AIRCRAFT ACCIDENT FINAL REPORT

A 03/15P

Air Accident Investigation Bureau (AAIB)

Ministry of Transport, Malaysia

Helicopter Dauphine AS 365 N3, Registration 9M-IGB

40 nautical miles south east of Subang Airport, Kuala Lumpur

on 04 April 2015

Air Accident Investigation Bureau
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Issued on 4 April 2016

AIR ACCIDENT INVESTIGATION BUREAU (AAIB)
MALAYSIA

REPORT NO.: A 03/15P

OWNER	**: ORION CORRIDOR SDN. BHD.**
AIRCRAFT TYPE	**: EUROCOPTER DAUPHIN**
MODEL	**: AS 365 N3**
NATIONALITY OF AIRCRAFT	**: MALAYSIA**
REGISTRATION	**: 9M-IGB**
YEAR OF MANUFACTURE	**: 1990**
SERIAL NUMBER	**: 6374**
PLACE OF OCCURRENCE	**: 40 Nautical Miles SE of Subang Airport MALAYSIA (N 03 00.64 E101 51.19)**
DATE AND TIME	**: 04 APRIL 2015 AT 1654 LT**

The sole objective of the investigation is the prevention of accidents and incidents. In accordance with Annex 13 to the Convention on International Civil Aviation, it is not the purpose of this investigation to apportion blame or liability.

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

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 these investigations in accordance with Annex 13 to the Chicago Convention, the Civil Aviation Act of Malaysia 1969, and the Civil Aviation Regulations of Malaysia 2016.

It is inappropriate that AAIB reports should be used to assign fault or blame or determine liability since neither the investigations nor the reporting processes have been undertaken for that purpose.

In accordance with ICAO Annex 13 paragraph 4.1, notification of the serious incident was sent out on 17 December 2022 to the National Transport Safety Board (NTSB), United States of America as the State of Design and Manufacture. A copy of the Preliminary Report was subsequently submitted to the Civil Aviation Authority of Malaysia (CAAM), Malaysia Airport Sendirian Berhad (MASH), and the Aircraft Operator on 13 January 2023.

In accordance with ICAO Annex 13 paragraph 6.3, the Draft Final Report was sent out on 07 July 2023 to the State of Registry (CAAM), the State of Manufacturer (National Transport Safety Board), the Aerodrome Operator (Malaysia Airport Sendirian Berhad), and the Aircraft Operator (Layang-Layang Flying Academy) inviting their significant and substantiated comments on the report.

Unless otherwise indicated, recommendations in this report are addressed to the investigating or regulatory authorities of the State having responsibility for the matters with which the recommendations are concerned. It is for those authorities to decide what action is to be taken

TABLE OF CONTENTS

ABBREVIATIONS

AIB	Air Accidents Investigation Branch
AOC	Air Operator Certificate
AMM	Aircraft Maintenance Manual
ALT	Altitude mode on Auto Pilot
BEA	Bureau d’Enquetes et d’Analyses
CAM	Cockpit Area Microphone
CVR/FDR	Cockpit Voice Recorder/Flight Data Recorder
CMR	Certificate of Maintenance Review
CG	Centre of Gravity
DVI	Disaster Victim Identification
DECU	Digital Engine Control Unit
ENT	Ear Nose and Throat
ESM	Electronic Scanning Microscope
FAA	Federal Aviation Administration
HS	Horizontal Stabiliser
ICS	Inter- communication System
IAS	Indicated Air Speed
LT	Local Time (UTC+ 8 hours)
MRR/MTC	Airframe Repair Manual/ Standard Practice Manual
METAR	Routine Weather Report Provided at Fixed Interval
MGB	Main Gear Box
NACA	National Advisory Committee for Aeronautic
OEI	One Engine Inoperative
PFD	Primary Flight Display
SK LKB	Sekolah Kebangsaan Ladang Kota Bahagia (Open Field)
SSCVFDR	Solid State Combination Cockpit Voice and Flight Data Recorder
STRIDE	Science and Technology Research Institute for defence
TCAS	Traffic alert and Collision Avoidance System

ULB	Under water Locating Beacon
VIP	Very Important Person
VHF	Very High Frequency
VNE	Velocity Never Exceed

SYNOPSIS

On 04 April 2015 a Dauphin helicopter, AS365 N3 bearing registration 9M-IGB was on a private flight carrying 7 passengers from Pekan, Pahang at 1540 LT to Muadzam Shah. The flight was to transport passengers who had attended a series of meetings and wedding reception at Pekan. It landed Muadzam Shah at 1600 LT with the engine shut down for approximately 10 minutes. It then flew towards the South Westerly direction with the intention to land at Bandar Tun Razak with the same number of passengers on board. While en route, it started to rain towards the destination. Due to the unfavorable weather conditions, a decision was made by one of the passengers not to proceed to the destination; however, they decided to proceed directly to Subang. Since one of the passengers had to stay back at Muadzam Shah, the helicopter then landed at a football field along the main road to offload him. While landing at the football field, the left landing gear suddenly sunk into the ground. The pilot subsequently maneuvered the helicopter to a hover and repositioned it about 10 meters forward. One passenger disembarked from the right passenger door and the helicopter took off from the field on a westerly heading en route to Subang airport. With 6 passengers onboard, it climbed to 2,000 feet. After passing Kuala Klawang, the helicopter made a last recorded radio call and started to descend to 1,500 feet. According to an eyewitness report on ground, he saw the helicopter suddenly making a steep dive and crashed into a rubber tree plantation.

A pilot of another helicopter, an EC155, flying from the south, who was earlier in communication with the ill-fated helicopter, saw the helicopter make a steep dive to the ground followed by black smoke. The ill-fated helicopter altitude based on the TCAS of EC 155 was estimated to be approximately at 1,700 feet. Upon observing the helicopter had crashed to the ground, the pilot of the EC155 made a radio call on the operating frequency and informed the sighting to Lumpur Information. There was no distress call made by the crew of the ill-fated helicopter on any of the operating frequencies.

Several witnesses on ground also claimed that they heard a loud noise from the helicopter followed by a steep descent to the ground. The helicopter crashed into a ravine and caught fire. All occupants were fatally injured.

The Chief Inspector of the Air Accident Investigation Bureau was informed immediately of the accident. An Investigation team was appointed by the Minister of Transport which comprised of 9 members headed by Captain Dato Yahaya bin Abdul Rahman as the Investigator-In-Charge. The investigation began at the crash site on 05 April 2015.

The investigation was assisted by BEA, France as Accredited Representative. The Air Accident Investigation Branch of the United Kingdom was also involved in the downloading of the SSCVFDR.

1.0 FACTUAL INFORMATION

1.1 History of the Flight

A privately-owned helicopter, Dauphin AS365 N3, registration 9M-IGB departed Subang Airport on 02 April 2015 at 1815 LT for Tanjong Gemok, Rompin, Pahang, with a pilot and 3 passengers on board. From Tanjung Gemok, after 2 of the passengers disembarked, the pilot and a female passenger continued to depart for Lanjut, Pahang, and arrived at 1930 LT for an overnight stay.

(For easy reference of this report, the subsequent helicopter registration will be termed as IGB).

On 03 April 2015, at 0902 LT, IGB departed Lanjut with the pilot and the same female passenger occupying the front left-hand seat. It flew to Tanjung Gemuk to pick up 3 passengers and then to Muadzam Shah. It stayed on the ground at both locations for approximately 15 minutes and departed for Kuantan Airport at 1510 LT. It arrived at Kuantan Airport at 1532 LT. After disembarking all the passengers, it departed Kuantan Airport with 2 persons on board, the female pilot and a passenger, departed for Kerteh Airport, Terengganu. At Kerteh, the crew refuelled the helicopter with 935 liters of aviation fuel (Avtur). It flew back to Kuantan airport and landed at 1700 LT for a night stay.

On 04 April 2015, it departed Kuantan airport at 1141 LT as per the flight plan, with the same pilot and the female passenger en route to Pekan. The short flight to Pekan was to pick up passengers for an onward flight back to Subang. It landed Pekan at 1213 LT and stayed on the ground for more than 3 hours. 5 joining passengers boarded the helicopter with the female passenger occupying the front left seat. It departed Pekan at 1540 LT for Muadzam Shah. The flight was uneventful and on arriving Muadzam Shah, one of the passengers suggested to land at an area near an abandoned factory for 5 minutes. The engines and rotors were shut down to allow the passengers to disembark to view the abandoned factory building. At 1600 LT, all 6 passengers boarded the helicopter, with the pilot occupying the front right seat and the female passenger occupying the front left seat.

The helicopter departed Muadzam Shah at 1610 LT with 7 persons on board. Initially, it was flying towards a South Westerly heading to a town called Bandar Tun Razak in

Rompin district. The Cockpit Voice Recorder (CVR) information revealed that after getting airborne, one of the passengers was not happy with the weather conditions en route to the destination. On several occasions, he suggested to the pilot to proceed direct to Kuala Lumpur. However, after a short discussion, they concurred to offload one of the passengers originally destined for Bandar Tun Razak, at any open field along the way. While flying along the road en route to Kuala Lumpur, they spotted a football field and executed an approach for a landing.

During the final approach, there was a moment of silence in the intercom until the helicopter was getting close to the ground for the landing. Upon landing, the CVR picked up a loud “thud’ sound which alerted the passengers. One of the passengers commented in the intercom system by saying 'watch out' twice. The pilot was uncertain about the landing gear position by saying “why my landing gear… is it down? I got three in the green, I am little nervous about this now, let me see it”. The female passenger was heard in the intercom by saying “it’s ok... it’s a… the dirt at the back… its ok…”. The female passenger continues “wheel went into the ground…, it’s a soft ground there.. after the rain .. we are good, we are good.. yes.. yes.. yes, we are good; it’s a soft ground there.. after the rain.. it’s the field… it’s the football field. The pilot then commented, “wow… that was crazy”.

According to a witness statement, he saw the helicopter's left wheel sunk into the ground and the helicopter tilted to the left. Shortly afterward, the helicopter was seen to take off to a high hover and repositioned to approximately 10 meters to the front of its last position. One passenger disembarked the helicopter while both engines and the main rotors were still running and he exited via the right door escorted by the pilot. Shortly afterward at 1625 LT, the helicopter took off from the field. As it climbed to a cruising altitude, the lady passenger commented through the intercom “Don’t worry, we absolutely safe”. The lady passenger reminded the pilot “shall we collapse our gear” and the pilot responded “no.. no.. no .. leave it down, there is probably some damage to the hydraulic or something” The pilot said “we went all the way to the belly, it’s not good”. He further said “it’s definitely not normal for the wheels go down into the ground that far”. It’s definitely not good to tip like that”. He said “as a matter of fact, I saw hydraulic fluid leaking and that’s why I don’t want to put them up”. They are locked in the down position and we keep them locked in the down position”.

At 1631 LT, a radio call to Lumpur Information on frequency 126.1 Mhz was made by the pilot that he had passed Muadzam and Bandar Tun Razak, tracking for Kuala Klawang at 2,000 feet and below with 6 persons on board and endurance of 1 hour 45 minutes.

At the same time, there was another helicopter, EC155 registration 9M-DBI flying from Johor Bahru to Subang. There was communication between the two pilots to maintain a safe separation.

At 1652 LT, IGB disappeared from the radar screen, and at 1654 LT, 9M-DBI made a radio call to Lumpur informing that IGB had crashed.

From the Air Traffic Control record, there was no distress call made by the pilot on any operating radio frequency.

The helicopter was found crashed in a ravine at a rubber plantation, Kampung Sungai Pening-Pening, Semenyih approximately 40 nautical miles to the East of Subang Airport. All the 6 occupants were fatally injured.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others	Total
Fatal	01	05	NIL	06
Serious	NIL	NIL	NIL	NIL
Minor/None	01	NIL	NIL	NIL

1.3 Damage to Aircraft

The aircraft wreckage was significantly damaged by the impact forces and the post-crash fire at the bottom of a ravine. Many of the aircraft parts including MGB and engine cowling, engine exhaust pipe, main rotor head and blades, entire fenestron, main landing gears, and fuselage doors were collected from a distance of about 300 meters from the main wreckage along the steep slope of the hills. The parts recovered were on the suspected trajectory of the route flown. No evidence of aircraft contacts with the terrain until the vertical impact of the main wreckage. All the parts recovered have been made available for examination in a hangar. The helicopter was destroyed due to high impact and consumed by post-crash fire. (See Figure 1 below)

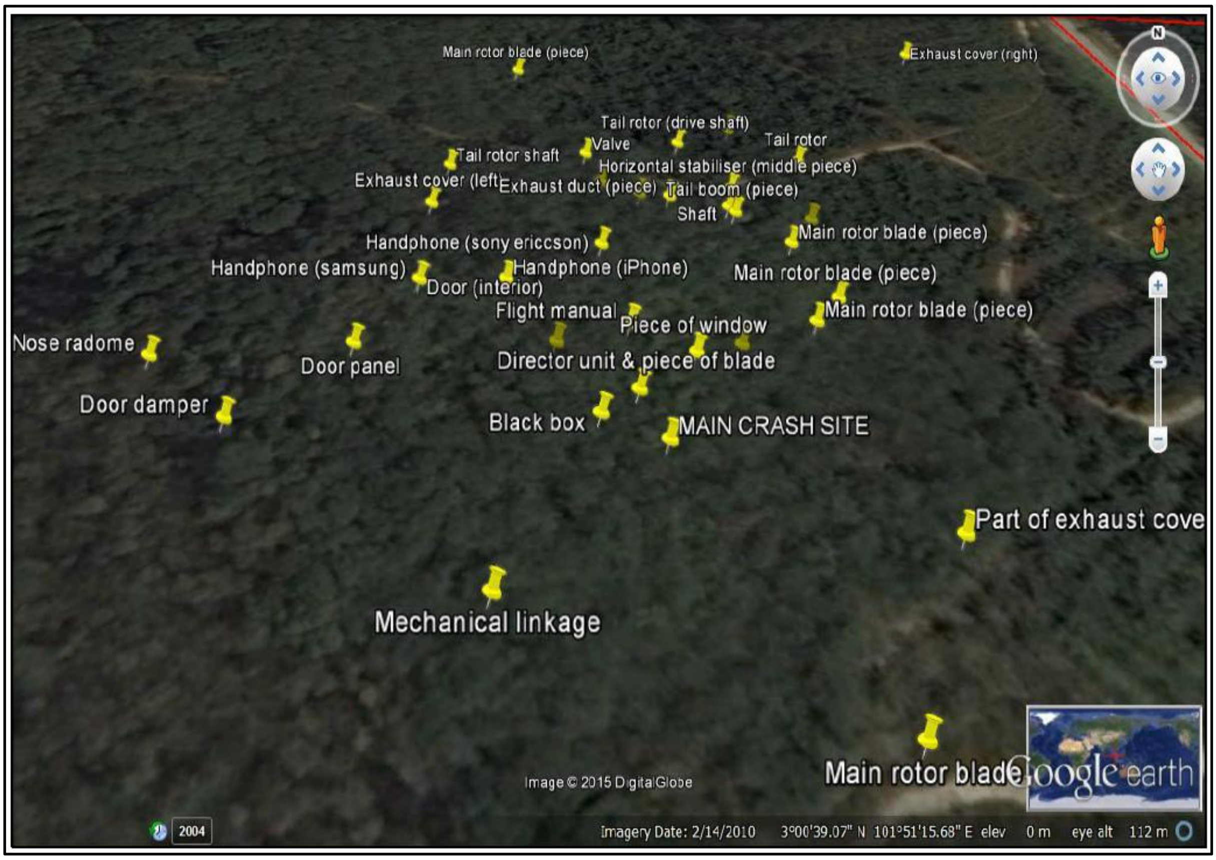


Figure 1: Wreckage distribution

1.4 Other Damage

Nil.

1.5 Personnel Information

15.1 The following are pertinent information related to the flight crew.

Status	Commander
Nationality	American
Age	47 years old
Gender	Male
License Type	CPL 2762/H

Medical Examination	Valid until 31 September 2015
Aircraft Rating	R22, R44, R66, AS 365N3
Certificate Test	04 November 2014
Instructor Rating	R44 & R66
Flying Experience	Total flying : 2,487:07 Hours Total on type : 188 Hours (AS 365 N3)

1.5.2 Pilot history

The pilot received his student pilot certificate on 28 May 1997 (3rd class medical) with 17 hours of flight time. On 02 June 2000, he received a 2nd class medical with 300 hours of flight time, listing a commercial certificate. His occupation was listed as sales for Power Sports. On 27 April 2001, he had 650 hours and listed Solaire Systems as his employer.

He was diagnosed with a problem in his left eye that stemmed from a minor myopia back in 1998; saw an ophthalmologist, and subsequently passed a 1st class medical on 6 July 2001. From 06 June 2001 to 07 August 2002, he listed “self” as employer.

From 25 July 2003 to the present, he was employed by Solaire as his employer.

On 25 July 2003 he was diagnosed with a minor high-tone hearing defect, saw an ENT, and passed his 1st class medical. His medical records recommend the use of hearing protection on him.

On 03 November 2007, he was involved in a motorbike accident in Kuala Lumpur and was admitted to the hospital. He had some head injury with no concussion, broken ribs, abdomen and limb contusions, and was intubated and ventilated. On 16 March 2007, he had an elective tracheostomy. Medical records indicated a full recovery. He then received a 1st class medical on 8 October 2007. From 2007 to the present, his medical records appear normal.

Earlier application records indicate he had some flying experience in the Marines prior to civilian flying. His last Certificate of Test was done on 04 November 2014 and is still valid.

1.6 Aircraft Information

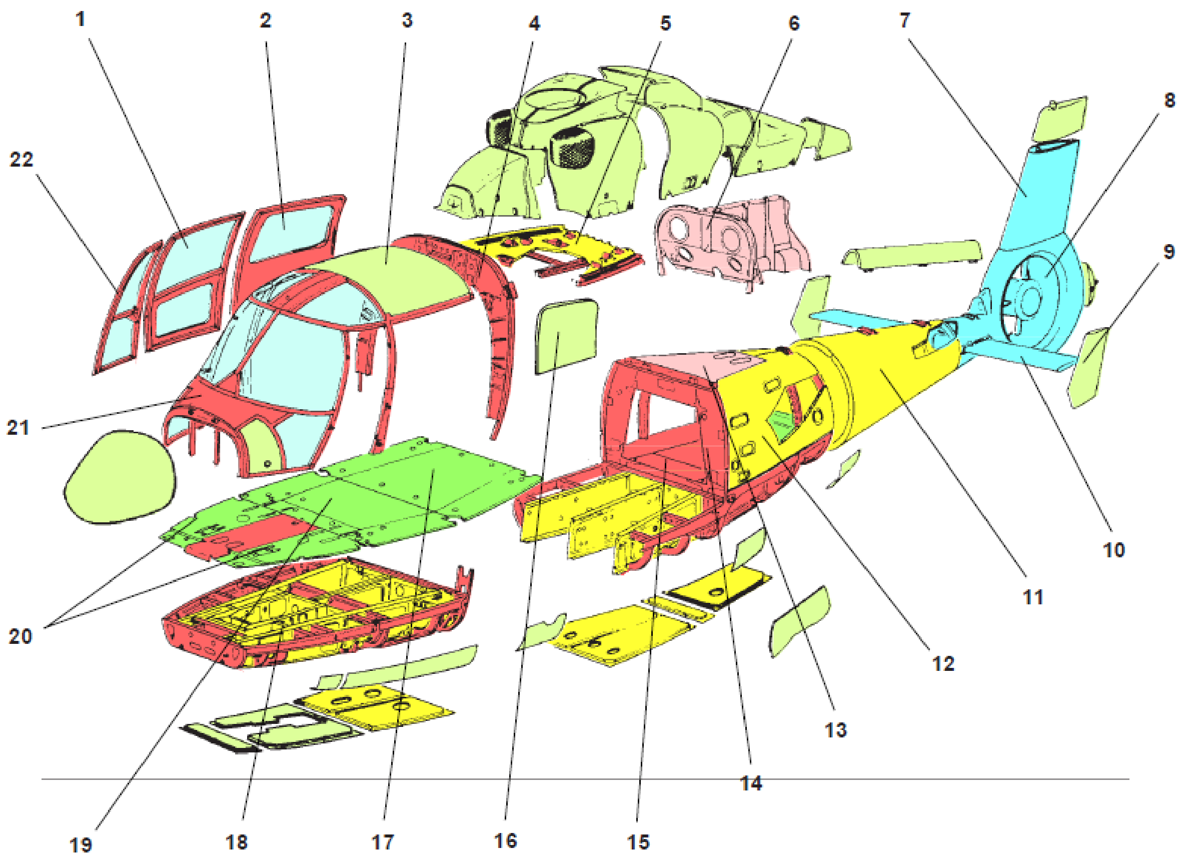
1.6.1 General

The AS 365 N3 is also known as Helicopter Dauphin 2. It is a twin-engine helicopter fitted with 2 Arriel 2C modular design free turbine turboshaft engines. It is designed for passenger transport, offshore, rescue, and aerial work operations. It is fitted with a standard seat of 1 pilot and 9 passengers.

The helicopter is fitted with 4 composite material main rotor blades aerofoil of high aerodynamic efficiency. The tail rotor is of fenestron design with 10 blades. The landing gear is of retractable tricycle type. It is complete with oleo-pneumatic shock absorber and hydraulic actuating cylinder. The nose landing gear is able to automatic centring and casting lock control. The hydraulic power generating system pumps are driven by the main gearbox and an electrically driven pump for emergency landing gear extension.

It is fitted with 2 fuel tanks groups and 2 booster pumps per engine which draw fuel from the feeder tank in each group. There is 1 transfer pump between the groups.

1.6.2 Main Structural Components



Light alloy	
Composite material : Fiberglass Kevlar or Nomex sandwich structure	
Nomex honeycomb, metal skin sandwich structure	
Metal honeycomb, metal skin sandwich structure	
Titanum	
Carbon fabric	
Plexiglas	

1 - Front passagers'door
2 - Rear passengers'door
3 - Ceiling
4 - 9° frame. Bears the attachment fitting of MGB front tie-bars
5 - Transmission deck
6 - Firewalls
7 - Fin
8 - "Fenestron" duct
9 - Outboard fin
10 - Horizontal stabilizer
11 - Tail boom. It is a buoyancy reserve
12 - Body structure
13 - Engine deck.
14 - Frame at station 4630. Bears the attachment fitting of MGB rear tie-bars and main landing gear attachment fitting.
15 - Hold floor. Acces to the rear fuel tank.
16 - Hold door. RH side only.
17 - Cabin rear floor. Acces to the central fuel tanks
18 - Hull.
19 - Cockpit floor. Acces to the front fuel tanks.
20 - Cabin forward floor.
21 - Forward structure. Canopy
22 - Pilot's door. Co-pilot's door opposite handed.

Figure 2

1.6.3 The horizontal stabiliser

The horizontal stabiliser (HS) is made up of one-piece carbon fiber which passes through perpendicular to the aft of the tail boom. The function is to counter any changes in the helicopter's attitude and to bring the helicopter back to its original attitude should it have deviated from it. At both ends fitted with two NOMEX sandwich structure side fins. Its asymmetrical NACA aerofoil, set at 2º 45' with respect to the helicopter datum. Under action of the relative wind V it will create an aerodynamic force F which tends to stabilise the helicopter back to a comfortable level attitude. In order to improve its performance, the HS is fitted with a Spoiler (5) on its leading edge and a step (4) on the trailing edge. (See Figure 4)

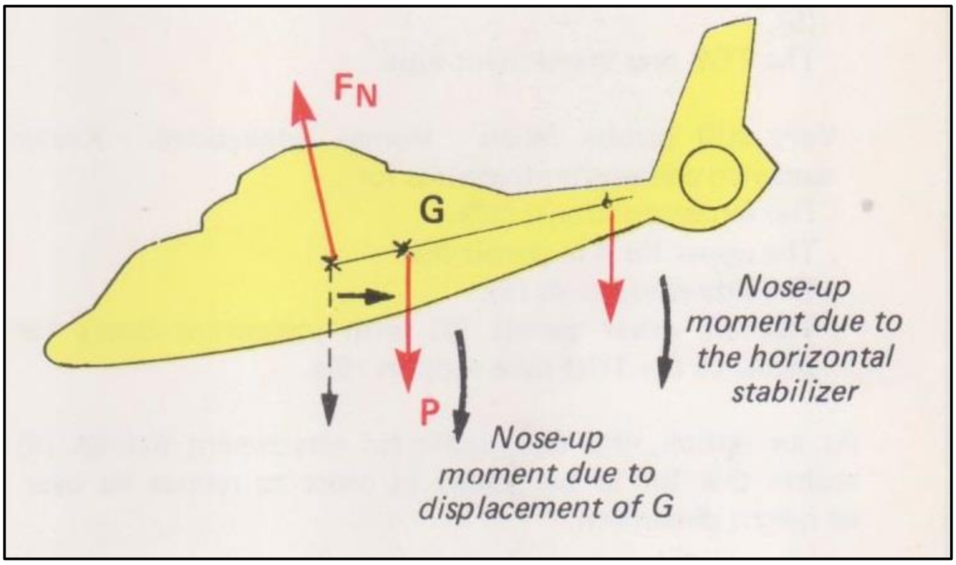


Figure 3

1.6.4 Spoiler

During the flight, the reduction in fuel weight causes the helicopter's centre of gravity to move aft. The displacement of CG will create a nose-up movement which is added to that caused by the action of HS. The spoiler on the leading edge acts as a detector when the helicopter reaches the horizontal position, the streamline flow breaks, and the force F is reduced as is the nose-up movement. This process enables the minimum permissible weight to be reduced without affecting the helicopter's performance. (See Figure 4)

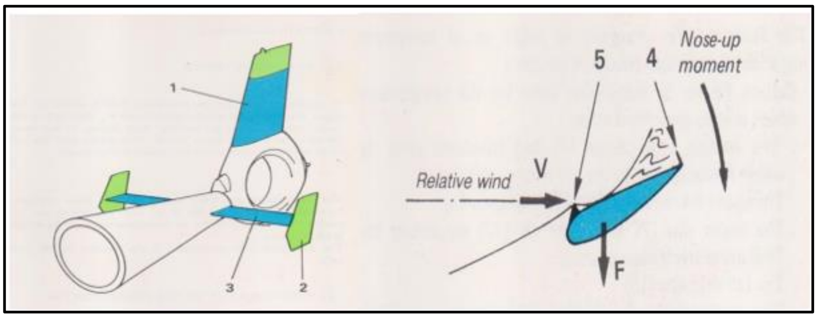


Figure 4

1.6.5 The step

The aerodynamic forces exerted on the HS depend on its surface area, the greater the surface area the more the forces increase. The steps enable the HS to be increased artificially by forcing the streamline flow back onto the aerofoil, under the suction pressure it creates. (See Figure 5)

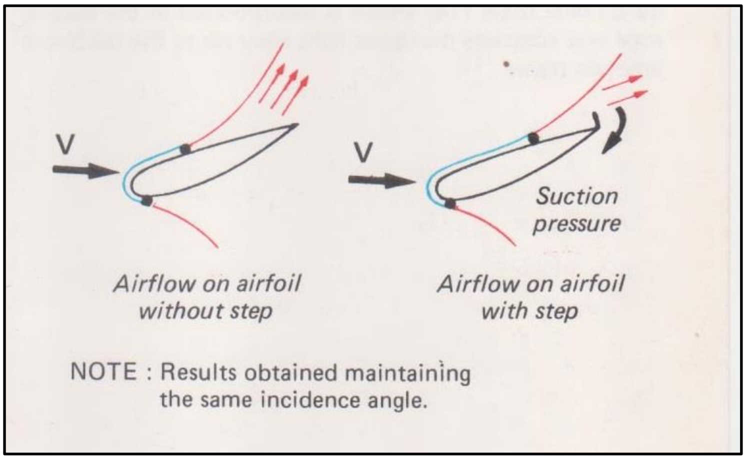


Figure 5

1.6.6 Outboard fin

The HS outboard fins have opposite hand aerofoil. They are set at 5º with respect to the helicopter centreline and create aerodynamic forces F2. The outboard fins contribute to the stability of the yaw axis.

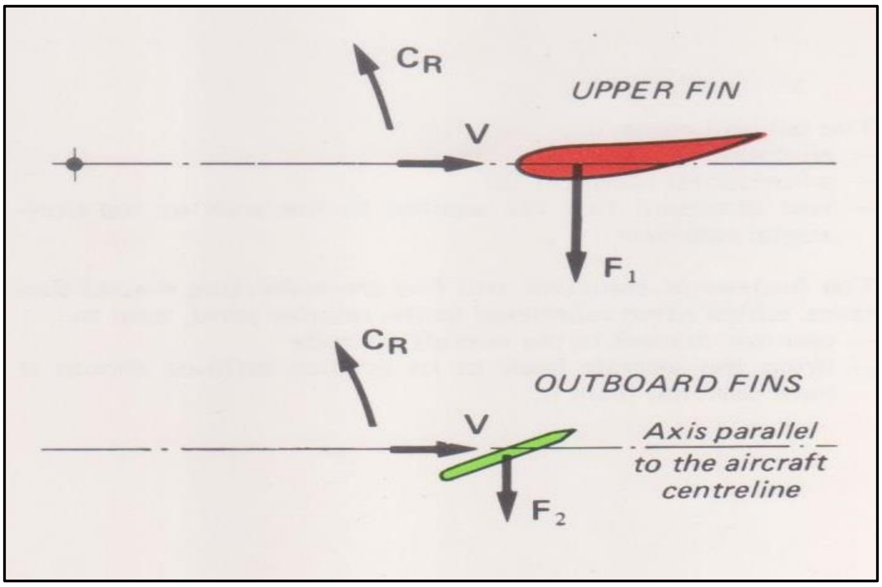


Figure 6

1.6.7 The horizontal stabiliser creates a pitch-up moment aerodynamically in order to establish a comfortable pitch attitude during high-speed flight. (See Figure 7)

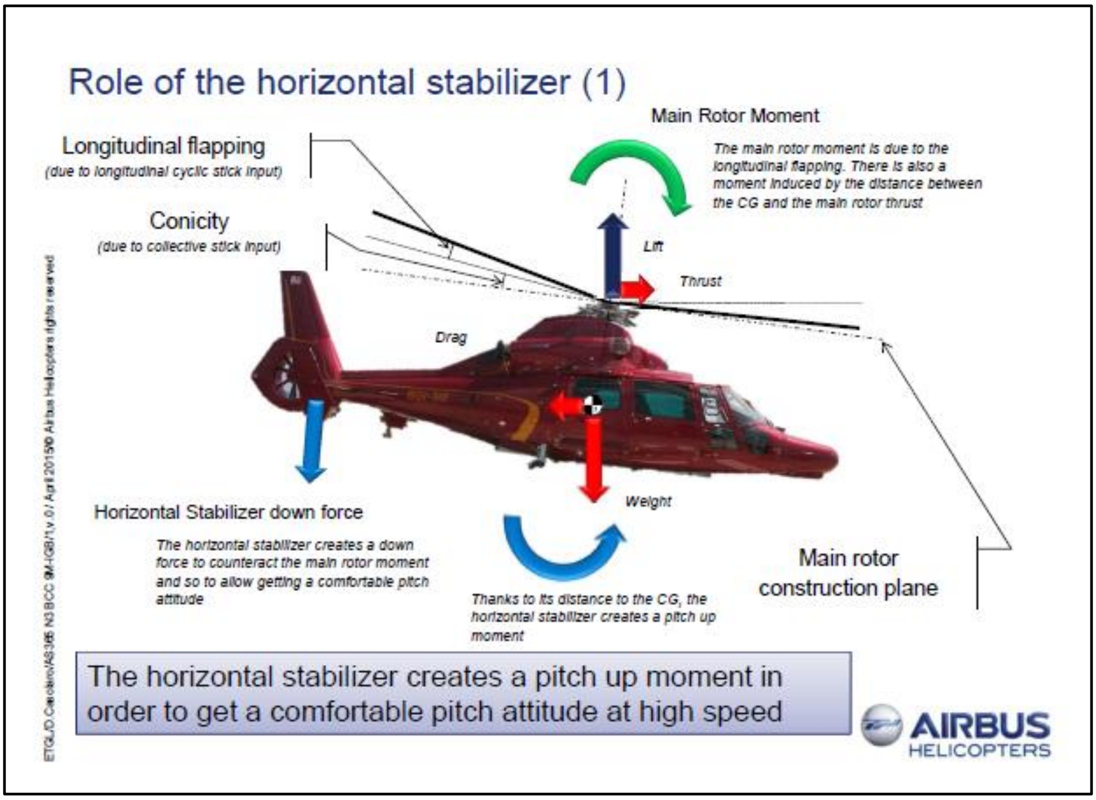


Figure 7

1.6.8 With the rotor running and landing gear down position, the hydraulic brake pressure is supplied by the auxiliary hydraulic power system (18 litres/minutes) up to a maximum of 130 bars at which the pressure switch opens (See Figure 8 and Figure 9).

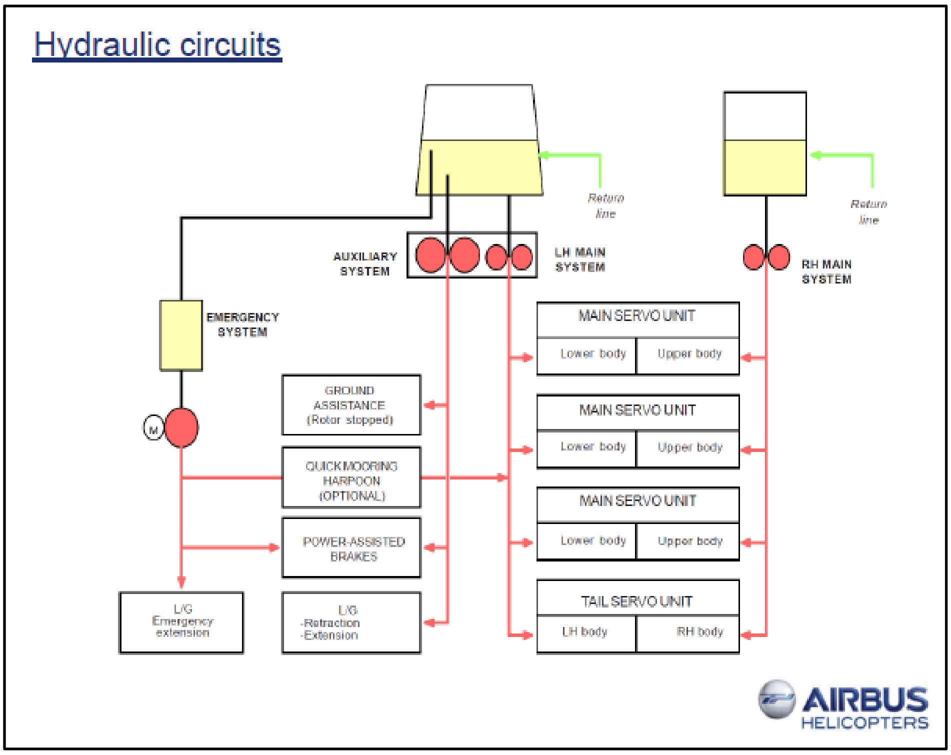


Figure 8

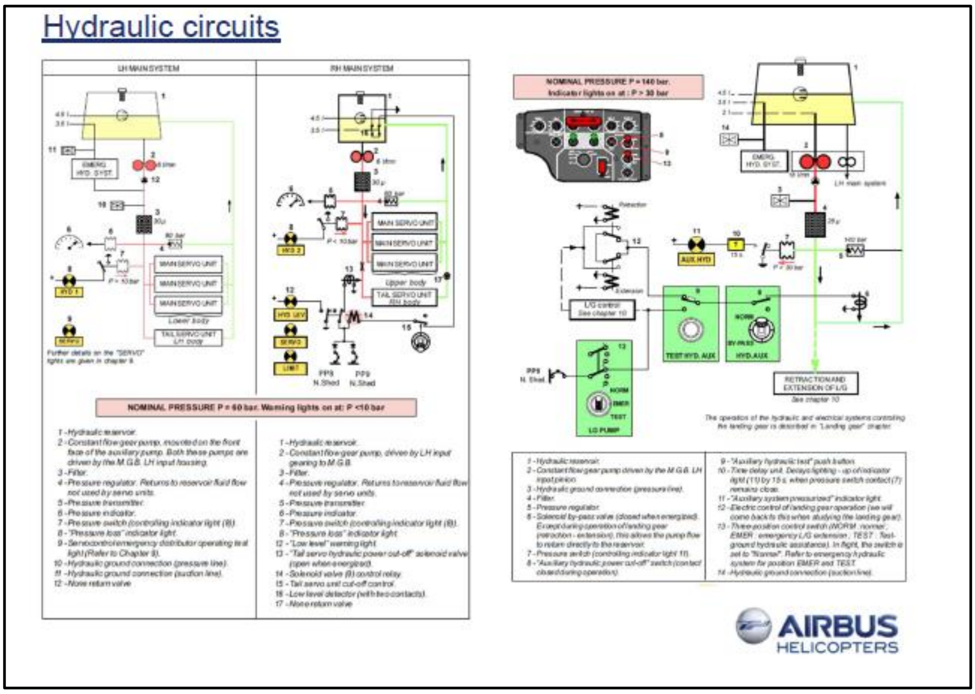


Figure 9

1.6.9 The differences between the Helicopter Dauphin N2 and N3 are as follows;

Both models are similar in dimensions except that most N3s (later models) will have a longer nose, both models may have a 10 or 11-bladed tail rotor, most N3s have a 10-bladed tail rotor as standard, the 10-bladed tail rotor is available as an option to replace the 11-bladed tail rotor. The N3 has a higher MTOW of 50kgs compared to the N2, the main differences in the engines are;

a. N2 fitted with 2 x Turbomeca Arriel 1C2, manually controlled, 551kW

b. N3 fitted with 2 x Turbomeca Arriel 2C, controlled by Digital Engine Control Unit (DECU), with manual backup, 625kW

c. The N3 uses electronic flight instruments unlike the analogue type on the N2

d. The N3 does not have an airframe fuel filter,

e. The layout of switches in the cockpit differs between both models,

f. Hydraulic system caution lights are similar but are in red on the N2 and amber on the N3.

1.6.10 Aircraft history

Event 1

On 16 July 1991 at 412.42, airframe hours. There was a repair request from ASESA following the fall of a metal sheet from the hangar roof on the helicopter. The fenestron was damaged. There was no damage to the horizontal stabilizer.

Event 2

On 19 May 1993 at 1,845 airframe hours, the aircraft was used by a politician for his political visit. During the visit, there was an unrest whereby the crowd had thrown stones towards the helicopter. The aircraft made an OEI take-off which could not be controlled by the pilot and it collided into a wall and damaged some parts of the helicopter. Based on the recorded repair scheme, the area close to the footsteps of the helicopter was repaired.

The repair and replacement of damaged parts was carried out in accordance with the MRR / MTC (Airframe Repair Manual/ Standard Practices Manual). The MTC contains procedures for repairs whilst the MRR contains minor repairs that the Maintenance Centers can carry out if the damage is within the acceptable limitations. If the damage is too extensive, AH may create a dedicated repair scheme. If the damage is not within the criteria and AH doesn't provide a repair scheme then the component must be scrapped and replaced. Since no repair scheme could be found and the damage was too extensive to be handled by MTC/MRR, the horizontal stabilizer had probably been replaced.

Event 3

On 12 September 1996 at 3,235 airframe hours, after landing on a platform, the left landing gear had retracted. The tail bumper and the left vertical fin of the horizontal stabilizer were damaged. The aircraft flew back to land where components were replaced/repaired according to MRR/MTC. Since no repair schemes could be found and the damage was too extensive to be handled by MTC/MRR, the left vertical fin had probably been replaced. The aircraft had flown for 3,000 hours after the repair works before it was grounded without any issues. From 2001 to 2003, the aircraft was grounded at ASESA-SAEMSA premises and was forbidden to fly due to a financial dispute between ASESA-SAEMSA with Airbus Helicopters. Only basic preservation was carried out. In 2003, a few of the 11 dauphins operated by ASESA-SAEMSA were returned to Airbus Helicopters in financial compensation. This includes the SN 6374.

From 2003-2005, Airbus Helicopters were looking for prospective buyers of second-hand helicopters before carrying out the necessary periodical overhaul. In 2006, in order to train AH Malaysia to do major periodical inspections and conversion retrofits on the Dauphin family, two helicopters were delivered to AH Malaysia. For this reason, the overall timeframe may be longer than usual. From 2006-2008, the helicopter SN6374 was brought to AH Malaysia facilities for inspection where it was completely paint stripped, thoroughly inspected, and examined to prepare the helicopter for a full work scope. Frequent sessions were made with AH experts to confirm the assessments.

From 2009-2012, 3 work packages were carried out in parallel at 5,400 hours INSPECTION as defined in the PRE (Master Servicing Manual). Several photos of each sub-component were taken for analysis and validation from AH to justify the decision-making process, component reused, repaired, or replaced. Priority was given to the replacement of components over possible component repair. It was emphasized that for - REPAIR SCHEME: this concerned only the main structure, not the tail boom area. All components and worksheets were prepared in AH and sent to Malaysia.

CONVERSION from AS 365 N2 to N3: the L2 (the work package that lists operations to be performed) includes worksheets and components that were prepared at AH to be sent to Malaysia. Due to the extensive work being carried out, the work scope was equivalent to a full re-assembly rather than a periodic inspection. The ground tests carried out were as extensive as the ones carried out at the end of the assembly lines. During that period, the vertical fins of the horizontal stabilizers were replaced by new ones. The horizontal stabilizer was inspected in detail as per AMM but not replaced nor repaired as it did not require a repair scheme or a replacement. The horizontal stabilizer was therefore returned to flight as its basis and considered fully airworthy.

On 09 February 2012 at 5,900 airframe hours, Airbus Helicopters Malaysia returned the helicopter status to “Available for flight” for SN6374. The helicopter was made airworthy for flight.

On 15 March 2012, AS 365 N3, 9M-IGB was put in service under Orion Corridor Sdn. Bhd. as a new owner.

1.6.11 Aircraft Maintenance History

Helicopter Registration	-	9M-IGB
Helicopter Serial Number	-	6374
Engine No. 1 Serial Number	-	24477
Engine No. 2 Serial Number	-	24479
Certificate of Registration	-	M1714
Certificate of Airworthiness:	-	M1475

The helicopter maintenance was carried out by Airbus Helicopters Malaysia Sdn. Bhd. based in Subang Airport.

The last Certificate of Maintenance Release to Service – Schedule Maintenance Inspection (CRS-SMI) was issued on 20 January 2015.

Aircraft Last check	:	1 year and 6 months inspection,
Airframe Hours	:	6,331:04
Engine No. 1 Hours	:	437:04
Engine No. 2 Hours	:	437:04

Last Certificate of Maintenance Review (CMR No: 554) was carried out on 07 January 2015.

1.6.12 Weight and Balance

The helicopter weighing check was carried out on 31 May 2012 after a major interior modification to install the VIP seats at the Airbus Helicopter hangar at Subang Airport. The aircraft Weight Schedule, dated 8th June, 2012 was reviewed with the following pertinent details.

Basic Empty Weight (BEW) of 2,791.50 kg.

Centre of Gravity (C of G); Longitudinal 4.153 meter and Lateral -0.0025 meter

Weight limitations (maximum authorised weight in flight) are 4,300 kg.

Name	Weight (kg)	Moment (kg.m)		Comment
		Long	Lat	
Basic Weight	2791,5	11593,527	-7,099	Weight and Balance report
Pilot	80	157,6	31,76	
Co-Pilot	60	118,2	-23,82	
Pax 1	70	212,1		
Pax 2	70	212,1		
Pax 3	70	296,8		
Pax 4	70	296,8		
Fuel G1	174	562,02		
Fuel G2	174	812,58		
Total	3559,5	14261,727		

Weight	3559,5	Kg
Xcg	4,01	m
Ycg	0,00	m

This indicates the weight and balance of the aircraft was within the allowable limits.

1.6.13 Fuel

The helicopter was refueled at Petronas Kerteh station on 03 April 2015. Amount up-lifted 935 Litres.

1.7 Meteorological Information

1.7.1 Metar Report Based on STATION WMKK (KLIA)

METAR WMKK 040800Z 20006KT 120V270 9999 FEW017CB BKN280 34/24 Q1004 NOSIG=
METAR WMKK 040830Z 20008KT 150V250 9999 FEW017CB BKN280 Q1004 NOSIG=
METAR WMKK 040900Z 19007KT 140V240 9999 FEW017CB BKN280 32/24 Q1003 NOSIG=
METAR WMKK 040930Z 19006KT 9999 FEW017CB BKN280 32/24 Q1003 NOSIG=
METAR WMKK 041000Z 22005KT 180V260 9000 TS FEW017CB BKN280 32/25 Q1004 NOSIG=

1.7.2 STATION WMSA (SUBANG)

METAR WMSA 040800Z 24008KT 8000 FEW017CB SCT020 BKN270 34/26 Q1004=
SPECI WMSA 040832Z 25010KT 3500 –TSRA FEW005 FEW017CB SCT025 0VC260 32/26 Q1003 RMK F95 1CB OVH tlo OVH=
METAR WMSA 040900Z 29011KT 5000 –TSRA FEW008 FEW017CB SCT025 OVC260 29/26 Q1004
SPECI WMSA 040923Z 16007KT 1500 TSRA FEW000 FEW017CB SCT026 OVC260 26/24 Q1005 RMK F95 2CB OVH tlo OVH=
METAR WMSA 041000Z 24005KT 5000 –TSRA FEW008 FEW017CB SCT025 OVC260 25/23 Q1005=

1.7.3 WMG5 (STATION PETALING JAYA)

METAR WMG5 040800Z 23004KT 180V330 9000 FEW018CB SCT160 BKN300 35/24 Q//// QFF1002 RMK F05 P00.0 R50 1CB N-NE z A/R=
METAR WMG5 040900Z 30011G22KT 180V350 3000 +TSRA FEW017CB SCT150 BKN290 27/23 Q//// QFF1003 RMK F95 P08.0 R79 1CB N-NE+SE tlo + l N-NE=
METAR WMG5 041000Z 25003KT 6000 -TSRA FEW005 FEW017CB SCT150 BKN290 26/23 Q//// QFF1003 RMK F95 P07.0 R83 1CB N-NE tlo N-NE=

1.7.4 The weather information and observation, there was a group of rain clouds forming in the northern part of the accident location. There were clouds moving toward the southwest (west location of the accident) with increasing intensity after 5pm.

1.7.5 Based on radar echoes, the cloud group does not have high intensity before 1700LT. Cumulonimbus large cloud with high intensity seems more concentrated in the western state of Johor, southern Pahang, Kuala Lumpur Federal Territory, and part of Selangor in the districts of Petaling and Klang. The weather has no bearing towards the accident. The weather forecasted by the Malaysian Meteorological Department for 0730h was fine weather with visibility of more than 10Km. There were few clouds at an altitude of 1,500ft. Nevertheless, the weather conditions on that day did not contribute to the occurrence of the event.

1.8 Aids to Navigation

Not applicable.

1.9 Communications

1.9.1 Very High Frequency (VHF) System

The aircraft was installed with two King KTR 9O8 VHF Systems (VHF1 and VHF 2). Each assembly comprises of three components; a transceiver unit, a control unit, and an antenna. The receiver is used to establish air-to-air and air-to-ground radio-telephone communications using very short waves.

The VHF 1 installation is supplied with 28 VDC via a 10-Amp Circuit Breaker (A11) on panel 4 ALPHA. The VHF 2 system is supplied with 28 VDC via a 10-Amp Circuit Breaker (D10) on panel 4 ALPHA.

VHF 1 and VHF 2 audio microphones and push-to-talk circuits are connected to the intercommunication system via connection strip 10 DELTA.

General specification data:

Power Supply	: 27.5 VDC
Current Draw	: 0.4 Amp (on reception) 7 Amp (on transmission).
Frequency range	: 118 to 135.975 MHz
Channel spacing	: 25 kHz
Frequency stability	: 0.0015 %.
Environment	: - 20°C to + 55°C (- 4°F to 131°F). 55000 ft (16764 m).

1.9.2 BA 1920 Passenger Interphone

The BA 192O auxiliary unit ensures the interphone for passengers in conference mode by means of the voice-operated switch, adjustable audio output using an outside potentiometer, passenger system cut off from the crew system, (control available to the crew). It is installed with three pushbuttons for the passengers to call the crew members.

The BA 192O system is powered with 28 VDC from the TB 31 ICS junction box. The Passengers Address is powered with 28 VDC from panel 4 ALPHA via a 3-Amp circuit breaker (F18), D9 (3A), or E2 (3A).

1.9.3 TEAM TB31 Inter-Communication System (ICS)

The ICS enables communication between crew members via the interphone in continuous conference with audio output volume adjustment possible, via press-to-talk control in case of a faulty voice-operated switch, via an independent "CALL" channel, using the built-in pushbutton on the ICS volume switches.

Outside communication via on-board transceivers transmission channel: four radio channels, reception channels: ten adjustable channels (of which four are associated with transmission channels) and one channel non-adjustable (eight adjustable channels can be provided if the option is installed) according to version.

Communication between crew members and passengers via the auxiliary unit and a telephone, A "VIP Call" light on the instrument panel informs the crew members that the passengers wish to establish communication with them.

The system is powered by circuit breakers located on panel 4 ALPHA. Lighting is ensured by lighting power boards 49L and 50L.

Junction Box powered by aircraft 28 VDC power system; two separate lines. The current draw is approximately 100 mA. The Main Control Panel is powered by an aircraft 28V power system; two lines are protected and filtered in the junction box and the current draw is approximately 200 mA. Lighting is approximately 250 mA.

There was no difficulty in radio communication on VHF operating frequency and the intercommunication between passenger and pilot was found to be normal.

1.10 Aerodrome Information

Not applicable.

1.11 Flight Recorders

1.11.1 The helicopter was equipped with Solid State Combination Cockpit Voice and Flight Data Recorder (SSCVFDR) model Honeywell AR-204C. The SSCVFDR is located on the rack on the left-hand shelf behind the baggage compartment.

Figure 10

The voice recorder of this SSCVFDR has a recording capacity of at least 120 minutes (two hours) and is capable of recording 3 crew channels and 1 area microphone channel. It keeps this audio in a solid-state memory.

The flight data recorder of this SSCVFDR has a recording capacity to record 25 hours of flight data information at a rate of 256 words per second.

1.11.2 Details of the SSCVFDR installed and specifications are as follows:

Manufacturer	: Honeywell
Model	: AR-204C
Part Number (P/N)	: 980-6021-066
Serial Number (S/N)	: 12129
Date last installed on aircraft	: 9 January 2015
Weight	: 4.2 Kg (9.2 lbs)
Power Supply	: 28VDC
Impact Shock	: 3400 G for 6.5 ms
Fire Temperature	: Max 1100°C (60 min)
Deep Sea Pressure and Sea Water Immersion	: 20,000 ft (30 days)

1.11.3 The SSCVFDR was equipped with underwater locator beacons (ULB) whose transmission time is at least 30 days, on the 37.5 kHz frequency, operating depth up to 20,000ft (6096 m) and activated with fresh or salt water immersion. The SSFDR was attached with a ULB as per below:

Manufacturer	: Dukane
Mode	: DK-120
S/N	: SD38654
ULB Expiry Date	: 30 June 2020

1.11.4 The SSCVFDR was recovered at the crash site approximately 18 hours after the accident. The SSCVFDR was hand-carried by AAIB Malaysia personnel to the Air Accidents Investigation Branch (AAIB) United Kingdom at Farnborough for the voice and data download on 07 April 2015. Both voice (from 4 channels) and data (approximately more than 400 parameters) from the SSCVFDR were able to be downloaded and readable. Detailed analysis of the voice and data recorders for each parameter is being carried out.

1.12 Wreckage and Impact Information

1.12.1 The helicopter wreckage was destroyed by the impact forces and post-crash fire at the bottom of a ravine. The main gearbox (MGB) and both engines were found close to the main wreckage area. Some components of the helicopter including the fenestron, door, main rotor blade parts, cowlings, engine exhaust pipe, tail rotor drive shaft, and horizontal stabilizer were found scattered around 200 - 300 meters from the main wreckage. The components were scattered along the trajectory of the helicopter. There was no evidence of the helicopter making contact with the terrain until it impacted the ground.

1.12.2 Engine Inspections.

No. 1 Engine, Serial Number: 4270

An inspection of the Metal Chip Detector and the Electro Metal Chip Detector of the No. 1 Engine did not reveal any evidence of contaminants or deposits of an abrupt engine failure. The oil filter appears normal and clean. The manufacturer's alignment marks which coupled the power transfer shaft to the spline at the reduction gearbox - Module 5 did not indicate of any signs of excessive engine over-torqued. Boroscope inspections around the impeller section revealed slight traces of aluminum deposits due to sudden scrapping under impact load. There was evidence of slight nicks on the compressor blades due to the ingestion of debris. The compressor blades had totally seized.

No. 2 Engine, Serial Number: 4272

An inspection of the Metal Chip Detector and the Electro Metal Chip Detector of the No. 2 Engine did not reveal any evidence of contaminants or deposits of an abrupt engine failure. There was no evidence of contaminants in the oil and fuel filters. Both these filters appear normal and clean. The manufacturer's alignment marks which coupled the power transfer shaft to the spline at the reduction gearbox - Module 5 did not indicate of any signs of excessive engine over-torqued.

The compressor blades were found jagged and severely bent due to foreign object damage (FOD) from the ingress of wooden branches. Boroscope inspections around the impeller section revealed traces of solidified aluminum deposits due to sudden scrapping under impact load and intense heat. The compressors were totally seized and there was evidence of post-impact fire on the engine.

1.12.3 Main Rotor Hub and Main Rotor Blades.

All four main rotor blades had separated from the attachment of the main rotor head. One of the main rotor blades had evidence of severe damage on the main rotor tip. This would suggest that it could have struck the fenestron leading edge.

Two of the main rotor blades had evidence of red paint marks on the leading edges of the centre section of the main rotor blades. The fragments on the main rotor blades suggest that the damage could be attributed to high impact force with the tail boom structure and subsequent post-impact damage after separation from the main rotor head.

1.12.4 Fenestron - Tail Rotor Section.

The examination of the fenestron revealed that extensive damage was caused by high-impact force which caused it to separate from the tail boom structure.

The breakage of the tail rotor blades revealed that there was evidence of sudden impact against the fenestron casing whilst under high rotational speed. There were severe scrubbing marks on the internal side of the fenestron casing. The evidence of some cutting marks on the leading edge of the fenestron would indicate contact with the main rotor blades.

1.13 Medical and Pathological Information

1.13.1 Evacuation and Identification of Remains.

The total number of persons onboard the helicopter was 6, including the pilot. The bodies were recovered from the crash site and transferred to Kuala Lumpur General Hospital for identification purposes.

The identification of the bodies was performed by the Disaster Victim Identification Team which comprised of surgeons, forensic pathologists, forensic odontologists, and DNA experts.

1.13.2 Injuries to victims.

Based on the examinations of the deceased bodies, injuries were observed on their skulls, face, limbs, and upper bodies. The nature of the injuries was consistent with injuries due to impact trauma and burns.

The autopsy performed on the bodies revealed no post-crash survival signs.

1.13.3 Aircraft Commander

The body of the deceased showed evidence of being transacted into 4 parts with multiple injuries and post-impact 80% charring of the body. There was no obvious evidence of heart disease. Toxicology for alcohol and common drugs of abuse was negative. The commander's body was found in the front right seat where the right position of the aircraft commander.

1.13.4 Female Passengers

The body of the deceased showed evidence of being transacted into 3 main body parts consisting of the upper half of the body with charring on the left side, the lower half of the body together with the left lower limb, and the right lower limb. The deceased sustained multiple injuries with post-impact fire resulting in the charring of some parts of the body. The body was found at the left of the commander where she was occupying the left front seat.

1.14 Fire

There was an extensive fire that consumed most of the components after impact.

1.15 Survival Aspects

The accident was non survivable.

1.16 Tests and Research

There were two tests conducted during the investigation;

a. Fluid Sample Test by Chemist Department Malaysia and

b. Structure Detail Examinations by STRIDE (Science and Technology Research Institute for Defence).

The result of the test will allow the investigator to verify the fluid sample collected at Sekolah Kebangsaan Ladang Kota Bahagia (SKLKB) belongs to IGB and the detail structure examination will allow the investigator to determine the failure mode and pattern, and to verify the direction of the failure.

1.16.1 Fluid Sample Test

The helicopter made an unscheduled landing at SKLBK. While landing at the school field, the left-hand (LH) Landing Gear sunk into the ground. The photo below shows the sunk hole on the ground due to the landing gear.

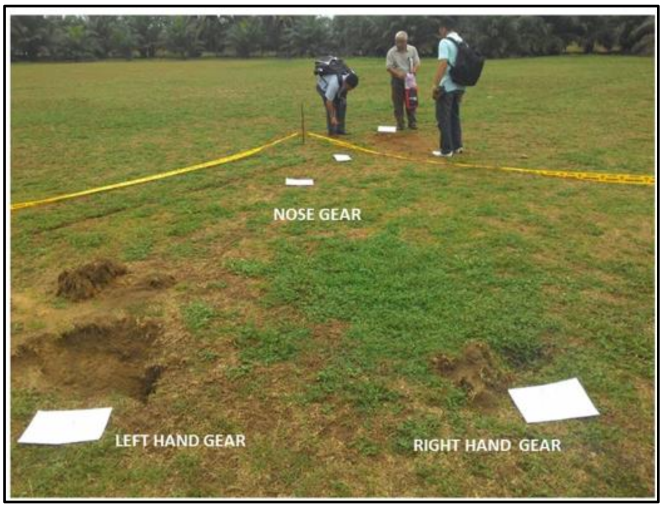


Figure 11

The traces of fluid from the sunken hole were collected and sent to the Chemist Department of Malaysia for detailed analysis. The sample fluid was traced to meet the Mobil Jet Oil II (Synthetic) specification. See Figure 11.

The hydraulic liquid for the landing gear system is also used for the oleo strut and brake system.

The photos below show the oil traces on the field at Sekolah Kebangsaan Ladang Kota Bahagia.

Figure 12

The traces of earth with oil samples were placed in a plastic bag and sent to the Chemist Department of Malaysia for detailed analysis. See Figure 13.

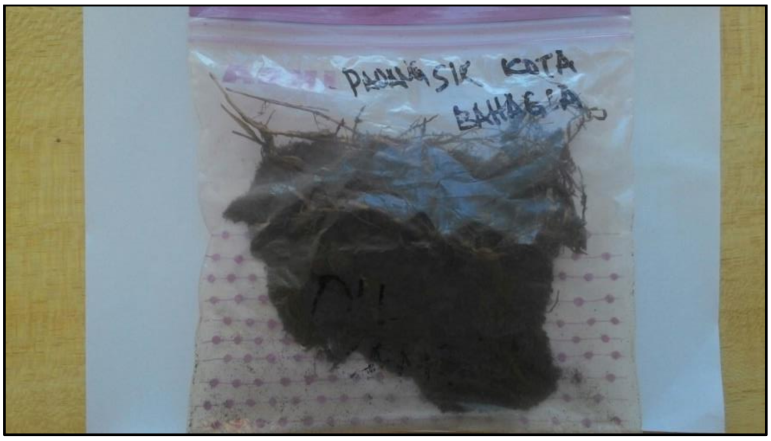


Figure 13

Test result from the Chemistry Department of Malaysia shows that the sample taken at the SK Ladang Kota Bahagia is consistent with the Mobil Jet Oil II (Synthetic) of the AS365N3 helicopter hydraulic fluid specifications.

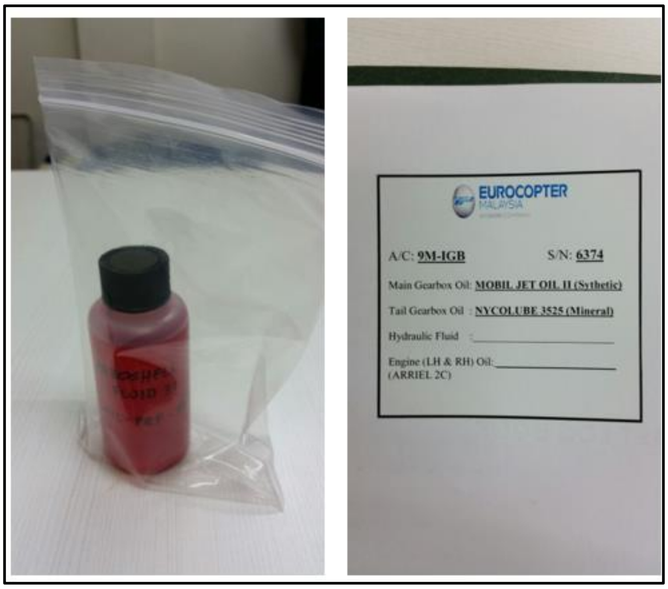


Figure 14

The hydraulic fluid may indicate evidence of some leakage from the helicopter hydraulic system at the field where the aircraft landed.

1.16.2 Detailed Structure Examination

a. A piece of chipped-off paint

During a subsequent visit to SKLKB, the investigator found a piece of chipped-off paint that is similar to the colour of the helicopter's leading edge of the horizontal stabiliser. (Figure 15)

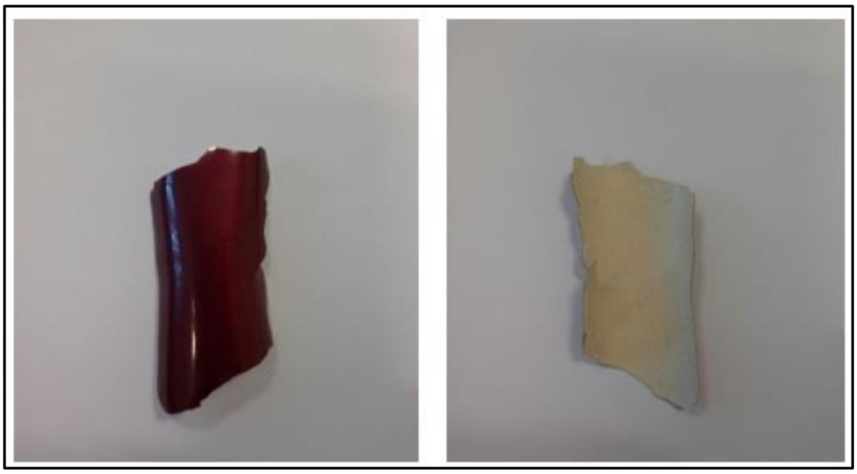


Figure 15

Figure 15 shows the piece of chipped-off paint that was sent to the Chemist Department for analysis. There was no conclusive result obtained on the analysis of the piece of sample. A further test was carried out by matching the paint contents and features from the chipped-off part and the paint from the helicopter. The Left-Hand Horizontal Stabilizer was missing; however, the RH Horizontal Stabiliser was found together with the wreckage and the piece of chipped-off paint matched the colour and contour of the aerodynamic profile of the horizontal stabiliser leading edge.

The piece of chipped-off paint sample could have been detached from the LH horizontal stabiliser leading edge.

b. The Horizontal Stabiliser

As the LH Landing Gear sunk into the ground, the vertical fin of the LH Horizontal Stabiliser contacted the ground and may have caused premature structural damage to the LH Horizontal Stabiliser. The piece of chipped-off paint found on the field provides evidence that the LH Horizontal Stabiliser and helicopter structures have been badly distorted causing the dislodgement of the piece of paint.

The investigation was focused on the LH Horizontal Stabiliser because it was suspected that the horizontal stabiliser had detached in flight before the helicopter lost control, and the section of the LH Horizontal Stabiliser had been missing from the wreckage site.

STRIDE (Science and Technology Research Institute for Defence) was requested by IIC as the technical experts to conduct a detailed structural assessment. The composite structure consists of laminated numbers of plies of fibers in numerous directions. Analysis of each ply failure will indicate the primary direction of failures which will provide information on the direction of loads. The plies failure features shown in ICAO Doc 9756 are used as guidance in determining the failure modes.

The following photo shows the fiber pullout resulting from the tensile load on the structure.

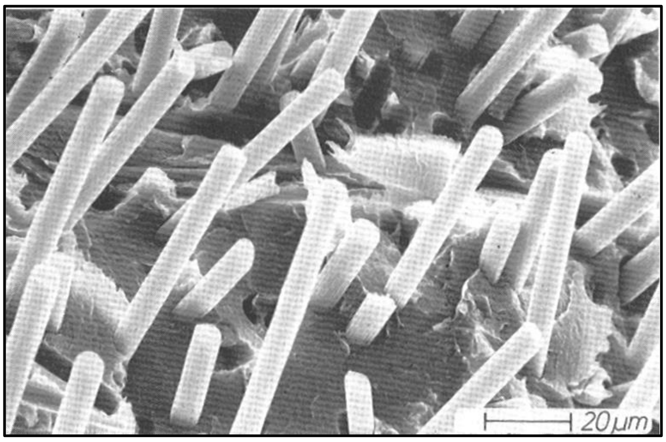


Figure 16

The kinking of fibers shown in Figure 17 indicates the results of compressive loads on the structure, with some applied load translated into all the fibers. It also shows the kinking of fibers in the direction of compressive load.

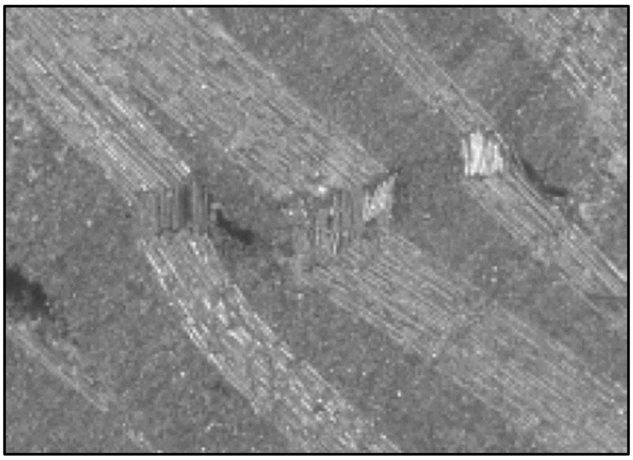


Figure 17

The following photo shows there was evidence of chop marks on the ends of the broken structure which indicate that the fibers had buckled and failed under compressive load as well.

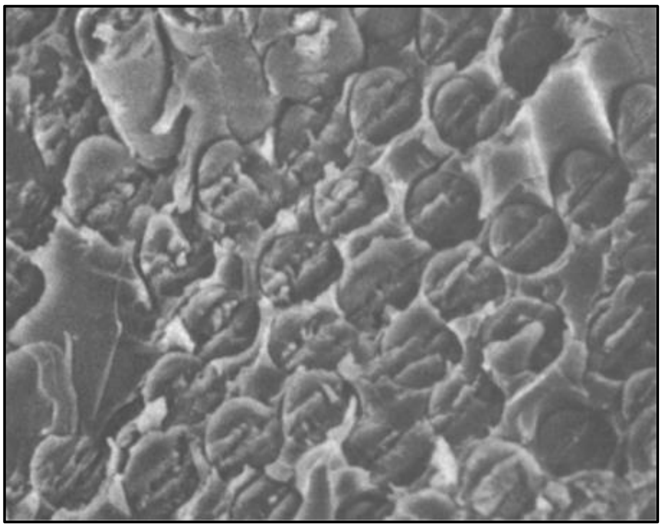


Figure 18

The following photo provides evidence of failure on the composite structure due to bending forces. See Fig. 16 – The relative rough area, visible strands of fibers and tension area, and the smooth region as shown in photos indicate failure by compression.

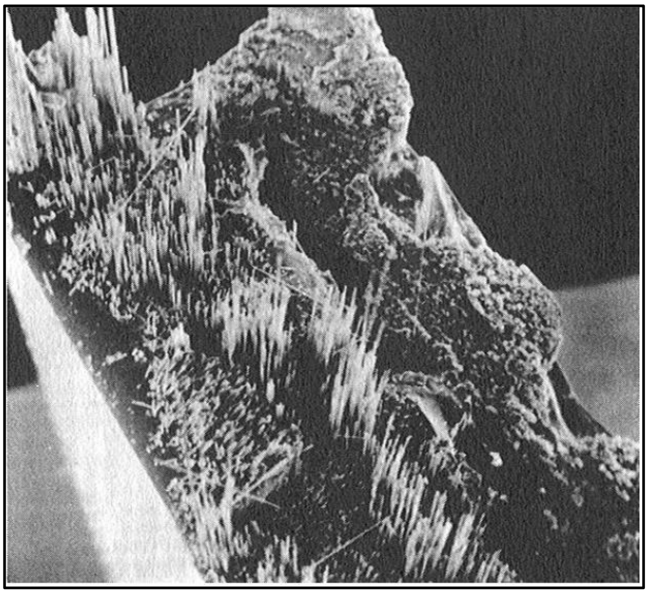


Figure 19

The following photos show the delamination between the composite plies which could be attributed to pre or post-impact.

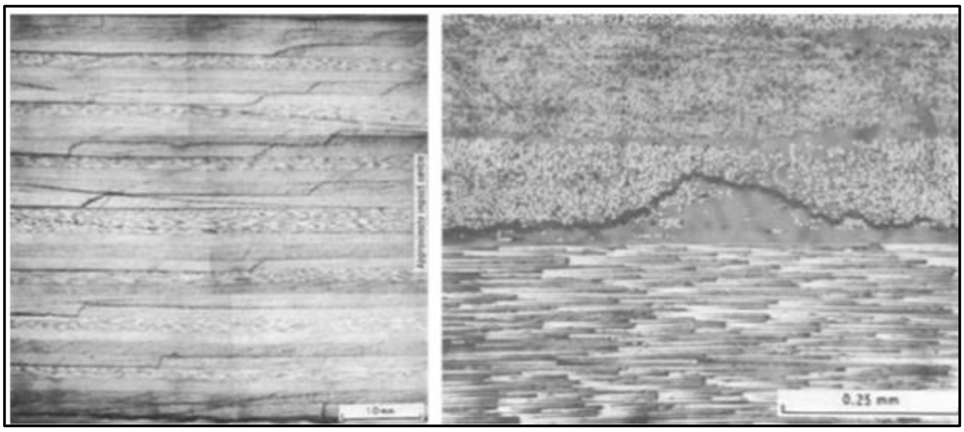


Figure 20

The AAIB and STRIDE team conducted the examinations in order to determine the failure characteristics.

Figure 21

The above photo shows the reconstruction of the horizontal stabilizer assembly. The Left-Hand Horizontal Stabilizer was missing.

The technique of examining the composite plies failure is by loading modes on the structure. This technique is detailed in the ICAO Doc 9756. The examination of the plies under the ESM will provide an accurate indication of the plies' failures. However, the ESM technique was not carried out. Only a thorough visual examination was carried out.

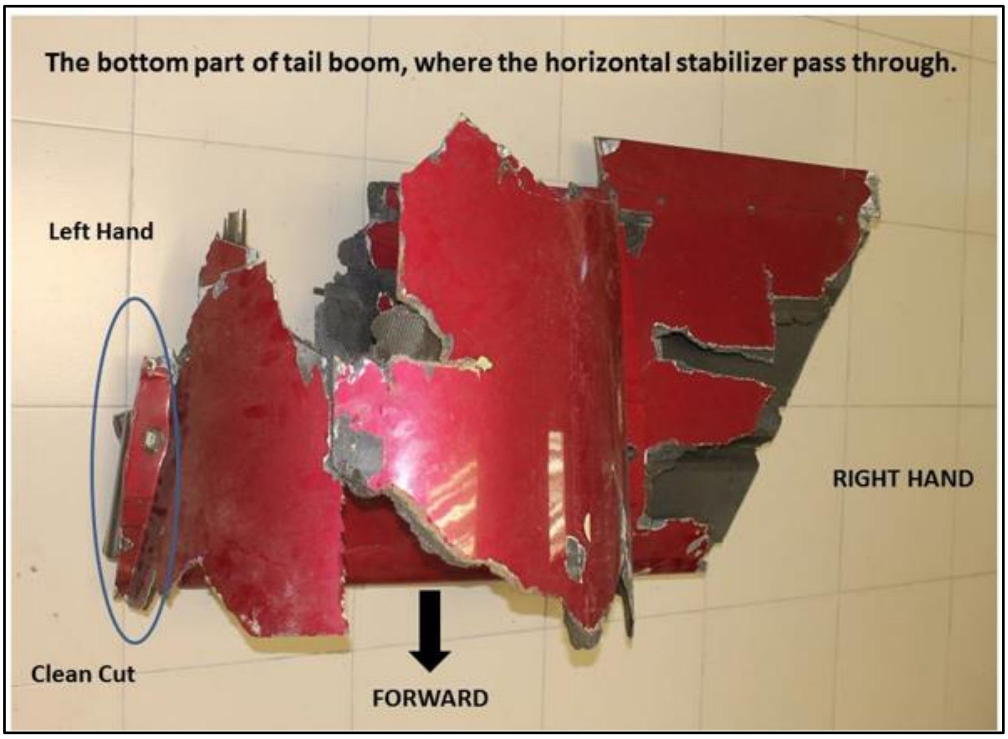


Figure 22

The tail boom section was reconstructed and each failure point was examined. The above photo shows the failure of the tail boom section after the wreckage of the tail boom and part of the horizontal stabilizer were reconstructed.

The tail boom section was examined in detail and the failure points show a clear cut on the tail boom skin parallel to the helicopter's longitudinal axis, as shown. (See Figure 22 and Figure 23)

Figure 23

A straight-line failure may indicate failure due to compression load. A detailed close-up examination showed a clean-cut failure in a straight line direction (See Figure 24).

Figure 24

The examination continued with the section of the horizontal stabilizer. As the tail boom section is removed, the horizontal stabiliser section at the breaking point is visible as shown in Figure 25.

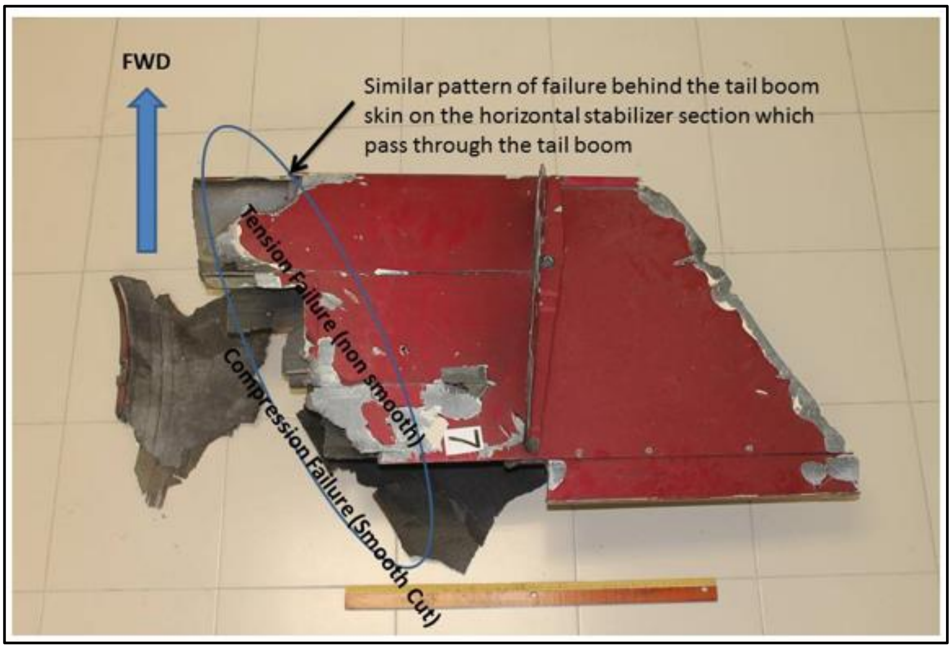


Figure 25

The top skin of the horizontal stabiliser had a smooth cut which indicates it had failed under compression load whilst the bottom skin of the horizontal stabiliser had jagged edges and failed under tension load. (See Figure 26)

Figure 26

The tail boom attachment to the horizontal stabiliser indicates a pulled-through failure. A review of the structure failure lines is shown in the following diagram (See Figure 27).

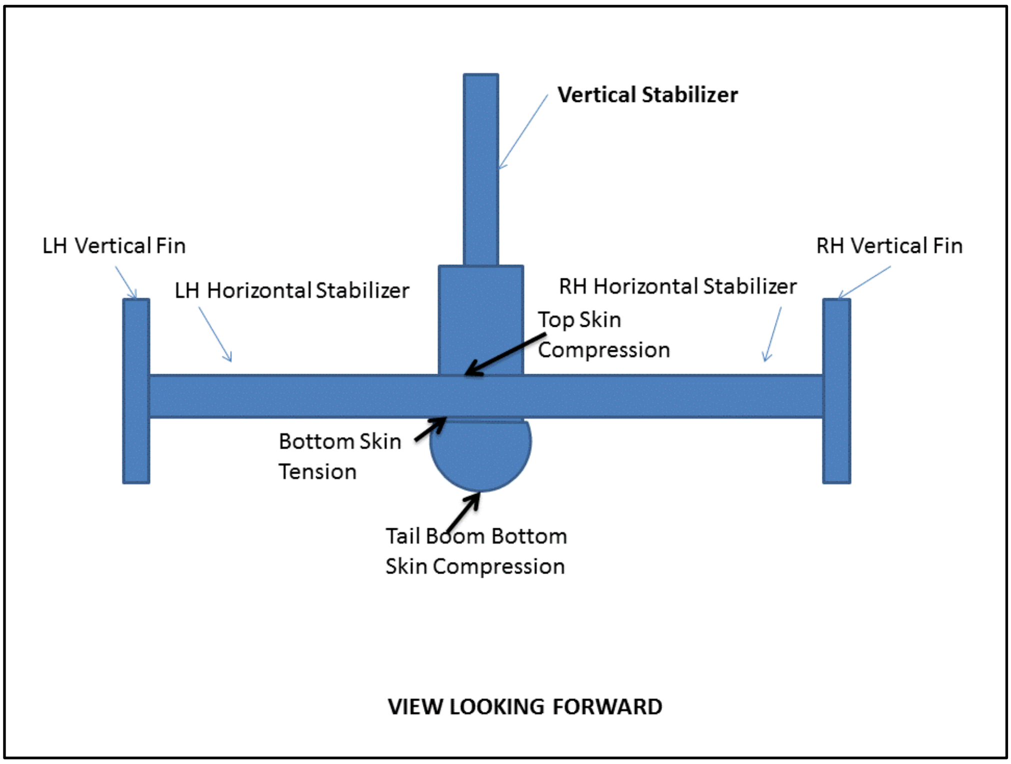


Figure 27

If we consider the down load force, the LH Horizontal Stabiliser will bend downward which will result in the top skin under tension and the bottom skin under compression.

However, the examination of the structure of the bottom skin of the tail boom appears consistent with the failure mode of the LH Horizontal Stabiliser bending downward as evidenced by the clean fracture line along the tail boom. (See Figure 27)

The inconsistency in the LH Horizontal Stabiliser failure pattern showing the top skin under compression and the bottom skin under tension might suggest that there could be a premature failure on the LH Horizontal Stabiliser structure as the vertical fin hit the ground when the helicopter landed and the LH Landing Gear subsequently sunk into the ground at SKLKB. As the LH vertical fin hits the ground, the LH Horizontal Stabiliser will bend upwards and will hinge at the mid-span of the LH Horizontal Stabilizer as shown by the failure line parallel to the tailboom attachment.

The section of the tail boom remains attached after the LH Horizontal Stabiliser was separated at the initiation of the failure point, near the attachment of the tail boom and the LH Horizontal Stabiliser.

1.17 Organisational and Management Information

1. 17.1 Aircraft Owner	:	Orion Corridor Sdn. Bhd. Level 32, The Gardens South Tower Mid Valley City Lingkaran Syed Putra 59200 Kuala Lumpur. Malaysia.
1.17.2 Ground Handling Services	:	Chempaka Helicopter Corporation Sdn. Bhd. Solaire Hangar, Skypark Terminal Sultan Abdul Aziz Shah Airport 47200 Subang, Selangor Malaysia

1.17.3 Orion Corridor Sdn. Bhd.

Orion Corridor Sdn. Bhd. was the registered owner of IGB and the pilot who flew on the day of the accident was one of the directors of the company. The pilot was also the director of Solaire Sdn. Bhd. and Chempaka Helicopter Corporation Sdn. Bhd. The Solaire Sdn. Bhd. was the sales agent for Robinson Helicopter in Malaysia. It has a credit facility with Petronas for refueling at all Malaysian Airports.

The Chempaka Helicopter Corporation Sdn. Bhd. was the AOC holder for the non-schedule operator of R22 and R66 helicopters. There was a contract signed on 20 June 2012 for the 9M-IGB helicopter to operate under Chempaka Helicopter Sdn. Bhd. for Public Transport operations. However, the helicopter was still under Private Category Certificate of Airworthiness and had not been included in the AOC, Operations Specification until the accident occurred. All previous flights prior to the accident were carried out under Private flights. The investigation was not able to determine if any reward had been paid or promised for the conduct of those flights.

Chempaka Helicopter Sdn. Bhd. has been providing hangarage for IGB and assisted its operations in terms of ground handling, flight planning, flight following, and refueling.

1.18 Additional Information

1.18.1 Stabilisers – Never Exceed Speed (VNE) and Rate of Descent (R/D) Limitations.

Airbus Helicopters had issued a Service Bulletin No: AS365-55.00.06 dated 14 November 2014 on Stabiliser – Horizontal Stabiliser – Upgrading of Stabiliser installation for suppression of the flutter phenomenon by addition of material offering damping characteristics which could eliminate the dynamic coupling between torsion and bending on the horizontal stabiliser.

EASA Airworthiness Directives AD No.: 2008-0204R1 dated 21 May 2014 has made it mandatory for compliance to SA 365N, SA 365 N1, AS365N2, and AS365N3 helicopters due to some reports of failed horizontal stabilisers on AS 365 N3 during acceptance test and training flights as part of the demonstration of the never-exceed speed (VNE) and resulted into in-flight separation and loss of the failed sections.

The test results revealed that the reported incidents were caused by a vibration phenomenon that may have been generated during descent flight phases at high speed, regardless of the stabiliser part number.

The EASA AD has imposed VNE limitation to all SA 365 N and AS 365 N helicopters, regardless of the part number of installed horizontal stabilisers an implementation of a – 1,500 ft/min Rate of Descent (R/D) limitation beyond 140 knots Indicated Air Speed (IAS).

The result of flying with all 3 landing gears in the extended position beyond 140 knots Indicated Air Speed would create a severe aerodynamic drag and undue stresses on the horizontal stabiliser due to its inverted camber structure and it may exceed its structural limitations.

1.19 Useful or Effective Investigation Techniques

1.19.1 Spectrum analysis audio data

The audio files CAM 0124 to 012520.wav, Ch1 0124 to 012520.wav, and Ch2 0124 to 012520.wav contain the beginning of the flight, at the engine power up. At this moment, the acoustic signature of this helicopter did not show any particular anomalies compared to the spectrum normally observed on the AS365 helicopter family.

The audio files CAM 0133 to 0137.wav, Ch1 0133 to 0137.wav, and Ch2 0133 to 0137wav contain the landing of the helicopter in a non-aeronautical field. During this landing, an impulse1 noise was recorded on the CAM track at 08 h 20 min 32 s 400. This impulse noise is immediately followed by a reaction of surprise from the pilot. Just after that noise, the rotation frequency of MGB rotating parts showed sudden variations with a high amplitude. During those variations, several warnings were triggered.

The audio files CAM last minute.wav, Ch1 last minute.wav, and Ch2 last minute .wav contain the last minute of respectively CAM, Channel 1, and Channel 2 recordings. The spectrum view showed several acoustic signatures (harmonic families) typical of the helicopter propulsion system spectrum:

The acoustic signature is associated with Main Rotor blade rotation with a fundamental frequency of 23.66 Hz (BR – Blade Rate).

The acoustic signature is associated with the Tail Rotor drive shaft with a fundamental frequency of 1085 Hz.

The acoustic signature is associated with MGB input meshing rotation with a fundamental frequency of 2740 Hz.

These fundamental frequency values indicate that the propulsion system was at 100% of its nominal rate (confirmed by FDR data). The propulsion system condition appeared to be nominal until 3.3 seconds before the end of recordings. At that moment, a transient noise was recorded on the CVR. It was not possible to determine the nature and the origin of that noise. 0.5 seconds after that noise (i.e. 2.8 s before the end of recordings), the spectral lines associated with the helicopter propulsion system disappeared. This disappearance coincided with the appearance of a high energy level phenomenon. That phenomenon was made up of multiple acoustic events similar to impact noises. Several warnings were triggered during that phenomenon. The interval between each impact is a multiple of the main rotor shaft rate, which allows asserting that the impacts recorded are main rotor blade collisions with an external unknown item. The measure of impact intervals at the High NR warning triggering indicated that the main rotor speed was 8% (i.e. 108.4 %) above its nominal speed rate, which was consistent with FDR data. However, the limitation of acoustic analysis made it impossible to describe the impact sequence.

1.19.2. Transcription

A transcription of the provided audio samples was performed. The contents of this transcription showed that during the landing phase, a loud “thud” noise was recorded on the pilot track. This noise corresponded to the vocal exclamation of the pilot consecutive to the left landing gear sinking into the soft ground in the open field. The pilot was first wondering if the landing gear was collapsing or not. The female passenger indicated to him that the “wheel went into the ground”.

1.19.3. Flight parameters - data quality

Acceleration parameters are of good quality. The A/P related parameters are not available most probably because of the failure of the converter that transmitted the information to the PFD and to the FDR. The hands-off and A/P warning parameters were taken into account. The flight command motion was consistent with A/P activity. The investigation will be based on circumstantial evidence, witness accounts and statements, and the human factors analysis and classification system (HFACS) in order to establish the contributing factors as well as the probable cause of this event.

2.0 ANALYSIS

2.1 Introduction

The fatal helicopter was seen making a steep dive by another pilot flying EC 155 in the vicinity. It was seen diving steeply to the ground shortly after making radio contact in order to maintain a safe separation. It impacted the ground overgrown by rubber trees almost vertically and caught fire followed by black smoke.

Upon examination of the wreckage, it was found that the LH horizontal stabiliser was missing. An extensive search for the missing LH horizontal stabiliser was carried out without any success. A detailed mathematical calculation for the approximate drop location of the stabiliser was also done with the assistance of the manufacturer. Several attempts to search for the missing LH horizontal stabiliser with the assistance of the police and military personnel were carried out on ground and a search from the air using an R66 helicopter was also carried out without any success. The tail empennage to which the left stabiliser attached was recovered not within the wreckage and is believed to have been consumed by fire. However, the remaining RH horizontal stabiliser was found near the main wreckage.

An analysis of the SSCVFDR carried out at the manufacturer's facility revealed that the behavior of the helicopter seconds before the dive was consistent with the LH horizontal stabiliser detached in flight. The recorder also revealed that when the helicopter landed at the last landing point, the Left-Hand Main Wheel had sunk into loose soil approximately 20 inches depth, causing the helicopter to tilt to the left for approximately 13 degrees. The sudden sinking of the Left-Hand Main Wheel and tilting would have caused the LH horizontal stabiliser vertical fin to hit the ground and cause some damage to the inboard root of the Left-Hand horizontal stabiliser. The extent of damage was still undetermined and was not detected by the pilot. Mathematical calculations on the depth of the wheel sunk into the soft ground indicated that the horizontal stabiliser could have bent upward at the root by approximately 45mm. Since the horizontal stabiliser was made of composite structure, the stress at the damaged area would weaken the structure of the LH horizontal stabiliser and would induce more stress and damage during the flight without significant vibrations, leading to a complete failure and detachment of the LH horizontal stabiliser in flight.

The evidence of excessive hydraulic fluid found around the landing area on the fields at Sekolah Kebangsaan Ladang Kota Bahagia would indicate possible loss of hydraulic fluid from the stressed oleo strut of the LH Main Landing Gear due to its abrupt inclination into the ground and possible damage to the LH Main Wheel hydraulic brake lines. Knowing that the undercarriage was damaged the pilot decided to continue the flight to the destination with all three landing gears remained in the extended down position. The most likely reason to press on for the flight was to accommodate the passenger's request to arrive at the destination without delay and to enable him to attend the formal dinner as planned.

It was noted shortly before the accident, the helicopter was cruising at 146 Kts and at an altitude of 1700 feet with a rate of descend of 400 feet per minute with the three landing gears remained in the extended down position.

EASA had issued AD Airworthiness Directives AD No.: 2008-0204R1 dated 21 May 2014 to impose VNE limitation to all SA 365 N and AS 365 N helicopters, regardless of part number of installed horizontal stabilizer an implementation of a – 1,500 ft/min Rate of Descent (R/D) limitation beyond 140 knots Indicated Air Speed (IAS). The result of flying with all three landing gears in the extended position beyond the 140 knots Indicated Air Speed would nevertheless create a severe aerodynamic drag and load on the weakened structure of LH horizontal stabiliser. This could contribute to the separation of the LH horizontal stabiliser in flight.

An analysis of the SSCVFDR revealed that 2.5 seconds prior to the steep dive, the LH horizontal stabiliser could have detached from the helicopter. While flying on Autopilot with ALT upper mode engaged on the pitch axis, the helicopter subsequently pitched down to 52 degrees and rolled to the right 70 degrees. At about this time, the pilot took action on the cyclic stick, but the helicopter was already in a state of unusual attitude which cannot be recovered. The main rotor blades under the extreme load factor impacted the helicopter structure which caused extensive damage to the fuselage and severed the tail fenestron. The helicopter became out of control and dropped steeply without any effect on the pilot's recovery action.

A detailed examination of the wreckage and damages on the main dynamic components such as the Main Rotor Head, Main Gearbox, Engines, Tail Rotor Transmission Shafts, Tail Gearbox, Tail Rotor Head, and the flight controls had attributed to the initial impact by the Main Rotor Blades hitting the cowling, tail boom and the fenestron, and the consequences of terrain impacts with high rotational power and torque.

The location of the first Main Rotor Blade impact on the fenestron leading edge indicates that the Main Gear Box suspension was normal and correctly connected to the airframe when the accident occurred.

The inspection of the Metal Chip Detector and the Electro Metal Chip Detector of the No. 1 Engine and No. 2 Engine respectively did not reveal any evidence of contaminants or deposits of abrupt engine failures. The oil filter appears normal and clean. The manufacturer's alignment marks which coupled the power transfer shaft to the spline at the reduction gearbox - Module 5 did not indicate any signs of excessive engine over-torqued.

A review of the past aircraft history from the aircraft log books on Events 1, 2, and 3 by Airbus Helicopter Malaysia revealed that it had been thoroughly inspected and supported by AH experts at the 5400 hours inspection and conversion to N3. The investigation revealed that the aircraft including the tail boom had been dismantled and the airframe paint had been removed to give full visual access to the sub-assemblies. The vertical fins of the horizontal stabiliser were exchanged with new ones. The rest of the stabiliser was removed and sanded down, inspected, and reinstalled as it met the inspection and validation criteria. Airbus Helicopter Malaysia stated that there was no reason to consider any horizontal stabiliser damage in the aircraft's history before the 2012 release to service as an underlying cause of the failure on the accident day. The long period of inactivity of this helicopter was due to a combination of causes ranging from financial issues and on storage awaiting prospective customers. The use of the helicopter for training purpose at AH Malaysia had made the completion of the work packages longer period than usual. On 09 February 2012 at 5,900 airframe hours, Airbus Helicopters Malaysia returned the helicopter status to "Available for flight" which made it airworthy for flight. On 15 March 2012, it was put in service under Orion Corridor Sdn. Bhd. as the new owner.

Based on the above information and due to the lack of hard evidence to substantiate the actual condition of the LH horizontal stabiliser, the use of the

SSCVFDR information was thoroughly analysed. The SSCVFDR recovered from the wreckage was in good condition and brought to UK AAIB for downloading. The recorded information on voice and flight data was in good condition and that information was shared with the manufacturer and BEA for analysis. The recorded information would enable the investigation to focus on the possible failure of the LH horizontal stabiliser in flight and the element of human factors of the flight crew.

2.2 Commander's (Pilot) experience and qualifications

The commander is a citizen of the United States of America with a date of birth of 29 March 1968. His height is 71 inches and weighs 205 kilograms. He possessed Malaysian and FAA commercial pilot licenses.

Based on the medical history, autopsy findings, and toxicology test, there was no evidence to indicate that the pilot's performance was affected by physiological factors.

2.3 Female passenger

She was 25 years old and a Kyrgyztan citizenship. She came to Malaysia in mid-2009 and studied at Sunway College, Subang Jaya from July 2009 until February 2010 on pre-university matriculation. She then went on to Lim Kok Wing University majoring in Foundation of Business (FB) from February 2010 until May 2010 but did not complete her studies there. From September 2013 until November 2013, she furthered her studies at SEGI College Kuala Lumpur for a degree in business studies. However, after three months, her study was terminated by the college due to her student visa was not approved by the Immigration Department.

She was a friend of the pilot and had been seen together at the airport and sometimes following the flight. Witness statement revealed that she had done a medical check-up at an approved Designated Medical Examiner clinic to prepare herself for formal flight training.

Her familiarity using the helicopter intercom system and her observation of the landing gear position and operations revealed that she had been in the helicopter cockpit on several occasions. She did not possess any flying license during the fatal flight. The AS 365 N3 helicopter flight manual requires a minimum of one pilot for operations.

2.4 The landing and take-off from the open field (last landing point)

The selected area for landing was about the size of 3 football fields and the approach path was considerably easy and safe for AS365 N3 to land. Instead of landing in the middle of the field, the pilot opted to land towards the extreme forward edge of the field. The chosen area for the landing was covered by grass and the view from the cockpit did not allow the pilot to assess the ground condition accurately.

At 1620 LT (7 minutes after taking off from Muazzam Shah) the helicopter landed on the field at Sekolah Kebangsaan Ladang Kota Bahagia to offload one of the passengers. As the wheel touched the ground and the collective lever reduced to 22%, the LH landing gear sunk into loose sandy ground. Subsequently, the helicopter tilted to the left up to 13.36 degrees inclination. The helicopter remains steady in this position for a duration of 6.6 seconds. At this juncture, a loud ‘thud’ noise was heard in the intercom system and raised concern by the passenger and the pilot. The helicopter was brought to hover and repositioned 10 meters forward of the landing point and remained on the ground for 3 minutes with the rotors running. Based on mathematical computation by Airbus Helicopters, it showed that the LH horizontal stabiliser structure was damaged without the knowledge of the pilot or any of the passengers. The excessive hydraulic fluid found in the hole made by the left landing gear did not trigger any hydraulic warning light during the take-off check performed by the pilot.

Analysis of the CAM track revealed that the loud ‘thud’ noise recorded during the landing had a noise level high enough to trigger the microphone threshold.

The helicopter took off from the open field at 1625 LT after offloading one passenger and flew in the direction of Subang (Mines).

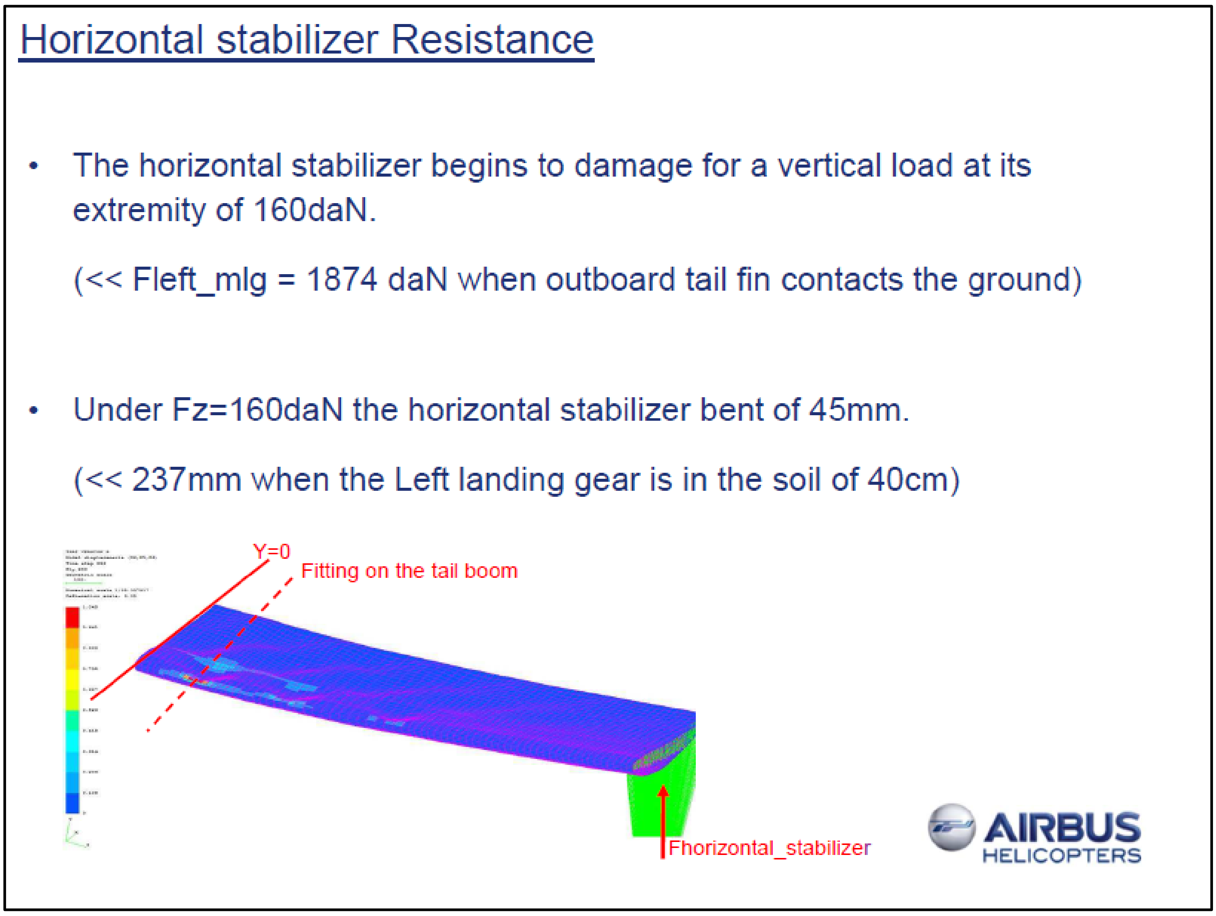


Figure 28

2.5 Stabiliser effect on aerodynamic

When the helicopter was cruising at high speed, at 148 knots, the helicopter was in a nose-down attitude. The nose-down attitude is to be corrected by the negative lift force generated by the horizontal stabiliser for a comfortable flight. The aerodynamic load on the horizontal stabiliser varies with helicopter mass, forward speed, and the altitude flown. At this condition, the horizontal stabilizer will experience high moment loading. Since the horizontal stabiliser was already damaged, this aerodynamic load would cause the horizontal stabiliser to separate from the helicopter. The configuration during this flight was reasonably high All Up Weight, high forward speed, 400 feet Rate of Descend compounded by landing gear in the down position, the sudden loss of the horizontal stabiliser will create an abrupt pitch down moment. Due to that sudden pitch-down movement, the helicopter can exceed its flight envelope if the movement is not counteracted by quick pilot action. In this case, the pilot had reacted on the cyclic 2.5 seconds after the suspected loss of horizontal stabiliser which was too late. The main rotor blades impacted the airframe approximately one second after the loss of the left horizontal stabiliser.

2.6 A piece of chipped-off paint found at the last landing point

A small chipped-off paint was found at the last landing field on the second visit by the investigation team. The chip was curvature in nature and had the colour of the horizontal stabiliser on the outer and white colour with the cross grain on the inside. This paint chip most probably came from the missing left horizontal stabiliser because the right stabiliser was found intact. When the critical area of the leading edge was subjected to bending, and when the outboard fin contacted the ground, the critical area experienced compressive stress to buckling. In these conditions, delamination and failure of fibers on one of several plies can occur causing it to buckle. The paint could have chipped off from the left stabiliser which had been weakened by the bending stress. (See Figure15)

2.7 The final disintegration

Analysis of the FDR revealed that at 08 h 53 min 57.800s, the longitudinal acceleration decreased from 0.02 g to -0.11g. At that moment, a transient noise was recorded on the audio file. The pitch was -4.2°and started to decrease.

500 ms after that transient noise, a high energy level phenomenon, similar to a succession of impacts was recorded. At that moment, the helicopter began a right roll.

The pitch decreased to -56° within 1.5 s and the helicopter began a right roll. The crew had reacted only 2.3 sec before the end of the recordings. At this moment, the helicopter was already beyond the flight envelope.

The recordings ended at 08 h 54 min 01.330 s probably when the G-Switch triggered. Triggering of the G-switch should occur between 6g and 8g.

Figure 29

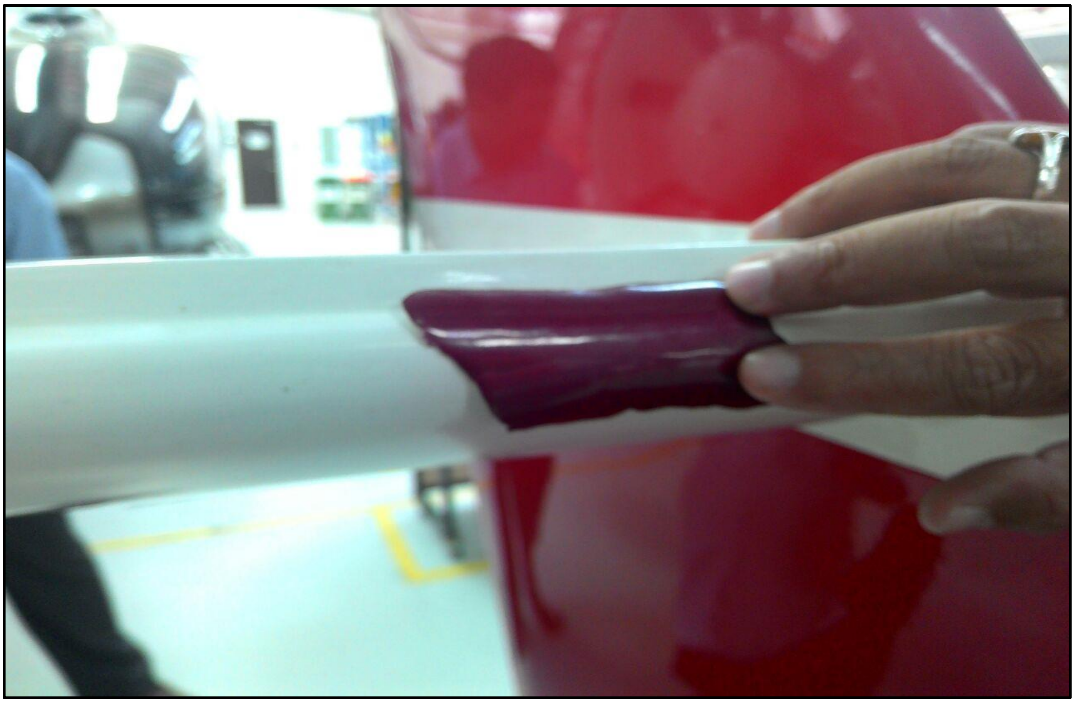


Figure 30

2.8 Engine recorder parameters

There was a sudden change in engine parameters in the last 3 seconds of recording with a sudden drop of Torque down to zero, Increase of Power Turbine speed, NR increase beyond the Power Turbine speed, reduction of Gas Generator speed, Gas Generator speed still high (> 70%).

Corresponds to the engine control unit (DECU) reacting to the Power Turbine speed increase due to the typical flight conditions.

2.8.1 Loss of automatic control by DECU only in the final second of recording

2.8.2 Erratic values in the final second of recording correspond to the final moment of the crash. Nominal engine parameters during the final flight and sudden changes in engines' parameters in last 3 seconds of recording when the DECU reacts to a typical flight condition. Loss of automatic engine control only in the final seconds of recording. Examination on the engines and FDR data correlate the engines were running normally until the event in the last 3 seconds of recording. The engines were under automatic control until the crash.

2.9 Operations under private flight

2.9.1 Sub Paragraph 2(4) of the Civil Aviation Regulation 1996 defines public transport as follows;

Subject to this regulation, an aircraft in flight shall for the purposes of these Regulations be deemed to fly for the purpose of public transport if in relation to such aircraft-

(a) hire or reward is given or promised for the carriage of passengers or cargo;

(b) any passenger or cargo is carried gratuitously by an air transport undertaking, not being-

(i) a person in the employment of the undertaking, including, in the case of a body corporate, any of its directors;

(ii) a person who with the authority of the Director General is making any inspection or witnessing any training, practice, or test for the purposes of these Regulations; or

(iii) cargo intended to be used by any such passenger as aforesaid, or by undertaking; or

(c) for the purposes of Part V, hire or reward is given or promised for the right to fly the aircraft on that flight, not being a single-seater aircraft of which the authorised maximum total weight does not exceed 910 kilogrammes and in respect of which a certificate of airworthiness of the Special Category is in force, otherwise than under a hire-purchase agreement; and the expression "public transport of passengers" shall be construed accordingly: Provided that, notwithstanding that an aircraft may be flying for the purpose of public transport by reason of paragraph (c), it shall not be deemed to be flying for the purpose of the public transport of passengers unless hire or reward is given or is promised for the carriage of those passengers: Provided further that a glider shall not be deemed to fly for the purpose of public transport for the purposes of Part V by virtue of paragraph (c) if the hire or reward given or promised for the primary purpose of conferring on a particular person the right to fly the glider on that flight is given or promised by a member of a flying club and the glider is owned or operated by that flying club.

Where under a transaction effected by or on behalf of a member of an unincorporated association of persons on the one hand and an incorporated association of persons or any member thereof on the other hand, a person is carried in or is given the right to fly, an aircraft in such circumstances that hire or reward would be deemed to be given or promised if the transaction were effected otherwise than as aforesaid, hire or reward, shall, for the purposes of these Regulations, be deemed to be given or promised.

The expression "pilot" in these Regulations or the Schedules thereto shall mean the holder of a Commercial or Airline Transport Pilot's license.

Any reference in these Regulations to a numbered regulation or Schedule shall be construed as a reference to the regulation or Schedule bearing that number in these Regulations.

However, Civil Aviation Regulation 1996 also define air transport undertaking as;

"air transport undertaking" means an undertaking whose business includes the carriage by air of passengers, cargo or mail for hire or reward;

2.9.2 Since the investigation was not able to determine any hire or reward was given or promised for the fatal flight, this flight was carried out in accordance with the CAR 1996 as a private flight.

2.10 Pilots licence

The pilot was the holder of Malaysian Commercial Pilot Licence number 2762 (helicopter). His last medical examination was done on 25 March 2015, however, his licence validity on his CPL was from 5th April 2015 until 30th September 2015. His commercial pilot license was valid for the flight.

On his aircraft rating (B) under group 1, there was an endorsement for AS 365 N3 dated 7 March 2012. However, there was no license validity certificate indicating the expiry date of PPL privileges in his CPL.

2.11 Authority on the flight deck

The flight was on Private Flight whereby the passengers were the guests of the Prime Minister of Malaysia to attend his daughter's wedding. The most senior passenger was the former Minister and Advisor to the Prime Minister's Department. He has been using the helicopter on several occasions especially visiting his constituency in Rompin.

During the flight from Pekan to Subang, the most senior passenger was consistently in communication with the pilot through the Aircraft Intercommunication System. An analysis of the communication from the CVR revealed that the pilot was well known to him. On several occasions during the flight, he insisted that the pilot fly to KL instead of flying to Bandar Tun Razak. His insistence could have influenced the pilot's decision to rush the flight even though the pilot was aware of the serious hydraulic leakage on the LH landing gear.

2.12 Maintenance

There was a maintenance contract between Onion Corridor Sdn. Bhd. (owner) and Airbus Helicopter but had expired. Upon further investigation, Airbus Helicopter admitted that on the day of the helicopter departure on 2nd April 2015 from Subang, the helicopter Daily Inspection was carried out by one of the Airbus Helicopter Licensed Engineers. The inspection was conducted based on a purchase order from Onion Corridor Sdn. Bhd. Subsequently, the Daily Inspection was carried out by the pilot himself under authorization issued by Airbus Helicopter through a Letter of Authorization.

There was no abnormality in the maintenance program of the IGB helicopter.

2.13 Recent similar accidents

2.13.1 One case was reported on AS365 N in 1999, Norway. - Rupture in the flight of both sides of the horizontal stabiliser further to an excessive aerodynamic disturbance in flight well in excess of its flight and certification envelope. AAIBN accident investigation report available on the website, describing the circumstances and consequence of this event (25 to 45% pitch down with firstly left following by right roll effect = pilot attentive able to react immediately to counter act the aircraft attitude)

Note: No corrective action was taken in relation to this case. It was considered as significantly out of flight envelope. Additional tests were performed in the Airbus Helicopter laboratory)

2.13.2 Flutter phenomenon: -

4 cases reported on AS365 N3 in 2006 (AH)

a. Loss in flight of the L/H side of the horizontal stabiliser during a reception flight to demonstrate de VNE. AS 365 N3 in 2008 (AH):

b. Loss in flight of the R/H side of the horizontal stabiliser during a training flight. AS 365N3 in 2008 (AH):

c. Loss in flight of the L/H side of the horizontal stabiliser during an acceptance flight. AS 365 N3 in 2008 (AH): Damage of the horizontal stabiliser discovery on ground during maintenance after a reception flight to demonstrate de VNE.

   Loss of the horizontal stabiliser due to flutter.

   Conservative measures: Issuing of an EASB (Emergency Alert Service Bulletin) 01.00.60 dated 06/2008: Limitation of the VNE to 150 kt. Issuing of EASB 01.00.60 Revision 1 dated 11/2008: To add a – 1500 ft/mn rate of descent (R/D) limitation beyond 140 kt.

   Corrective measures: Issuing of the SB (Service Bulletin) 55.00.06 dated 11/2014: Introduction of the modification 07.55B28 to suppress the Flutter phenomenon. Issuing of EASB 01.00.60 Revision 2 dated 09/2014: Cancel the flight limitation (VNE and R/D) after application of ASB 55.00.06.

d. Accidental damages: AS 365 N3 in 2014 - rupture due to a contact of the horizontal stabiliser fin with the ground while the aircraft was landing on snow-covered terrain). SHK accident investigation report available on the website describing the circumstances and consequences of this event.

This accident had some similarities with the accident of IGB. The air ambulance AS365 N3 landed lightly on a snow surface at a remote location to pick up a man after a snowmobile accident. The LH wheel penetrated the snow so much that the roll angle was more than 10 degrees. The LH fin hit the snow/ground and was bent to a higher position. The helicopter took off and after 200-300 meters of flight, it got into unstable pitch. The speed was reduced and it was noticed that half of the stabiliser and left-hand fin was missing.

2.14 Simulation on loss of horizontal stabiliser in flight

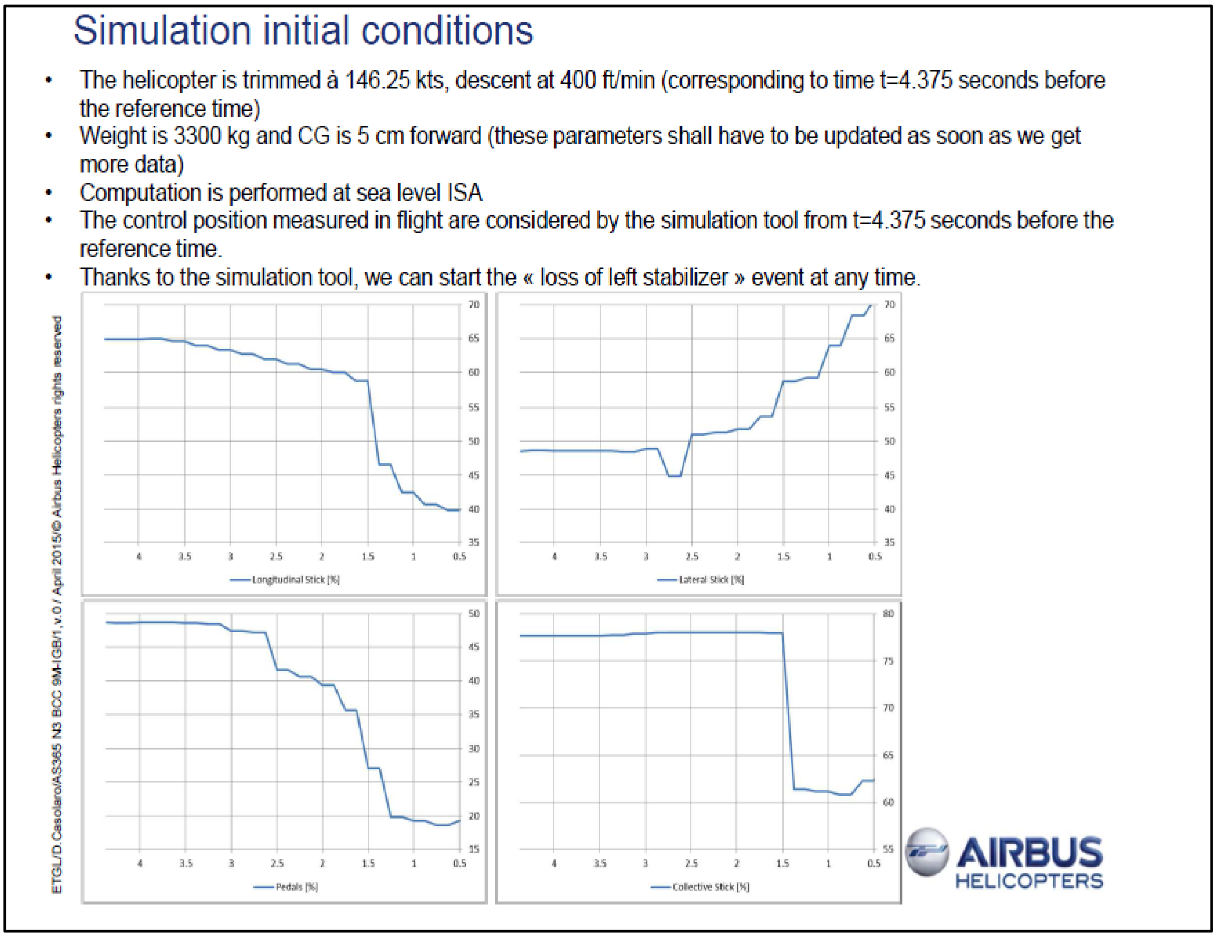


Figure 31

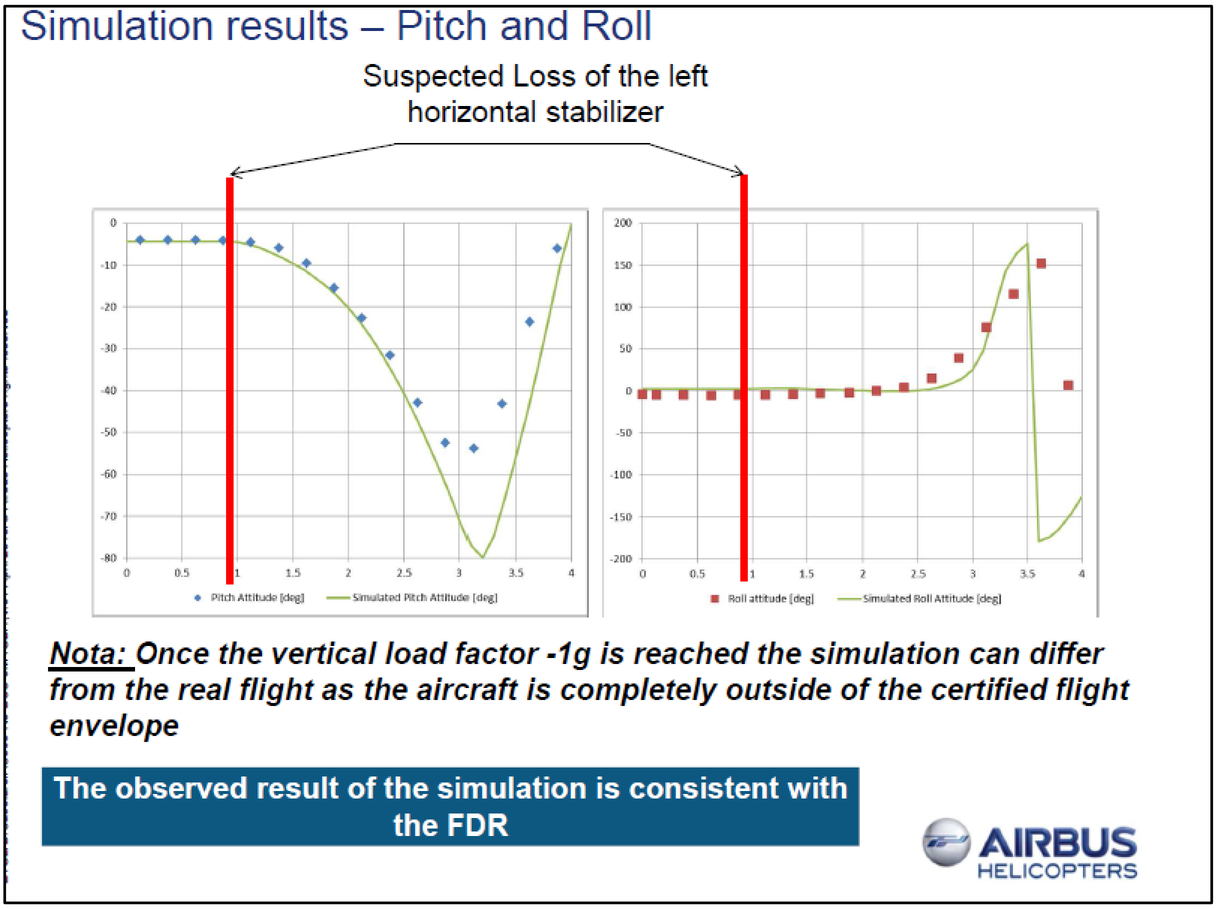

Simulation results – Pitch and Roll
Suspected Loss of the left horizontal stabilizer
Pitch Attitude [deg]
Simulated Pitch Attitude [deg]
Roll attitude [deg]
Simulated Roll Attitude [deg]
Nota: Once the vertical load factor -1g is reached the simulation can differ from the real flight as the aircraft is completely outside of the certified flight envelope
The observed result of the simulation is consistent with the FDR
AIRBUS HELICOPTERS

Figure 32

3.0 CONCLUSION

3.1 Findings

3.1.1 SSCVFDR information and inspection of the last landing area before the accident revealed that the helicopter had its left main landing gear sunk into loose soil while attempting a landing at an open field at Sekolah Kebangsaan Ladang Kota Bahagia. The left landing gear had sunk to approximately 20 inches deep into the soft ground causing the helicopter to tilt more than 13 degrees to the left. The LH horizontal stabiliser vertical fin and the tail section below the tail rotor fenestron had impacted the ground causing some damage to the inboard root of the LH horizontal stabiliser.

3.1.2 There was also evidence of excessive fluid leak in the sinkhole made by the left landing gear as well as on the grass about 10 meters forward of the landing point. The fluid could have originated from the LH landing gear oleo strut and hydraulic brake system. However, no hydraulic warning was triggered during the check performed by the pilot before taking off,

3.1.3 The pilot was seen by a witness to have exited the helicopter and accompanied the disembarked passenger clear of the main rotor area. However, he did not carry out any inspection of the helicopter.

3.1.4 The main wreckage was concentrated in one area in a ravine. The 4 main rotor blades were found at different places from the main wreckage. The tail rotor and the right horizontal stabiliser was found about 200 meters away from the main wreckage.

3.1.5 Both the left and right engine parameters were operating normally.

3.1.6 At the end of the recording, as the helicopter was flying under autopilot at 148 kts., the pitch of the helicopter unexpectedly and significantly decreased. The helicopter rapidly went beyond the flight envelope limits without any pilot input.

3.1.7 Inspection on the reconstruction of the wreckage revealed that the main rotor blades had struck the cowling, tail boom, fenestron, and the left cabin door while the helicopter was still in the air. This action is considered consequential and there was no indication that the helicopter had struck terrain or any trees in flight prior to the impact. The helicopter descended almost vertically to the main wreckage area.

3.1.8 The crew was properly licensed and proficient to fly the helicopter,

3.1.9 The helicopter maintenance contract with Airbus Helicopter was properly carried out as per the maintenance program and there was no anomaly in the maintenance documents.

3.1.10 The history of previous repair works on the helicopter by Airbus Helicopter did not reveal any anomaly that could contribute to the structural failure of the helicopter in flight.

3.2 Cause

3.2.1 The cause of the accident was due to the separation of the left horizontal stabiliser in flight causing the helicopter to dive and bank to the right exceeding its flight envelope. The main rotor blades subsequently severed the tail boom and severed parts of the airframe resulting in the accident.

3.2.2 The following factors contributed to the accident:

a) Unplanned landing at an open field causing the left main landing gear to sink into loose soil. The vertical fin attached to the LH horizontal stabiliser contacted the soil and subsequently fractured the inboard root of the LH horizontal stabiliser.

b) Failure of the pilot to conduct a detailed damage assessment of the left main landing gear knowing the presence of excessive oil leak and damages to other parts of the helicopter.

c) A descending high cruising speed compounded with landing gears down would aerodynamically put excessive loads on the fractured left horizontal stabiliser.

d) Passenger intervention to the pilot to return home on several occasions could create peer pressure on the pilot to rush to fly home.

4.0 SAFETY RECOMMENDATIONS

It is recommended that:

4.1 Pilot in command is to conduct pre-flight for every flight and to include risk assessment on the route and destination for suitability before the flight commences. The DGCA notification letter dated 17 August 2015.

4.2 Helicopter pilot is to avoid landing at any place unplanned whether on their own or at passenger discretion except when absolutely necessary, such as in an emergency situation.

4.3 DCA is to determine the necessity for flight manifest for all private flights. The DGCA notification letter dated 17 August 2015.

4.4 DCA is to study the activation of the Emergency Locator Beacon fitted to the helicopter after the non-activation of several accidents involving emergency hard landings.

4.5 DCA to review the validity of private pilot license privileges, when the holder has a professional license.

4.6 DCA to review the procedure for single pilot helicopter operations, in order to ensure safety for passenger embarkation or disembarkation with the engine and main rotor running.

4.7 The pilot in command is to ensure that the passenger occupying the co-pilot's seat is prohibited from taking part in the operations of the helicopter.

INVESTIGATOR-IN-CHARGE
Air Accident Investigation Bureau
MALAYSIA