of the passengers was recovered in the Batang Lupar on 06 May 2017 and subsequently all other occupants and several helicopter parts were found in the Batang Lupar by the SAR team within the next three days.

Two (2) Investigators from AAIB were dispatched to Kuching on the 06 May 2016 and the investigation began on the same day. Eight (8) investigators were appointed by the Minister of Transport to carry out the investigation. The investigation was led by Investigator-In-Charge, Capt. Dato' Yahaya bin Abdul Rahman.

FACTUAL INFORMATION

1.1 History of the flight

1.1.1 A helicopter bearing registration RP-C6828 was on a charter flight by Hornbill Skyways, based in Kuching, Sarawak. The helicopter was utilised for carriage of personnel and ballot boxes during the duration of the State election from 22 April until 09 May 2016.

1.1.2 The helicopter was flown from Puerto Princesa Airport, Philippines and arrived Kota Kinabalu International Airport on 22 April 2016. At Kota Kinabalu, the crew made necessary immigration clearance and after refuelling the helicopter departed Kota Kinabalu for Miri Airport at approximately 1534 LT. At Miri Airport, DCA Malaysia flight operations Inspector performed a ramp inspection[1] to ensure that it meets the ICAO safety standard. The helicopter stayed on ground at Miri until 25 April 2016.

1.1.3 On 26 April 2016, the helicopter departed Miri at 0955 LT for Kuching International Airport. It arrived Kuching at 1330 LT on the same day.

1.1.4 On 29 April 2016, the helicopter was assigned to fly passengers to Simunjan and back to Kuching. On the following day, 30 April 2016, it departed Kuching for a passenger flight to Sri Aman, Rumah Samion, Semaong Ulu, Rumah Jack, Engkerepok, Sri Aman and back to Kuching.

1.1.5 On 2 May 2016 until 4 May 2016, RP-C6828 was assigned to fly passengers from Kuching to Engkelili, Entabai, Ulu Akoh, Sekolah Skaroh, Sekolah Balai Ringin, Mentu, Tuba Tengah, Pakan, Sekolah Ng. Kota, Sekolah Kedup, Pakan and back to Kuching. All the flights were carried out uneventfully.

1.1.6 On 5 May 2016, after performing the pre-flight inspection, RP-C6828 took off from Kuching with six (6) persons on board at 0930 LT, for its first destination Bungin. Meanwhile another helicopter Bell 206 with registration 9M-AZX carrying five passengers (fatal) flew from Kuching five minutes later to the same destination. All passengers from both helicopters stayed on ground for hello community function and travelled by road to Spaoh and Betong. Helicopter RP-C6828 then flew to Spaoh and waited on ground.

1.1.7 A passenger from Sarawak State Office boarded the helicopter and it took off at 1600 LT for Betong, where it landed 2 minutes later. After the passenger from the Sarawak State Office disembarked (5) five passengers who had been waiting on ground at Betong rest house boarded the helicopter, while the rotor was still running.

[1] Ramp Inspections are to allow DCA Inspectors to observe and evaluate the routine methods and procedures used by an operators' personnel during the period immediately before or after a flight, and to determine the operators' compliance with regulations and safe operating practices.

At 1612 LT, RP-C6828 departed Betong for Kuching with fuel endurance of one hour thirty two minutes. (The flight plan is at Appendix A). A radio call was made to Kuching Information (134.75 MHz) shortly after take off Betong at 1615 LT giving an estimate time abeam Triso at 1630 LT and estimate time abeam Simunjan in 20 minutes. Subsequently, there was no more communication with RP-C6828. According to other aircraft flying around the area during that time, the weather en-route from Betong to Kuching was observed to be raining with thunderstorms. The route that was flown is as per Figure 1 below.

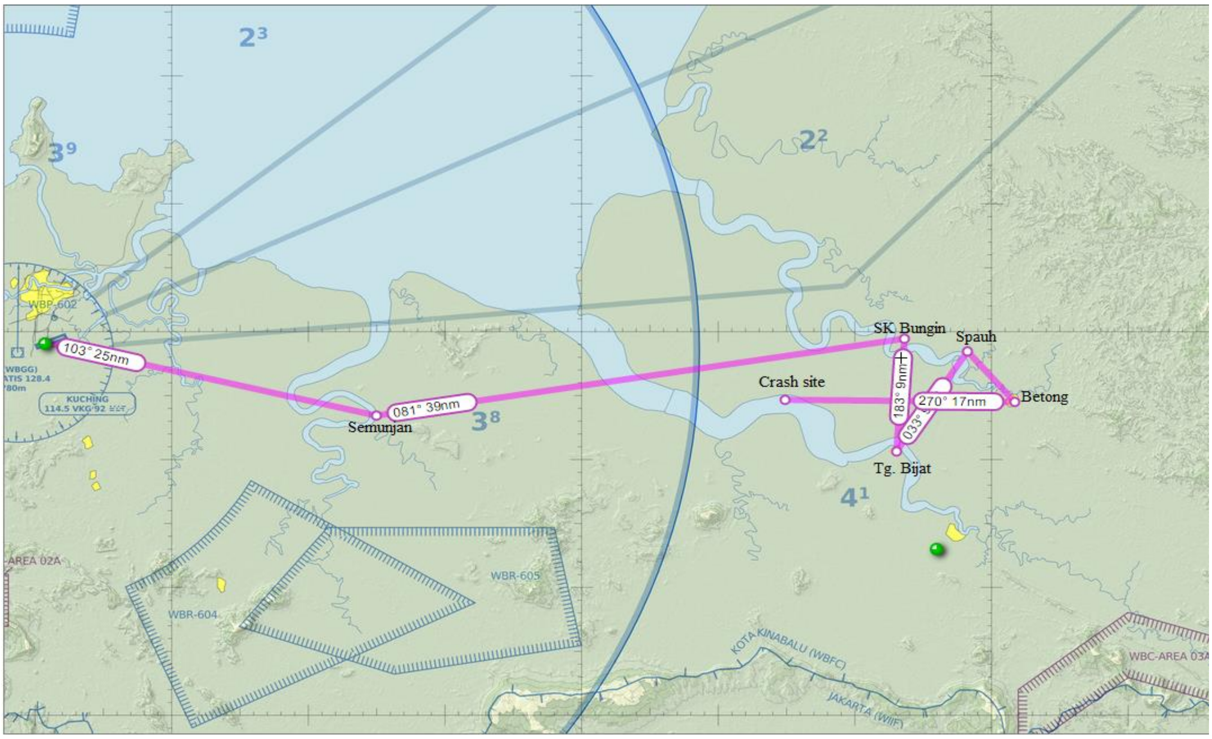


Figure 1

1.1.8 The SAR operations was activated at 1926 LT with boats from the Fire and Rescue Department searching the Batang Lupar area. The first body was recovered in the river the following day. The search continued on 7 May 2016 where the 2nd ,3rd ,4th and 5th body were recovered together with several helicopter parts. The areas from where the bodies were recovered were not far from Lingga, a small village along Batang Lupar. The sixth body which was that of the pilot of the flight was recovered on 9 May 2016 near Sebuyau, a town about 30 kilometers downstream from Lingga. All the bodies were taken to Kuching General Hospital where autopsies were carried out by the Disaster Victim Identification (DVI) team. All the occupants of the flight RP-C6828 were fatally injured. All the helicopter parts found were taken to Hornbill Skyways hangar and subsequently transported to Subang DCA hangar for detailed examination.

1.2 Injuries To Persons

Following are the injuries to both crew and passengers:

Injuries	Crew	Passengers	Others
Fatal	01	05	Nil
Serious	Nil	Nil	Nil
Minor/None	Nil	Nil	Nil

1.3 Damage To Aircraft

The main wreckage has not been found. However, several helicopter parts were found in the river by the SAR team. See pictures of recovered parts at Appendix C.

1.4 Other Damages

NIL

1.5 Personnel Information

1.5.1 Pilot

Age	: 53 years (male)
License Type and No.	: CPL/117073
License expiry	: 30 September 2019
Medical Cert. expiry	: 06 June 2016
Total Flying Hours	: 7,000 hrs
Total Hours on Type	: 700 hrs

1.5.2 The pilot was well rested before the incident. He had rested more than 24 hours at Kuching.

1.5.3 He started his career by joining the Philippines Air Flying School in 1989 for his private ground course and continued his flying training for Commercial Pilot Licence at Link Flight Training School in Philippines. He was employed as corporate helicopter pilot at Allied Bank Aviation from 1993 to 2009. From 2009 he joined several helicopter operators that include Eurocopter Philippines, R2 Builders, Mega View Aviation, Helitrend Laviation and Tropic Helicopters between 2009 to 2010. In 2013 he did his AS350 B3e type conversion at Eurocopter South East Asia in Singapore and another type training for AS350 B3e in the Philippines. He has flown several types of helicopters that are as follows:

Bell 412 EP/Hp	-	700 hrs
Bell 430	-	650 hrs
AS 355 F2	-	1,700 hrs
AS 350B/BA	-	1,400 hrs
MD 500e	-	700 hrs
MD 500C	-	500 hrs
MD 500	-	650 hrs
R 22-Beta	-	250 hrs

1.6 Aircraft Information

1.6.1 General

The single engine AS350 Ecureuil [Squirrel] is renowned for its high performance, its safety and its reduced operating costs. The single-engine AS350 B2, powered with a Turbomeca Arriel 1D1 engine, has a proven track record. Its flexibility and low acquisition cost has made it a very sought-after helicopter to perform a wide range of missions (passenger transport, aerial work, fire fighting). Its design calls for widespread use of composite materials (airframe, "StarflexT "main rotor head, main blades, beam type tail rotor, etc.)

The AS350 B3 is "the high performance" version of the single engine Ecureuil range. Powered by a Turbomeca Arriel 2B turbine engine it is equipped with the FADEC system (Full Authority Digital Engine Control). It is totally suited for operations in conditions such as mountainous areas or hot countries or for very demanding missions, performance wise. The AS350 B3e outclasses all other single engine helicopters for performance, versatility, safety and competitive acquisition and maintenance costs. It excels in hot conditions and very high altitudes, and broke records when a standard production aircraft landed on the top of Mount Everest in 2005 (altitude: 29,029 ft/8,848 m). Eurocopter is taking this aircraft to a whole new level with the enhanced AS350 B3e.

The powerful, high-performance AS350 B3e is designed to carry out the most demanding missions in the most extreme weather and geographical conditions. Its exceptional lifting capability, high endurance, extended range and fast cruise speed make the AS350 B3e the leader in its class. Another world record: An AS350 B3 climbed to 3,000 meters/9,900 foot in 2 minutes 21 seconds and made a world record landing on Mount Everest.

The AS350 B3e is a member of Eurocopter's rugged and proven Ecureuil family. Some 4,900 Ecureuils have been delivered in 98 countries for some 1,600 operators. These aircraft have cumulated more than 22 million hours. More than

900 AS350 B3 series are currently in-service worldwide, and are mainly used for high performance missions in "high and hot" conditions.

1.6.2 Aircraft Details

Aircraft	: Eurocopter AS350 B3e
Owner	: GCA Skyline Aviation Inc.
Registration	: RP-C6828
Type	: AS350 B3e
Serial No.	: 7602
Air Operator Cert. expiry	: 20 March 2018
Cert. of Airworthiness expiry	: 22 September 2016
Cert. of Registration issued	: 20 August 2014
Year of manufacture	: March 2013
Operations	: Commercial Air Transport
Engine Type	: Arriel 2D
Engine Serial No.	: 50266
Engine Total Time	: 406.44hrs

1.7 Meteorological Information

1.7.1 Meteorological Situation. There was no direct observation of the weather conditions at the point of accident (somewhere between Sebuyau and Pulau Seduku).

1.7.1.1 The nearest observed weather station is the Meteorological Aerodrome Report Regular (METAR) that was issued at 1600 LT and 1700 LT from Sri Aman (WBGY) (20km South West of Pulau Seduku) recorded light winds of 3 knots and less, good visibility of more than 10 kilometers and did not record any rainfall between 1600 LT and 1700 LT consistent with the radar images (Figure 2 below). METAR from WBKK (Kuching) and WBSB (Sibu) are too far (more than a hundred kilometers away) to provide any representation of weather at the point of accident.

1.7.1.2 Meteorological radar image that was taken at 1630 LT on 5 May 2016 (*Figure 2*) showed that there was moderate rainfall of 5 to 10 millimetres per hour at the point

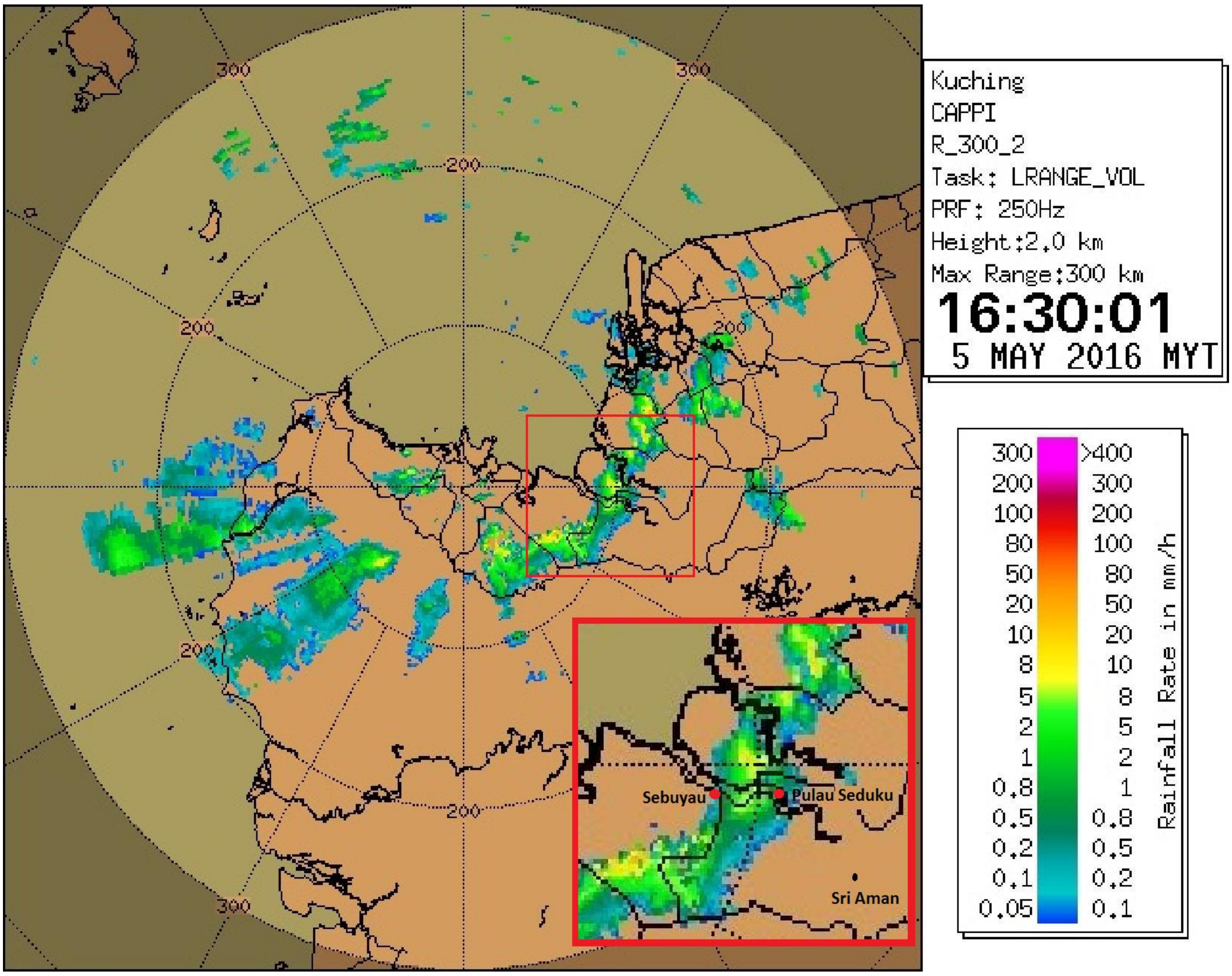


Figure 2 Meteorological radar image at 1630 LT 5 May 2016

Infra-red images that were taken by the meteorological geostationary satellite Himawari-8 ASEAN INFRARED ENHANCED IR of Japan Meteorological Agency (JMA) at 1630 LT on the 5 May 2016 *(Figure 2)* showed that there were significant cumulus nimbus clouds developed from convective activities at the point of accident at 1630 LT.

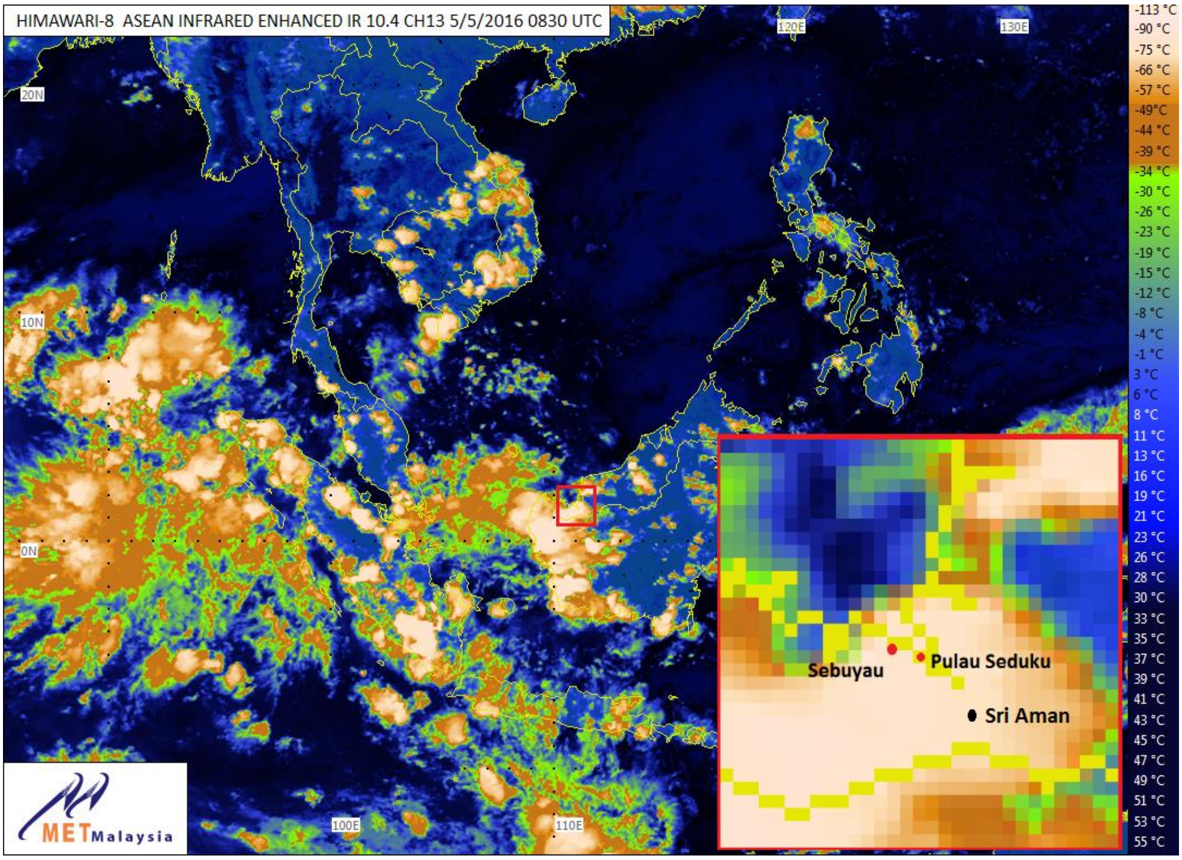


Figure 3 Infrared satellite image taken by Himawari-8 at 1630 LT, 05 May 2016.

1.7.2 The cloud image indicated that the cumulonimbus has reached mature stage. Thunderstorms contain many significant hazards to aviation especially for light aircraft flying at low levels such as the following:

1.7.2.1 Contain lightning and that lightning can strike more than 15 kilometres from a thunderstorm;

1.7.2.2 Can produce strong winds;

1.7.2.3 Turbulence exceeding the performance capability of most aircraft can be found in and around thunderstorms;

1.7.2.4 Wind shear can cause extreme changes in wind speed and direction near the surface during critical phases of flight;

1.7.2.5 Microbursts are possible with many thunderstorms and heavy rain and low cloud ceiling can reduce visibility.

1.7.3 Report of aviation weather information on the 5 May 2016, Weather Forecast Airport (metaphor) to Airport Kuching and Sri Aman Meteorological Station issued at

0700 LT and 1300 LT expecting rain thunderstorm (SRA) occurred between 1400 LT to 2000 LT on the 5 May 2016. Warning Airport weather was also issued at 1410 LT for Kuching airport. Three Significant Weather Warning (SIGMET) for WBKK FIR has also been released at 0955 LT, 1255 LT and 1555 LT on the 5 May 2016.

1.7.4 The following are brief explanation on the effect of wind shears, turbulence and microbus:

1.7.4.1 Wind shear

Refer to a sustained change (lasting more than a few seconds) in the wind direction and /or speed, resulting in a change in the headwind or tailwind encountered by an aircraft. A decreased in total rotor thrust will caused the aircraft to descend and conversely an increased in total rotor thrust will caused the aircraft to climb. Pilots should be aware that significant wind shear at low levels during flight or during approach may cause difficulty in control, thus requiring timely and appropriate corrective actions to ensure the aircraft is safe.

1.7.4.2 Turbulence

Caused by rapid irregular motion of air. It brings about rapid bumps or jolts but does not normally influence the intended flight path of an aircraft significantly. However, in severe turbulence cases, abrupt changes in the altitude and attitude of the aircraft may occur and the pilot may suffer a momentary loss of control. In general, rapid fluctuations in the wind speed and direction encountered by the aircraft for less than a few seconds are turbulence where as a sustained change of the headwind or tailwind of 15 knots or more for more than a few seconds is significant wind shear.

1.7.4.3 Microburst

The most violent form of downdraft from a thunderstorm. It is characterized by an intense and localized descend of cool air, causing a sudden outflow of horizontal winds above the ground with a typical horizontal extend of a few kilometres. An aircraft flying through a microburst may first encounter an increasing headwind and rotor thrust, then a downdraft from above the aircraft, followed by an increasing tailwind and sink. To overcome the adverse effect of the microburst, the pilot needs to take timely corrective action to ensure aircraft safety.

That is the ideal theoretical world, though it can happen like this in practice, as some pilots have experienced. The first point, however, is that microburst can be asymmetric, having winds on one side stronger than the other side. The second point is that the column of down draft can hit the ground at an angle, rather than vertically downward.

1.7.5 There were 4 other helicopters flying around the area of Betong at the same day with the following actual weather observations:

1.7.5.1 9M-WSE that was on ground at Spaoh took off 5 minutes ahead of RP-C6828 reported that the direct route to Kuching weather was very bad with lightning and black clouds and minimum visibility. He had to divert the flight path to the right 45 ˚ to 60 ˚ off course to Pusa areas (NW). He further explained that the weather condition to the north at Kg. Triso was clear and the weather within the Batang Lupar seemed to be bad.

1.7.5.2 9M-WSA departed Sri Aman for Kuching at 1600 LT. claimed that the helicopter flew in rain with very strong wind and heavy turbulence until Banting which is 5 nm to the South of Lingga. The helicopter arrived Kuching at 1645 LT.

1.7.5.3 9M-WSM (EC135) was flying at around the area at 1630 LT and claimed that it was raining at Bungin and Debak area, forcing him to deviate east of track in order to maintain VFR from Seraban to Betong.

1.7.5.4 9M-AWB flying from Kuching to Betong had to divert to Debak due to bad weather with low clouds and heavy rain at Betong at about 1600 LT.

1.7.5.5 9M-AZK took off Betong at 1625 LT for Kuching, claimed that the weather en-route to Kuching was bad with dark clouds and heavy rain. The helicopter deviated to the left of track over the mainland to maintain VMC.

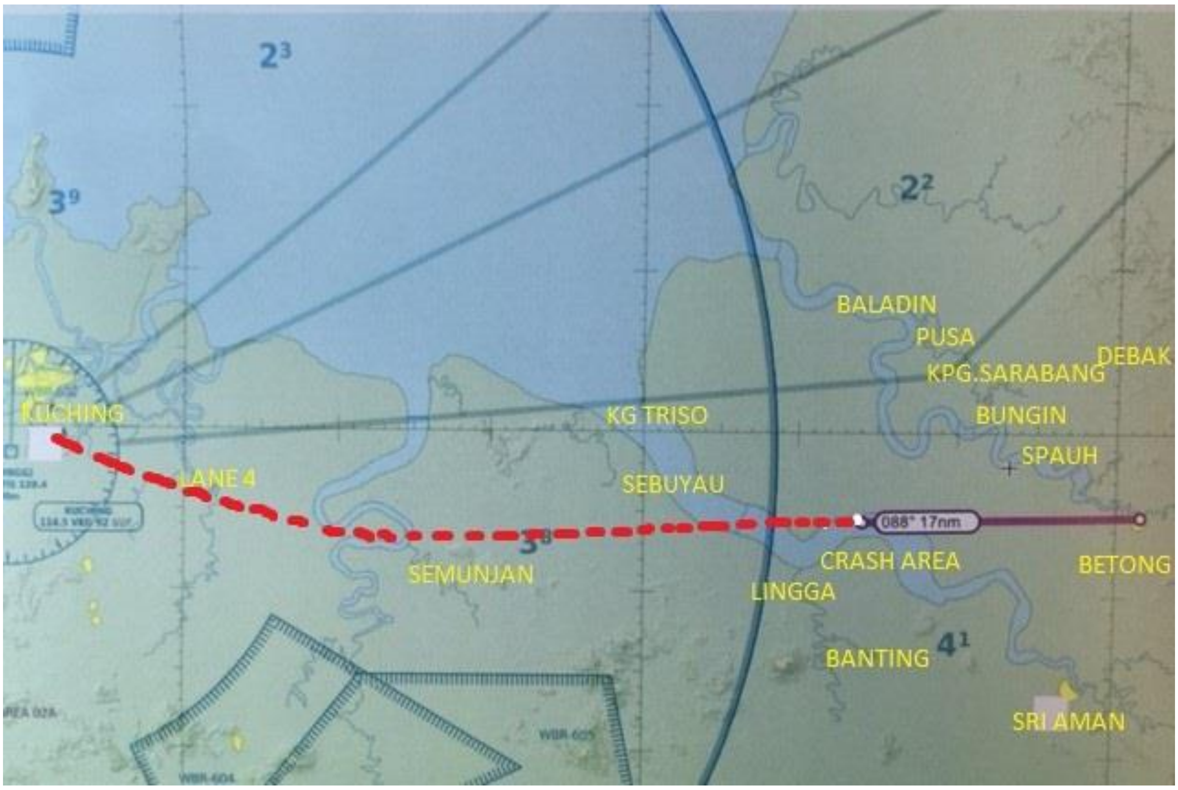


Figure 4 The places surrounding the route of RP C6828 (in relation to Para 1.7.5)

1.8 Navigation Aids

NIL

1.9 Communication

On the day of the accident at around 1630 LT, Kuching Information VHF Radio on frequency 134.75 MHz was monitoring at least five (5) helicopters flying during that time. There was no distress call received on this frequency. The last call made by RP C6828 was at 1615 LT giving his ETA abeam Triso at 1626 LT and estimated arrival Simunjan in twenty minutes.

1.10 Aerodrome Information

Not applicable.

1.11 Flight Recorders

The helicopter was not equipped with flight recorder.

1.12 Wreckage and Impact Information

The main wreckage has not been found. However, several pieces of the helicopter parts were found scattered within the suspected impact area in the river vicinity. See Figure 5 and Figure 6 depicting the pictures of the helicopter parts recovered.

Figure 5 – Parts collected and stored at Sebuyau Police station

Figure 6 – Parts collected and stored at Lingga Police Station

1.13 Medical and Pathological Information

1.13.1 All the bodies were recovered outside the cabin/cockpit of the helicopter indicating the restraint system failed to function. The failure of the restraint to keep the occupants within their seats caused serious injury to the occupants.

1.13.2 The occupants experienced a negative G forces. All occupants had serious head injury. The fracture to the long and short bones are due to gravity forces and flailing effect. Bruises on the chest area and lower abdomen may be due to aircraft restraining system with possibilities of submarining effect of the seat.

1.13.3 The post mortem discovered that the pilot was having solitary gallstone from the gall bladder and no indication of cholesterol found from the carotid or aorta that could cause sudden incapacitation. Most of the organs from the stomach were found in the lung that had ruptured the diaphragm. The other finding was the laceration over the thenar eminence of right hand measuring 0.8 cm x 0.6 cm and broken bones of the pilot's 4th and 5th fingers. Multiple fractures involved midshaft of radius and ulna. Visualised carpal and metacarpals are normal. There was evidence of fractures to the distal 4th and 5th phalanges and the 3rd finger of his right hand was extremely injured.

1.14 Fire

NIL

1.15 Survival Aspects – Search and Rescue/Recovery

1.15.1 Initial SAR effort was concentrated to locate the missing helicopter. After the recovery of all the Six (6) bodies and several helicopter parts, the SAR committee decided to change the mission to Search and Recovery. The Search and Recovery mission involved agencies from the Royal Malaysian Air Force, Royal Malaysian Navy, Royal Malaysia Police, BOMBA, APMM, JPAM and LSS. Their assets were deployed for search from the air as well as surface search and recovery. From 19 May 2016, the search was further intensified using intensive sonar scanning in the river to search for the main wreckage.

1.15.2 After six (6) full days of scanning the Batang Lupar riverbed, the main wreckage was still not found. With reference to Sector A of Figure 7, the area was thoroughly scanned except for some areas which are too shallow even at high tide. These areas were less than two meters deep and it was assumed that any wreckage would protrude above the surface and be visible. Royal Malaysian Navy personnel scanned the highly probable areas adjacent to Sector A but their efforts were unsuccessful.

1.15.3 Following the completion of the search and recovery of Sector A, Sector B and subsequently Sector C were covered. Sector B was done from 12 July 2016 to 2 August 2016 and Sector C was carried out from 22 August 2016 to 26 August 2016. In the search and recovery of these two areas, the main aircraft wreckage was unable to be located.

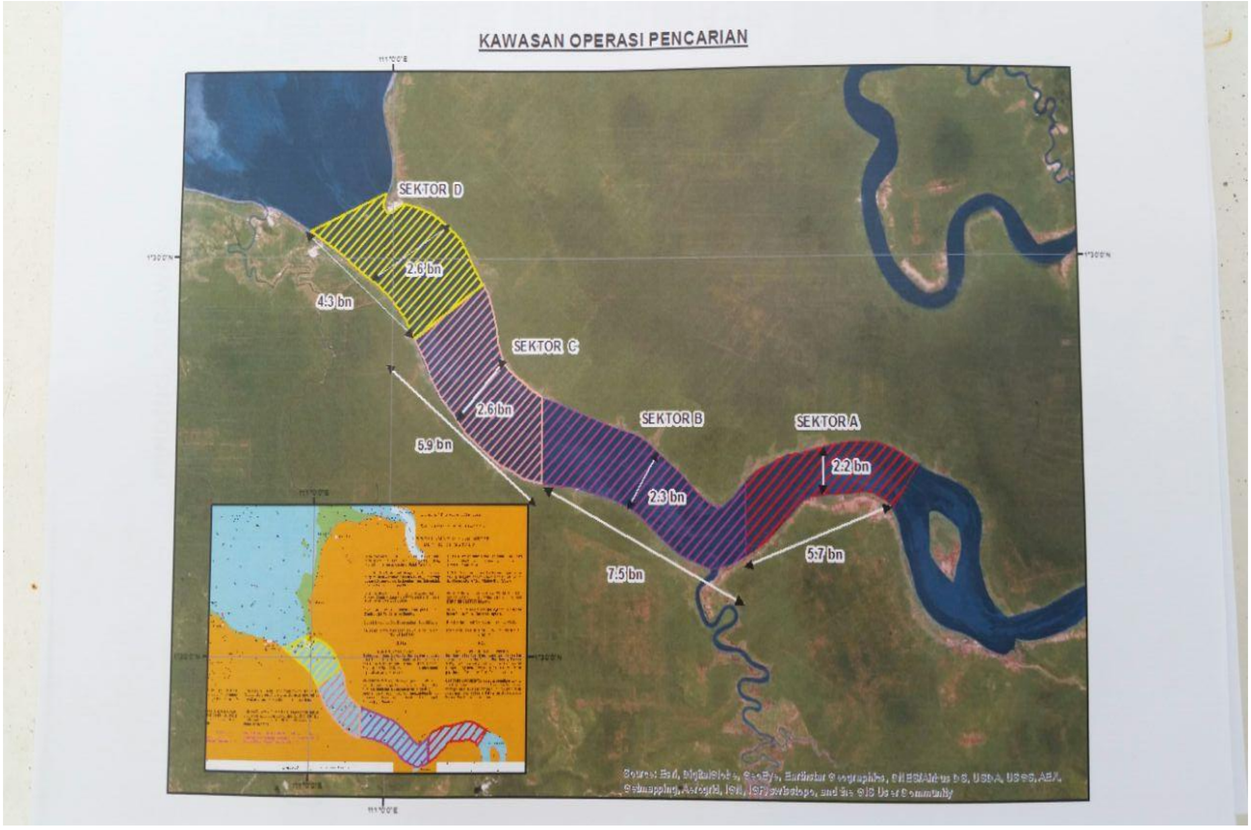


Figure 7 : Search areas divided into sectors.

1.15.4 Challenges encountered during the search and recovery mission.

i. Immense Area of Operations (AO). Limited personnel and assets for the search and recovery was a challenge owing to the size (Distance of roughly 40 km and an average of about 3 – 4 km width [5 km at its widest]) making the scanning of the riverbed progress very slow and hazardous.

ii. Unpredictable Currents. Marine Police divers have experienced surface currents running opposite to sub-surface currents. LSS lost a buoy during SAR Operations only for it to be found by the Marine Police 5km upstream from where it was last moored.

iii. Large Tidal Range. This caused the water to flow upstream. When the tide goes out, debris can be seen floating downstream. Six hours later when the tide comes in, the same piece of debris can now be seen floating upstream. This makes predicting the most probable position of the wreckage even more difficult.

iv. Crocodiles. The Batang Lupar is home to a large population of crocodiles which pose an immediate and present danger to those operating in its environment.

v. Search Equipment. While sufficient to complete the task at hand within the time frame specified it must be noted that there was no back-up. If either of the sonars was to go unserviceable, the time to complete the remaining task would immediately double.

vi. Search Platforms. The boats that were employed for the sonar scans, whilst sufficient to complete the task at hand, it must be noted that the margin of safety could be better enhanced.

vii. Radio Communications. GIRN Coverage is poor even when a repeater (Cube) was positioned at Lingga by Sapura during SAR Operations. Maritime Radio Channel 72 reception was also poor to non-existent.

viii. Cellular Communications. Around Lingga only Celcom cellular service was available with fluctuating signal strength. Voice communications were satisfactory but data was marginal.

Figure 8 : The locations and time the bodies were found

1.16 Tests and Research

NIL

1.17 Organizational and Management Information

1.17.1 Hornbill Skyways (HS) has a valid Air Operator Certificate (AOC) Number 22 issued by the DCA Malaysia to operate foreign registered helicopters in coping with the flight requirements for the Sarawak State election. HS is the coordinator of flight operations to ensure the overall safety of the helicopters flying was being monitored and supervised especially in areas on flight following, weather report, fuelling, tasks related to ground operations.

1.18 Additional Information

1.18.1 Handling of Overdue Aircraft

The investigation revealed that the initial action by the Air Traffic Controllers at Kuching Air Traffic Control Centre for overdue aircraft did not comply with the rules and regulations as stated in the Manual of Air Traffic Services (MATS), Part 9 – Emergencies. In the MATS, preliminary action (INCERFA) should commence not later than the ETA plus 3 minutes. The last radio call from RP-C6828 reporting his ETA for Simunjan is at 1635 LT. The ALERFA should be initiated 30 minutes after activation of INCERFA. DETRESFA should be initiated after 1 hour of the last ETA. Record showed that the distress was declared as follows:

a. ALERFA was declared at 1850 LT. It should be declared at 1705 LT.

b. DETRESFA was declared at 1926 LT. It should be declared at 1735 LT.

1.18.2 All the passengers on board the helicopter was on official visit and based in West Malaysia. These passengers had return tickets to fly back to Kuala Lumpur on 06 May 2016. However, one of the passengers had confirmed ticket on MH 2529 at 2135 LT ETD on the same day.

1.19 Useful or Effective Investigation Techniques

1.19.1 Introduction

Part of the tail rotor blade was discovered by the search team on 06 May 2016. The rotor was taken to STRIDE for detailed analysis on the breakage pattern. The recovered tail rotor blade is as shown in Figure 9.

(a) Outer section (a) Inner section

Figure 9: Recovered rotor blade

Figure 10 shows illustration of the complete section of the tail rotor blade. The examination was done in one section of the tail rotor blade while the other separated blade was missing.

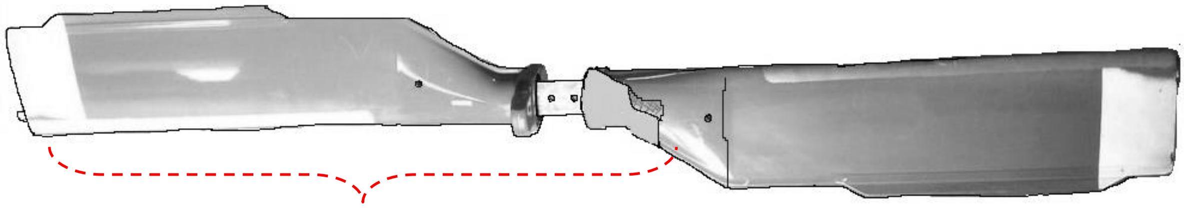


Figure 10 : Tail rotor blade unit

An illustrated drawing of the tail rotor blade in Figure 11 shows the fractured location and the straight crack line found as received. The location of the tail rotor blade unit and detailed type of material in each section of the helicopter are shown in Figure 12.

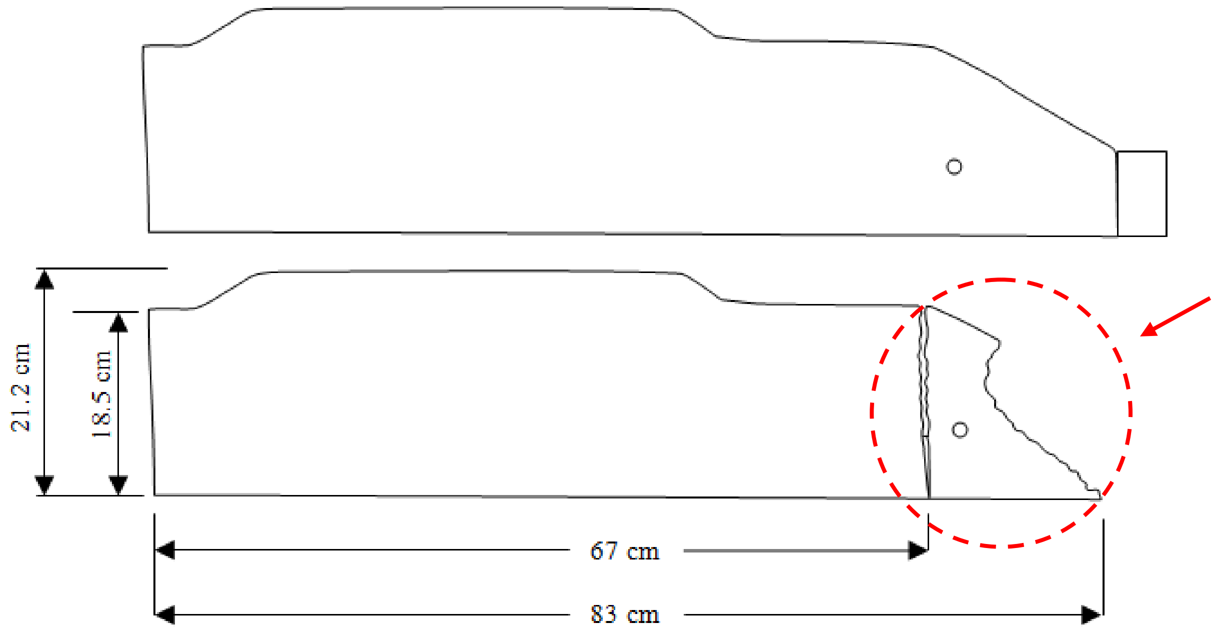


Figure 11 : Illustrated drawing of tail rotor blade

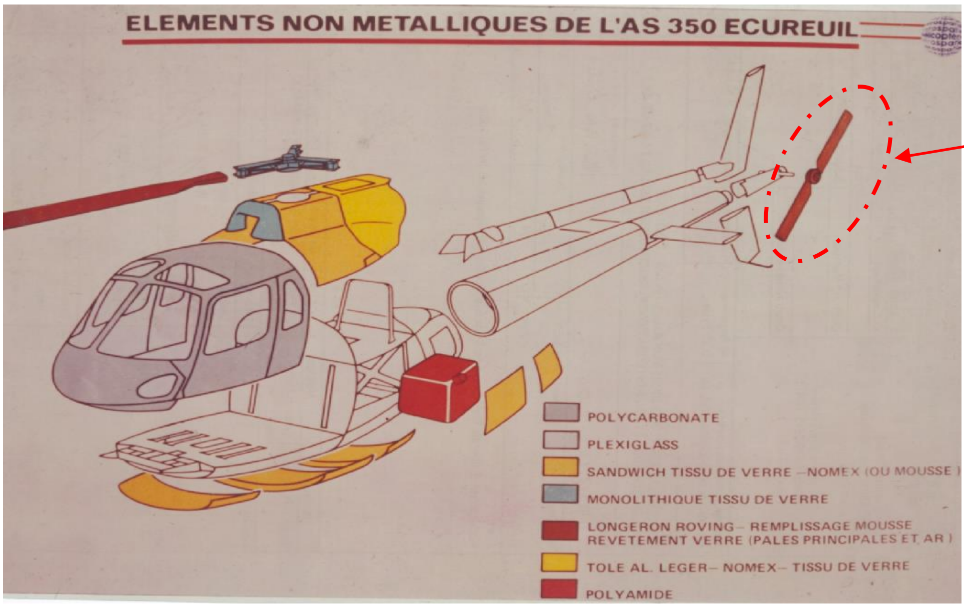


Figure 12 : Location of tail rotor blade

For this report, the detailed assembly part of the tail rotor blade is needed for simplifying the terms to be used later, as shown in Figure 13 (Source; Airbus Helicopter).

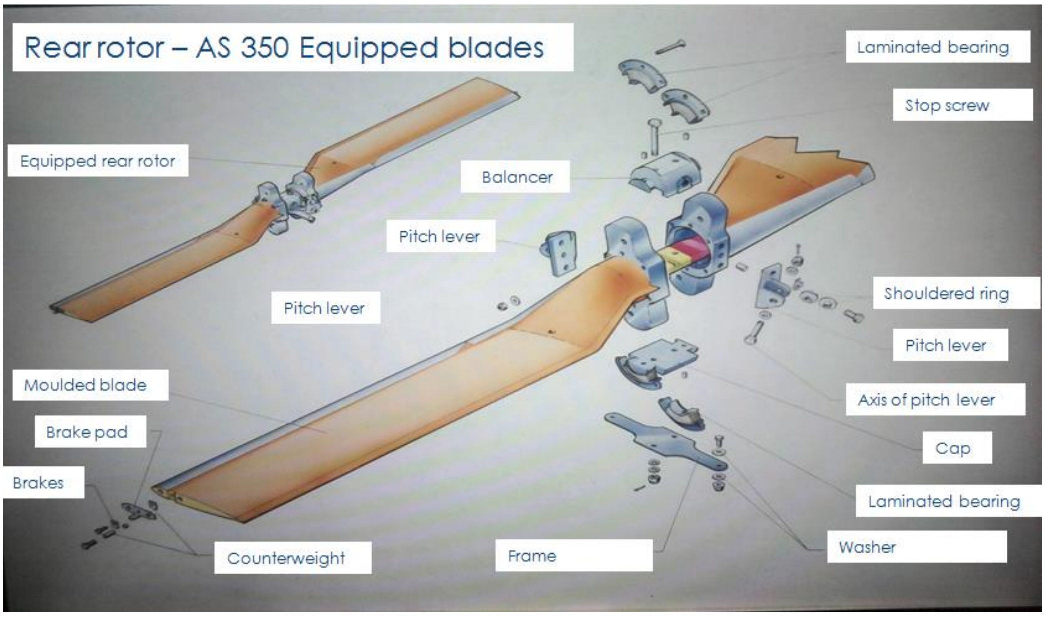
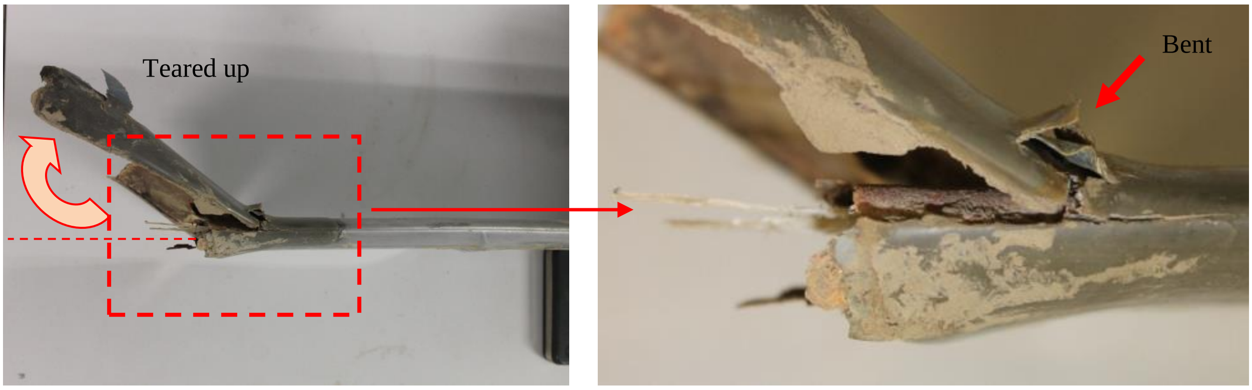


Figure 13 : AS350 tail rotor blade part details

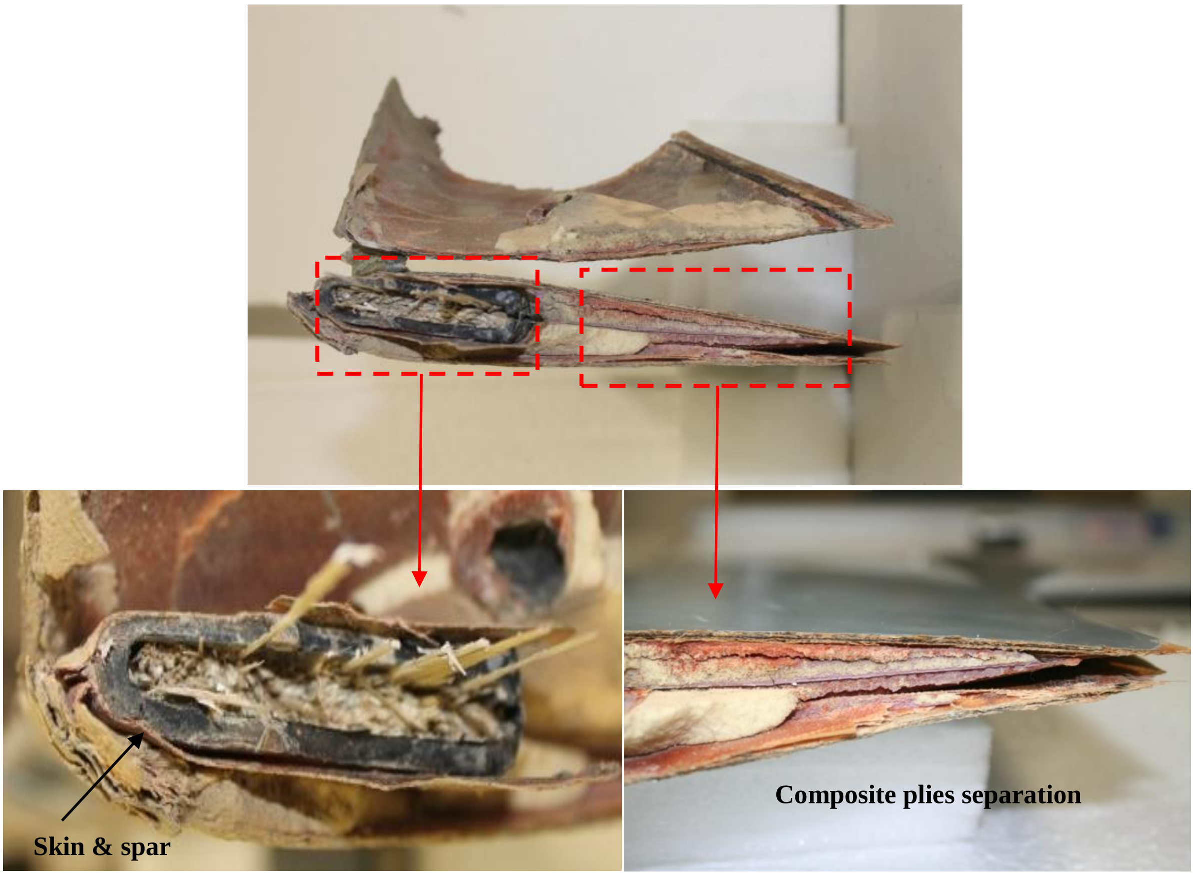
1.19.2 Examination

1.19.2.1 Visual Examination

Figure 14 shows several locations of damage occurred. It was observed that the leading edge of the tail rotor blade was teared up (Figure 14 (a)) at the root section caused by high impact force. From the cross section of Figure 14 (b), it was evident that the skin and spar was fractured due to consistent overload force. The same findings were expected as further examination of the inner section of the teared up tail rotor blade showed that it had experienced overload force as seen in Figure 14 (c).



(a)

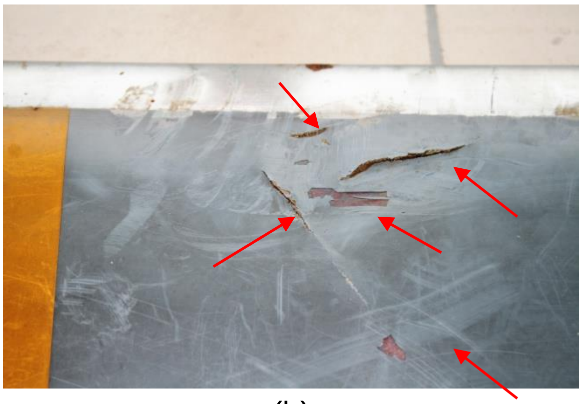


(b)

(c)

Figure 14: The damage due to high impact

Examination on the inner and outer skin of the tail rotor blade showed, several locations of peeled off paint, scratched and dented marks as shown in Figure 15 (a) and 15 (b). This is due to impact from foreign or unknown outside object.



(a) (b)

Figure 15: Damage at inner and outer skin of tail rotor blade

1.19.2.2 Macroscopic Examination

Further analysis was done using Zeiss Stereo Microscope for macroscopic examination. Six locations were marked based from the severe condition as shown in Figure 16. At Location 1, the arrow shows the direction of bending forces which acted along the leading edge of the blade. The marking from the high impact force are shown by the striation lines at the damaged hole at Location 2. Sign of fractured along the trailing edge of the blade indicates a consistent upward direction of high impact at Location 3. Cracking traces of fibers are the result of high impact at Location 4 and 5. Severe damage showed that high impact happened at the outer skin and middle part of the span near the trailing edge. As a result, the skin and the fibers were twisted and pressed downwards from that deep impact in Location 6.

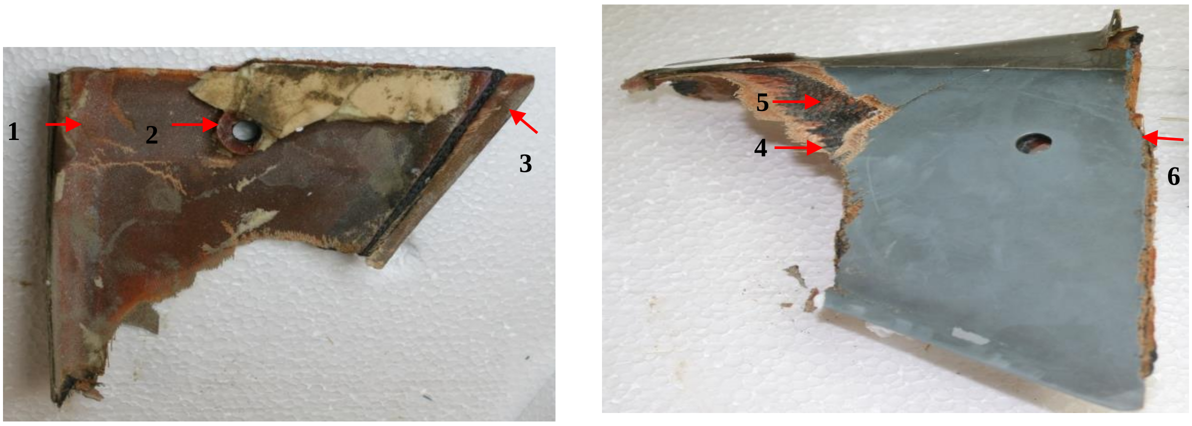
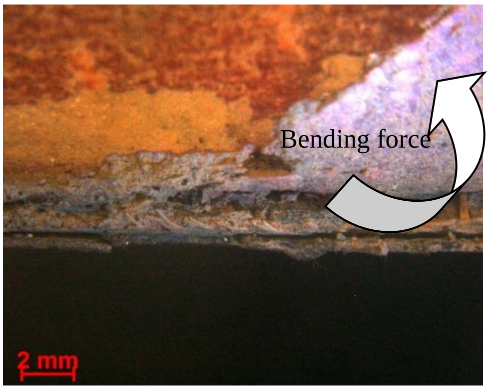
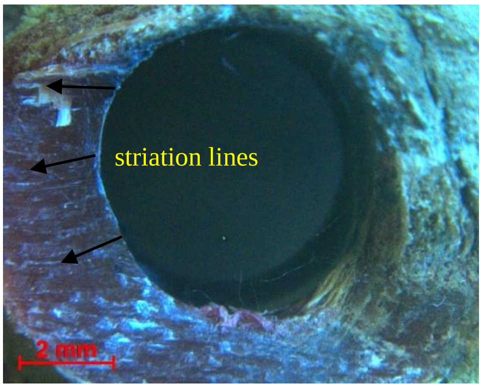


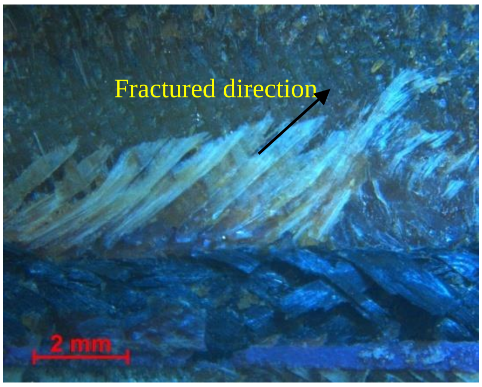
Figure 16 : Selected locations for macroscopic examination



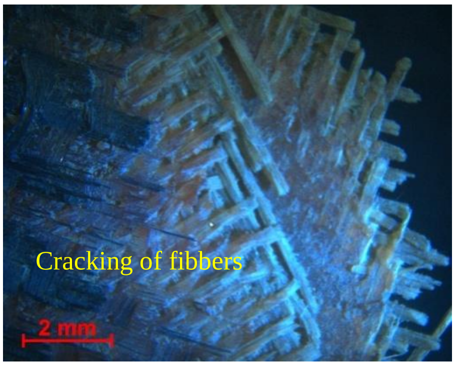
(a) Location 1



(b) Location 2

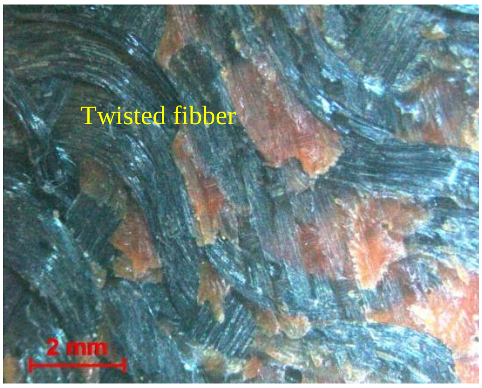


(c) Location 3



(d) Location 4

(e) Location 5



(f) Location 6

Figure 17: Tail Rotor Blade fracture direction due to the impact

1.19.2.3 Microscopic Examination

Microscopic examination was carried out using Scanning Electron Microscope (SEM) on the selected regions of the fracture surface as shown in Figure 18. Figure 19 shows a micrograph of the fracture surface that revealed a fibers rupture in pull out mode due to over load during the incident.

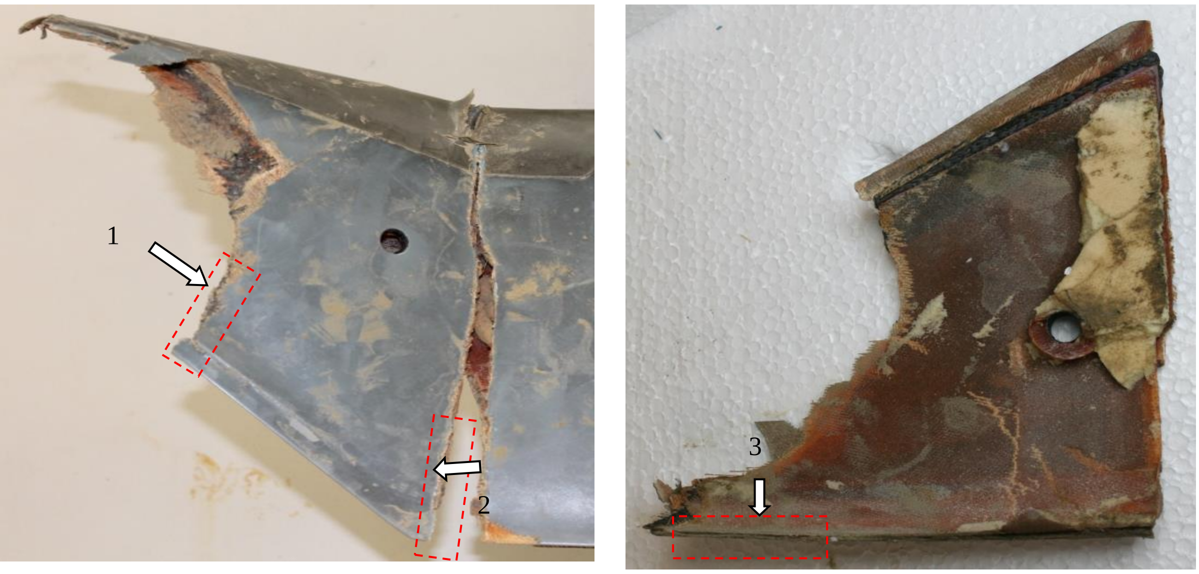
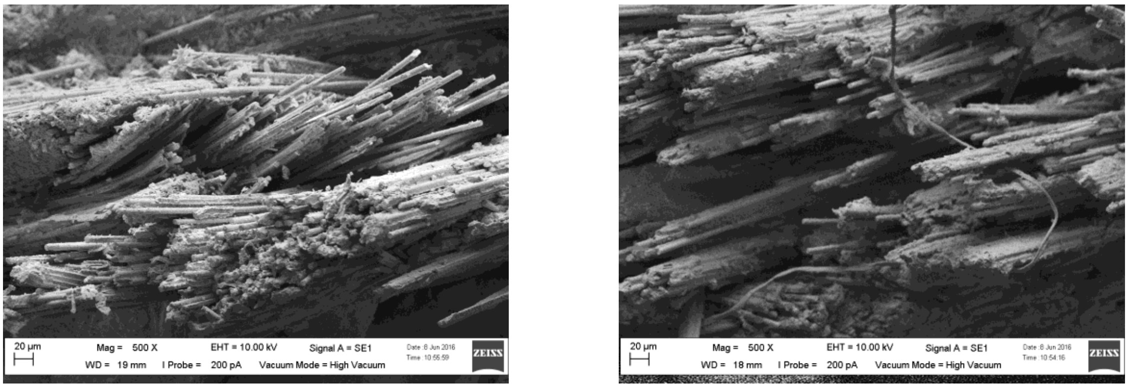
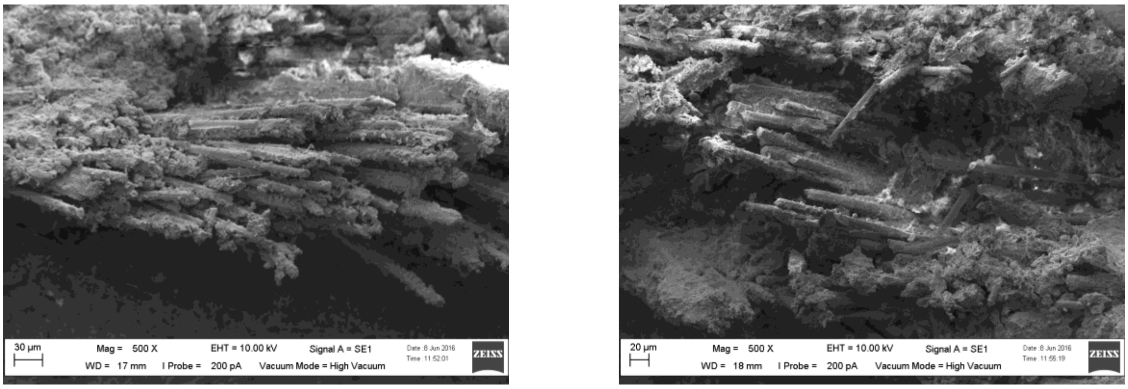


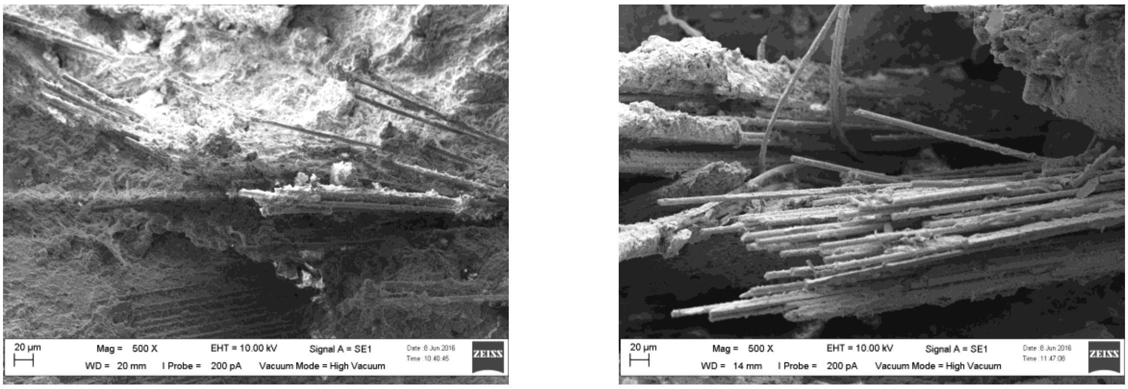
Figure 18: Three (3) different location of the fractured teared off the root section examined under SEM



SEM-Location 1



SEM-Location 2



SEM-Location 3

Figure 19: SEM images of the broken rotor blades show a fibers rupture in pull out mode during the incident

1.19.2.4 Visual examination of the tail rotor blade showed several damage has occurred. It was observed that the leading edge of the tail rotor blade was teared up at the root section. It also found an evidence of the damage and the fractured skin, spar, hole and composite plies separation due to the high impact. The inner and outer skin of the tail rotor blade found to has several paints peeled off, scratched and dented surfaces.

1.19.2.5 Macroscopic examination could suggest the impact and fractured direction of the blade during the separation. Examined on the several locations of the carbon fiber and composite plies showed similarities in direction resulted from the high impact of the adjacent object (could be tail boom). Carbon fiber and glass epoxy has fractured in multi directional to indicate the incident load is higher than the ultimate strength of the material. Twisted and disoriented carbon fiber material indicates high impact coupled with the rotating tail rotor blade during the impact.

1.19.2.6 SEM analysis of the fractured tail rotor blade found the fractured fiber in pull out mode to indicate the high impact and overload failure.

1.19.2.7 The finding of examination has been simplified in the schematic drawing (Figure 20) to show the sequence of the event that could contribute to the tail rotor blade failure.

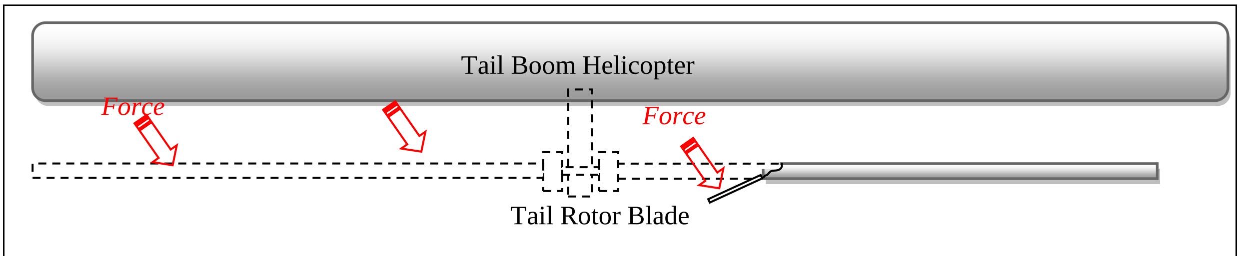


Figure 20: Schematic drawing of the tail rotor blade

1.19.2.8 From the examination, it was suggested the tail rotor blade was struck and detached from its position by the tail boom at high impact. There is no other premature crack or abnormalities found in the examination.

2.0 Analysis

2.1 General

2.1.1 Examination of the helicopter maintenance records revealed the maintenance was carried out in accordance with the published procedure and found to be in order. RP-C6828 has less than two years in service since registration under the Philippines registry. There was no abnormality recorded since it arrived Kuching on the 29 April 2016.

2.1.2 The pilot was well rested for the flight. Based on several witnesses' statement, he was very cautious about navigation and weather condition for the flight on the 05 April 2016. Although he had sufficient experience as a pilot on AS 350B3, he lacked local terrain knowledge and weather pattern since this was his first flying tour in the State of Sarawak. On this fatal flight he was not provided with the latest weather report for the Betong to Kuching route. According to his technician, based in Kuching, he made several phone calls prior to his departure from Betong enquiring about the weather condition at Kuching Airport.

2.1.3 After the helicopter landed at Spaoh, a huge storm was detected moving from Kuching area to the North East passing through Batang Lupar at around 1630 LT. At Spaoh, he was scheduled to pick up 3 (three) passengers and fly to Kuching. However, there was a change of schedule whereby he was asked to fly to Betong instead. Due to his unfamiliarity with the landing point at Betong, an officer from the State Office came on board to help to identify the landing point at Betong rest house. Upon landing Betong, with the engine running and the rotor turning 5 (five) passengers boarded for the flight to Kuching. It took off at 1612 LT. The change of schedule could have led him to rush the flight to Kuching, knowingly the weather direct route to Kuching was raining with storm and strong wind.

2.1.4 Standard radio call was made at 1612 LT on frequency 134.75 MHz to Kuching Information, giving number of passengers on board (5), one hour thirty two minutes of fuel endurance and flying at, one thousand feet and below. He made another radio call at 1615 LT giving the estimate time abeam Triso at 1626 LT and estimate time Simunjan in twenty minutes. That was the last radio call made from this flight. There was no distress call heard in all operating frequencies to indicate any distress. The absence of distress call from flight RP C6828 led the investigation to believe that there was no technical related malfunction. According to witnesses flying during the time, there was no reply by the pilot of RP C6828 even several radio calls were made on company frequency of 131.3 MHz. This silence indicated probability of high workload on the pilot during the flight.

2.1.5 When DETRESFA was declared by the ATC at 2326 LT, extensive search was carried out by land, water and the air to locate the helicopter. The first body was found in the river near Lingga at 1205 LT on the second day of the accident. The search was intensified focusing over the river where 4 bodies were found not far from where the first body was found. The 6th body, the pilot, was found at Sebuyau area on the sixth day of search, which was 30 kilometres away from the first location. All bodies were found and recovered from the river and brought to nearby hospital for post mortem. (See bodies' location at Appendix 8). All the bodies were recovered outside the helicopter indicating it impacted the water with high rate of descent and probably high forward speed. The last body recovered after six days at 30 Kilometres downstream was due to river current drifted him downstream towards the sea.

2.1.6 Several debris or helicopter parts were recovered in the river and retrieved for investigation purposes. The main parts of the helicopter main frame, main gearbox and the engine were still missing. Search using sonar equipment were utilised to search for the mainframe but were not successful. The distribution of the debris clearly indicated that the helicopter impacted the river water with high rate of descend and high velocity causing the helicopter parts to be broken, detached and thrown out from the main frame.

2.1.7 The investigation had difficulty to accurately determine the sequence of the accident without the availability of Cockpit Voice Recorder and Flight Data Recorder information. Additionally there was no reliable eyewitness on ground that witness the helicopter during the last moment of the flight before the impact. The investigation had to focus all available material evidences, air traffic recordings and flight crew flying during that time as witnesses for the analysis. The detailed analysis is divided into several areas as follows:

2.2 Severity of the weather

TAFOR (Terminal Forecast) for Kuching Airport and Sri Aman Meteorological Station issued at 0700 LT and 1300 LT forecasted rain thunderstorm (TSRA) between 1400 LT to 2000 LT on 05 May 2016. Aerodrome Warning was also released issued at 1410 LT for Kuching airport. Three Significant Weather Warning (SIGMET) for WBKK FIR was released at 0955 LT, 1255 LT and 1555 LT on 05 May 2016.

Based on the weather information, it can be concluded that there was a group formation of cumulonimbus that brings rain to the eastern part of Sarawak This includes the location of the accident as the clouds were moving towards the northwest with intensity increasing at 1430 LT and continue until 1700 LT. According to the radar, echoes were also found, the group was not a high-intensity cloud after 1700 LT (Appendix C).

5 helicopters (9M-WSE 9M -WSA, 9M-WSM 9M-AWB and 9M-AZK) that were flying in the same area at about the same time reported heavy rain with strong winds over Lingga area.

Based on the forecast and actual weather investigation believed that the flight has penetrated the rain and flying over the river at Lingga area.

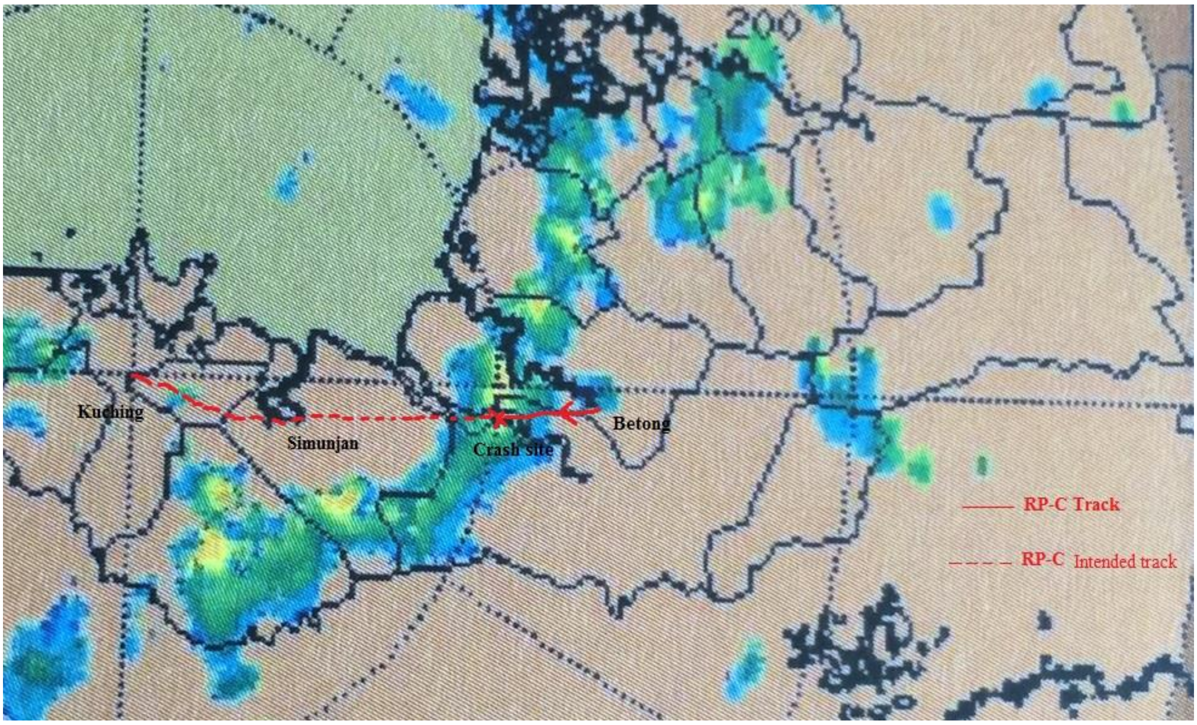


Figure 21 : Satellite weather at 1630 LT on the 5th May 2016

2.3 Distribution and condition of the debris found

2.3.1 Twenty-one (21) items from RP-C6828 parts were found in the river during the search phase. However, the main frame, engine, main gearbox, main rotors, fuel tank etc. were still missing. The focus by the investigators was the portion of tail rotor blade that was found on the second day of the accident. The broken part was taken to Science and Technology Research Institute for defence (STRIDE) for detailed examination. It was described in detail at paragraph 1.19 above.

2.3.2 The investigation strongly believed that the tail rotor was at high energy rotational speed shortly before the impact. The absence of damage at the blade leading edge indicated that it did not strike any hard object, instead the tail rotor blades strike the river surface. This was indicated by the sideway bending of the blade.

2.3.3 Visual inspection on the recovered left skid together with partial inflation of the float showed that the skid was exposed to high vertical impact during the crash. The broken part of the skid is shown in Appendix E, figure 20. The floatation device was not activated indicating the accident happened so sudden that the pilot failed to activate it.

2.4 Autopsy report

All the bodies were transported to Forensic Medicine Department, Sarawak General Hospital for an autopsy examination. All the victims were believed to have died on impact. Based on the post mortem examination the victims died of head, chest and abdominal injuries which were consistent with high deceleration Gravity forces crash. Investigation estimated the deceleration was between 20 to 300 Gs. The helicopter believed to have crashed with high forward and vertical speed.

2.5 Incapacitation

The post mortem of the pilot's body, discovered a solitary gallstone found in his gall bladder. The investigation believed this will not cause any sudden incapacitation. There was no indication of cholesterol found from the carotid or aorta that can cause sudden incapacitation in flight.

2.6 Route selection by the pilot

The required route by Air Information Publication on VFR routes from Betong to Kuching is via Simunjan. Since the pilot was not familiar with the terrain and the severity of the weather during the flight, he could have navigated using the GPS information for the direct route to Simunjan which was the reporting point for VFR flight to enter Kuching control through VFR lane 4. However, before he could reach Simunjan at 1620LT, the weather surrounding Lingga, based on the satellite picture was covered with squalls and thunderstorm. He could have flown into the rain directly to Simunjan. See figure 22a and 22 b.

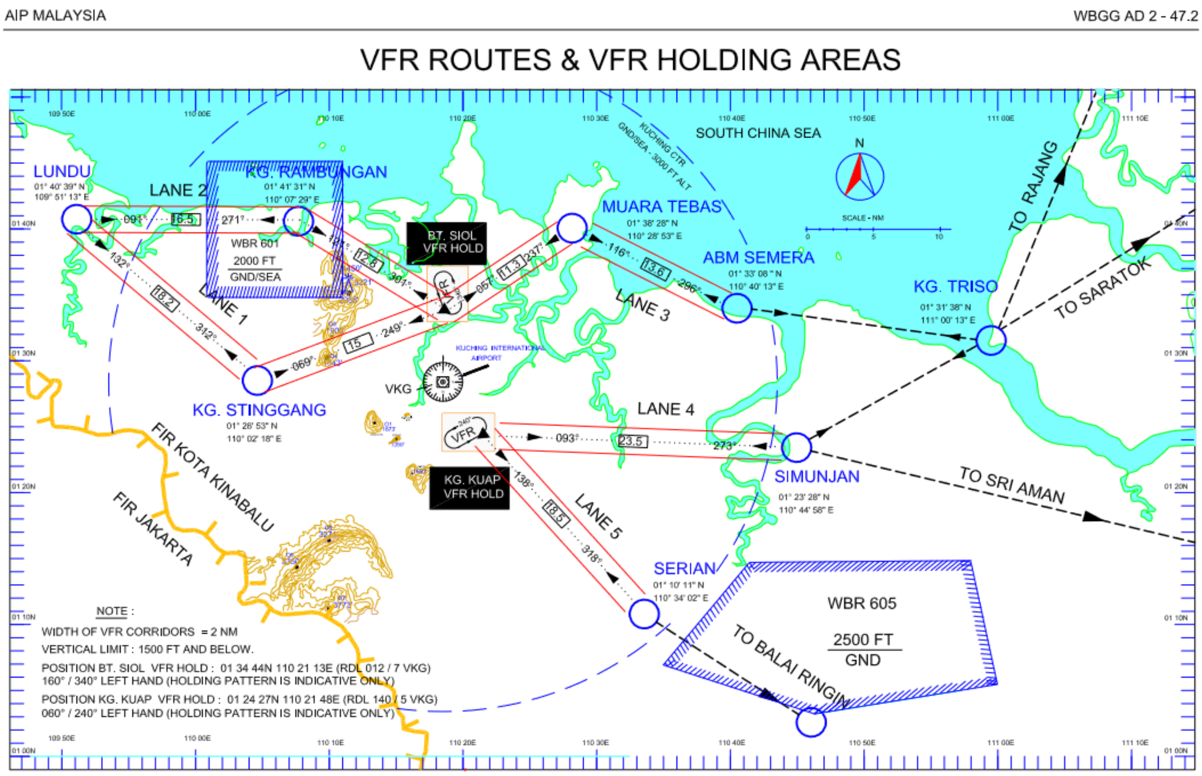


Figure 22a : VFR routes and VFR holding areas

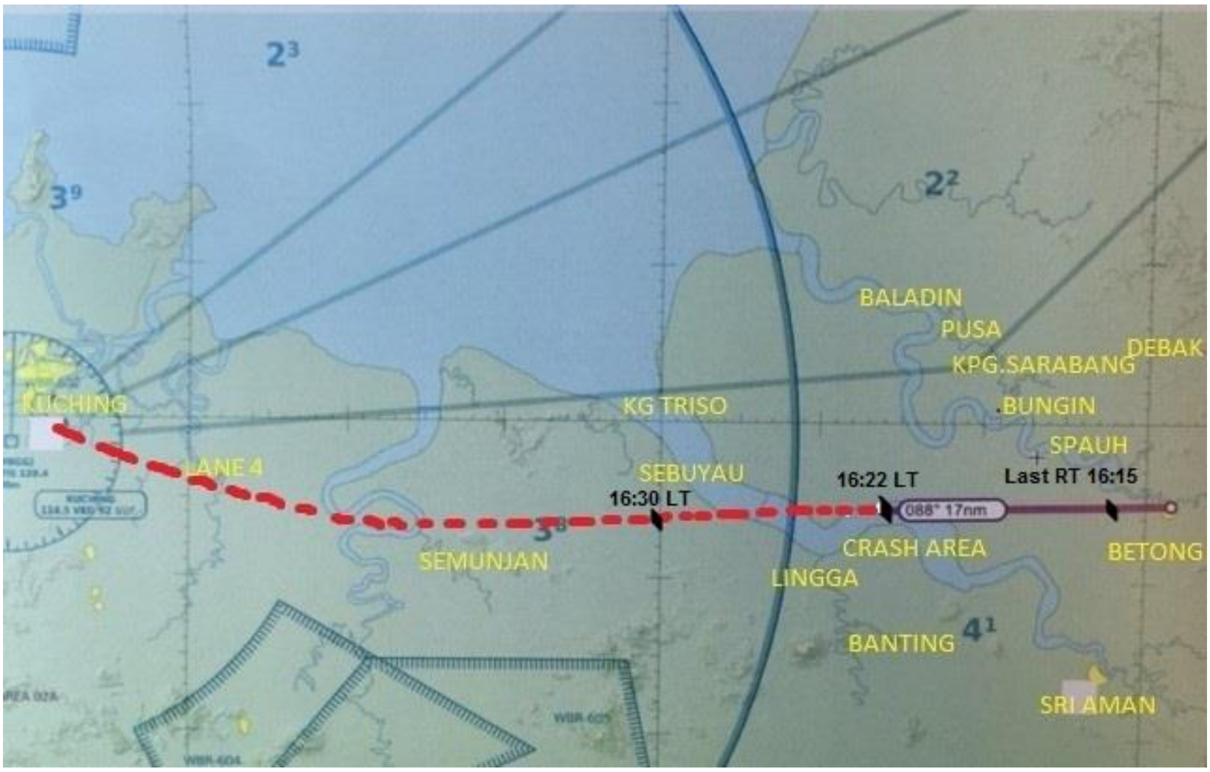


Figure 22b : The estimated time and position of the RP-C6828

2.7 Pilot decision making

It was believed that the pilot was under tremendous stress prior to the crash. There was no response to several radio calls made by other helicopter pilots flying in the area. His last transmission call was at 1620 LT. The thunderstorm, rain and lack of local terrain and weather knowledge could have hindered his ability to make effective decisions. The behaviour pattern to complete a planned flight to accommodate passenger's convenience, could lead him to continue the flight even with unfavourable weather conditions. This action indicated that the pilot lacked the crew resource management knowledge for an effective decision making prior to entering weather conditions. (Please refer to Appendix B for single pilot crew resource management guidelines.)

2.8 The crash

Since the flight was conducted at a considerably low height of 1,000 feet and below, rain falls on the windscreen could reduce forward visibility. To ensure effective visibility, the forward speed would have to be reduced to allow reaction time in the event of obstacles en-route. The other option that most experience pilot do, is to descend visually, terrain permitting. Added to this, the murky river and ripples on the river surface could lead to lose of horizon and susceptible to disorientation. Another contributing factor that lead to the crash was possibly due to the lack of reference to flight instruments, resulting in loss of height unnoticed. The examination of the bodies indicated that all body injuries were due to extreme impact on their forehead and most of the long and short bones were fractured which was consistent to high velocity impact. The pilot seat belt had snapped and one of the front seats came off from the floor attachments due to tremendous G forces against the helicopter floor. See Attachment C which depicted the damages on the parts recovered.

2.9 Lightning

Examination of the helicopter parts that were found during the search and rescue did not indicate any evidence of lightning strike. The victim's body also did not show any indication of lightning strike.

2.10 Spatial Disorientation

2.10.1 Spatial disorientation (SD) is defined as the inability of a pilot to correctly interpret aircraft attitude, altitude or airspeed in relation to the Earth or other points of reference. It is a very common problem, and it has been estimated that the chance of a pilot experiencing SD during their career is in the order of 90 to 100 per cent. Statistics show that between 5% to 10% of all general aviation accidents can be attributed to SD, 90% of which are fatal.

2.10.2 In this case, conditions exist that point towards SD as a probable cause of the accident. Flight into poor weather conditions with low forward visibility, lack of a visual horizon as a reference and flying low and fast over a vast expanse of water devoid of features which may provide visual orientation cues. Couple this with an aircraft which is not IFR Rated and a pilot with very limited instrument flight experience (only 20 hours on a simulator in 2009) the chances of SD occurring are very high.

2.11 Declaration of Search and Rescue by Kuching Air Traffic Control Centre

It was found that INCERFA, the first phase of emergency was never officially declared. Based on the standard operating procedures INCERFA should have been declared at 1638 LT, 3 minutes after the estimated time over Simunjan which was at 1635 LT. Based on the interview with the ATCO and examination of the log books,
ALERFA and DETRESFA were declared well beyond the alert phase and the expected fuel exhaustion time of the 1 hour and thirty two minutes of endurance was given earlier.

2.12 Previous helicopter accident in the same area due to bad weather

On the 20th July 2012, a USA registered helicopter, N8899 crashed into the Batang Lupar not far from Sebuyau. The helicopter was flown with 4 persons on board. They were flying from Kuching to Nanga Merik, near Kapit. The weather was marginal with light rain and low clouds. It flew low to maintain Visual Flight Rule. After 25 minutes' flight from Kuching, while crossing Batang Lupar, the pilot decided to turn back 180 degrees' anti clock wise over the river to return over land. During the turn the helicopter descended unnoticed and the main rotors hit the water and subsequently crashed into the river. The pilot managed to swim to the shore but all the passengers drowned. All 3 bodies were recovered. The wreckage sunk and is still missing until today.

3.0 CONCLUSION

3.1 Findings

3.1.1 The helicopter was airworthy and maintenance records showed no anomaly.

3.1.2 The pilot was experienced and properly licensed for the operation. However he was not familiar with the local terrain and weather pattern.

3.1.3 The handling of overdue aircraft by Kuching Air Traffic Control Centre was slow and not in accordance with the published Standard Operating Procedure.

3.1.4 The forecast and actual weather surrounding the suspected crash area was raining with thunderstorm during the flight.

3.1.5 Absence of constant operational surveillance capability slowed the activation of SAR.

3.1.6 There was no distress call made by the pilot and no distress signal from the helicopter before and immediately after the crashed.

3.1.7 All bodies were found in the river, which indicate that the most probable impact point was in the river near Lingga.

3.1.8 Twenty-one (21) helicopter parts were found in the river, which indicate the most probable impact point was in the river near Lingga and the helicopter main frame is still not found.

3.1.9 The allocation of passengers by the responsible operator to every helicopter (manifest) and weather information to the pilot was not properly carried out.

3.1.10 The pilot did not properly assess the risk of flying in the unfavourable weather versus the urgency to complete the flight schedule.

3.1.11 The pilot either had insuffient local knowledge or did not rationally consider the severity of the weather situation that obscured visibility leading to disorientation when flying over water.

3.2 Probable Cause

3.2.1 The most probable cause of the accident is the inability of the pilot to use all available information's to make the correct decision, so as not to make the flight susceptible to disorientation when flying over water at low altitude in bad weather with limited visibility.

4. Safety Recommendations

4.1 Malaysia and Philippines Civil Aviation Authorities are to ensure that VFR single pilot operations to have sufficient knowledge on decision making process when flying in marginal weather or in the vicinity of thunderstorm. It is for these authorities to make CRM or Aeronautical Decision Making course a mandatory knowledge to single pilot operations. (See guidance material provided at Appendix F)

4.2 DCA Air Traffic Controller should adhere to all procedures related to emergency responses as published in the Manual of Air Traffic Services, especially on the timing for declaration of each phase of emergency so that other SAR Agencies will be able to react accordingly.

4.3 Foreign pilots flying in Malaysia are to be familiar with and exposed to local terrain and weather pattern prior to flying on his own operationally. It is recommended 10 hours of under supervision flying prior to flying on his own.

Investigator-in-Charge

Air Accident Investigation Bureau

30 March 2017