AIRCRAFT ACCIDENT REPORT 1/2007

ACCIDENT INVESTIGATION DIVISION

Civil Aviation Department
Hong Kong

Report on the accident to
Robinson R44 helicopter, B-HJS,
operated by Topjet Aviation Limited at Pak A, Sai Kung, Hong Kong
on 11 June 2005

Hong Kong

In accordance with Annex 13 to the ICAO Convention on International Civil Aviation and the Hong Kong Civil Aviation (Investigation of Accidents) Regulations, the sole objective of this investigation is the prevention of aircraft accidents. It is not the purpose of this activity to apportion blame or liability.

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April 2007

The Honourable Donald Tsang, GBM
The Chief Executive
Hong Kong Special Administrative Region
People's Republic of China

Dear Sir,

In accordance with Regulation 10(6) of the Hong Kong Civil Aviation (Investigation of Accidents) Regulations, I have the honour to submit the report by Mr John T C Lau, an Inspector of Accidents, on the circumstances of the accident to a Robinson R44 helicopter, registration B-HJS at Pak A, Sai Kung, Hong Kong on 11 June 2005.

Yours faithfully,

(Norman S M Lo)
Director-General of Civil Aviation

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GLOSSARY OF ABBREVIATIONS USED IN THE REPORT

ATS	Air Traffic Service
CAD	Civil Aviation Department Hong Kong
cm	Centimetre
^{o}C	Degree Celsius
^{o}	Degree
FAR	Federal Aviation Regulations, the United States
FIS	Flight Information Service
FSCC	Fire Services Communication Centre (FSD)
FSD	Fire Services Department
g	Acceleration due to Gravity
GFS	Government Flying Service
IF	Induced Flow
HKAC	Hong Kong Aviation Club Limited
HKO	Hong Kong Observatory
HKP	Hong Kong Police
hrs	Hours
km	Kilometre
knots	Nautical Miles Per Hour
lb	Pound
LTE	Loss of Tail Rotor Effectiveness
LTT	Loss of Tail Rotor Thrust
METAR	Aerodrome Routine Meteorological Report
MHz	Megahertz

m	Metre
NTSB	National Transportation Safety Board, the United States
POH	Pilot’s Operating Handbook
POR	Plane of Rotation
RAF	Relative Air Flow
RCCC/K	Kowloon Regional Command & Control Centre (HKP)
RCCC/M	Marine Regional Command & Control Centre (HKP)
RPM	Revolutions per minute
SAR	Search and Rescue
UCARA	Uncontrolled Airspace Reporting Areas
UKCAA	United Kingdom Civil Aviation Authority
UTC	Universal Co-ordinated Time
VFR	Visual Flight Rules
VHF	Very High Frequency
α	Angle between the Relative Air Flow and the Chord of the Rotor Blades
β	Angle between the Tail Rotor Blades and the Plane of Rotation

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ACCIDENT INVESTIGATION DIVISION

CIVIL AVIATION DEPARTMENT

Aircraft Accident Report 1/2007

Registered Owner:	Topjet Aviation Limited
Operator:	Topjet Aviation Limited
Aircraft Type:	Robinson Helicopter Company R44 Helicopter
Nationality / Registration:	B-HJS
Place of Accident:	Pak A, Sai Kung, Hong Kong
	Latitude: 22º 21.3' N
	Longitude: 114º 21.1' E
Date and Time:	11 June 2005 at 0612 hrs (1412 hrs)
	All times in this Report are in Universal Co-ordinated Time (UTC) with Hong Kong Local Time in parenthesis

SYNOPSIS

In the afternoon of 11 June 2005, a Robinson R44 helicopter of Topjet Aviation Limited operated by a pilot with three passengers on board took off at 0610 hrs (1410 hrs) on a private Visual Flight Rules flight from Pak A to the Hong Kong Aviation Club at the former Kai Tak Airport.

Whilst the pilot was executing a spot turn to the right after lift-off, the helicopter yawed continuously to the right, drifting to the left until it impacted with the ground on a southerly heading at approximately 10 m to the northeast of the lift-off position. The helicopter then came to rest on its left side. The left skid was substantially damaged. The main rotor blades remained attached to the helicopter but were significantly bent and twisted. Both blades of the tail rotor were severed. The tail boom was severely fractured, locally twisted and bent to the starboard near the tail rotor drive shaft damper bearing. There was no post-impact fire. The pilot and two passengers of the helicopter were injured. The first emergency service unit, a Government Flying Service helicopter, arrived at the scene at approximately 0632 hrs (1432 hrs) to commence the airlifting of the injured persons to hospital and the last injured person was airlifted from the scene at 0741 hrs (1541 hrs).

Upon receipt of the notification of the accident from the duty Aerodrome Supervisor at the Hong Kong International Airport, a team of CAD Inspectors of Accidents arrived at the scene at approximately 0919 hrs (1719 hrs) to conduct a site appraisal and survey. The team then carried out a preliminary inspection of the wreckage including the collection of evidence. The Chief Inspector of Accidents subsequently ordered an Inspector’s Investigation into the accident in accordance with the Hong

Kong Civil Aviation (Investigation of Accidents) Regulations. The sole objective of this investigation is the prevention of aircraft accidents. It is not the purpose of this activity to apportion blame or liability.

The investigation concluded that the helicopter experienced, during a yaw turn to the right after lift-off, a loss of tail rotor effectiveness that led to the stalling of the tail rotor. Two safety recommendations have been made.

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1. FACTUAL INFORMATION

1.1 History of Flight

1.1.1 On 11 June 2005, a Robinson R44 helicopter, Registration B-HJS, of Topjet Aviation Limited fitted with single controls, was operated by a pilot on a series of private flights under Visual Flight Rules (VFR) between the Hong Kong Aviation Club Limited (HKAC) at the former Kai Tak Airport and Pak A near the High Island Reservoir at Sai Kung. The pilot had conducted two flights into Pak A earlier in the morning, each with three passengers on board.

1.1.2 After lunch at Pak A, the pilot intended to operate two runs out of Pak A to transport all passengers back to the HKAC. The first run with three passengers on board took place uneventfully. The accident occurred during departure on the second run from Pak A with three passengers on board. One of the passengers on all these flights was a R44 type rated helicopter pilot and she had assisted the pilot in escorting the other passengers into and out of the helicopter. On the accident flight, she occupied the left rear seat.

1.1.3 The helicopter lifted off at 0610 hrs (1410 hrs) from a sandy-grassed area at Pak A (see Photograph 1). Whilst the helicopter was in a hover on a northerly heading, the pilot made a yaw turn to the right with the intention that the spot turn would stop at 180° (half a revolution) so that the helicopter could be stabilized in a hover facing the sea before transitioning to forward flight over the water. This subsequently developed into a continuous uncontrolled yaw turn, drifting to the left. The helicopter then impacted with the ground on a southerly heading at approximately 10 m to the northeast of the lift-off position. The helicopter eventually came to rest on its left side. The left skid was substantially damaged. The main rotor blades remained attached to the helicopter but were significantly bent and twisted. Both blades of the tail rotor were severed. The tail boom was severely fractured, locally twisted and bent to the starboard near the damper bearing of the tail rotor drive shaft. There was no post-impact fire.

Photograph 1 Helicopter Lift-Off and Wreckage Positions at Pak A

1.2 Injuries to Persons

Injuries	Pilot	Passenger	Total in the helicopter	Others
Fatal	-	-	-	-
Serious	1	2	3	-
Minor	-	-	-	-
None	-	1	1	-
Total	1	3	4	-

1.3 Damage to Aircraft

The helicopter was destroyed.

1.4 Other Damage

There was no other damage.

1.5 Personnel Information

Pilot:	Male, aged 45 years
Licence:	Private Pilot's Licence (Helicopters)
Aircraft Rating:	Robinson R22 Robinson R44

Licensing Flight Test on Type:	4 December 2004
Medical Certificate:	Class 2, renewed on 24 March 2005, valid until 31 March 2006. No limitations.
Flying Experience:	Total all types 180 hours Total on type 34 hours

1.6 Aircraft Information

1.6.1 Airworthiness and Maintenance of Aircraft

Manufacturer:	Robinson Helicopter Company
Type:	R44 Clipper I
Aircraft serial number:	920
Year of manufacture:	2000
Certificate of Registration:	Issued on 28 November 2000 in the ownership of Topjet Aviation Limited

Certificate of Airworthiness:	Issued on 15 December 2000 in the Private Category and valid until 15 December 2005
Engine:	Lycoming O-540-F1B5 piston engine
Maximum Approved Gross Weight:	2,400 lb
Total airframe hours:	1,087 hours

1.6.1.1 The helicopter was imported as a new aircraft to Hong Kong in 2000 and had since been registered under Topjet Aviation Limited. Aircraft technical records indicated that the helicopter had been maintained in accordance with Maintenance Schedule MS/R44/01 Issue 1 and there had not been any significant airworthiness problems. The most recent scheduled maintenance check was a 100-hour Inspection carried out on 26 March 2005. At the time of that inspection, the airframe and engine had each accumulated 1,042 flight hours since new.

1.6.1.2 A review of the Aircraft Log Book indicated that the helicopter had no outstanding defects prior to the accident flight. The helicopter was fully serviceable in all respects.

1.6.2 Aircraft Description

1.6.2.1 General

R44 is a single-engined helicopter manufactured in the United States. The maximum gross weight for this helicopter is 2,400 lb. The airframe is primarily constructed of welded steel tubing covered with aluminium skin and is supported by a skid type landing gear. The tailcone is a typical monocoque aluminium structure. There are two front and two rear seats in the cabin. The helicopter is equipped with dual controls and certified for single pilot operations on the right front seat. Flight controls for the left front seat should be removed if the person occupying this seat is not a rated helicopter pilot.

1.6.2.2 Powerplant and Transmission System

R44 Clipper I is powered by a Lycoming O-540-F1B5 piston engine with a maximum take-off power rating of 225 shaft horse power with fuel supply controlled by a carburettor. A pulley sheave (lower sheave) carried on the horizontal engine output shaft drives four vee-belts which transmit power to an upper sheave when the belts are tensioned by an electric screwjack clutch actuator. When activated, the actuator raises the upper sheave and automatically sets and maintains the required tension. An over-running clutch within the upper sheave transmits power forward to a main rotor gearbox and aft to a tail rotor drive shaft and also allows the rotors to continue to turn in the event of an engine stoppage. The main rotor gearbox contains a spiral-bevel gear set that drives a vertical main rotor shaft. Appendix A shows a simplified schematic diagram of the powerplant and transmission system of the helicopter.

1.6.2.3 Main and Tail Rotors

1.6.2.3.1 The main rotor system has two all-metal blades with stainless steel skin attached to a main rotor hub. The main rotor hub is mounted to the shaft with a horizontal teeter hinge located above the coning hinges. The main rotor rotation is anti-clockwise when viewed from above. Pitch-change bearings for the blades are enclosed in a housing at the respective blade root.

1.6.2.3.2 The tail rotor system has two all-metal blades with aluminium skin. The tail rotor drive shaft, running inside the tail boom, transmits power to a splash-lubricated gearbox which in turn drives a horizontal tail rotor shaft. The two tail rotor blades are attached to a teetering hub with a fixed coning angle, elastomeric teetering and Teflon pitch-change bearings.

1.6.2.4 Flight Controls

1.6.2.4.1 R44 has dual controls actuated through push-pull tubes and bellcranks. The cyclic grip is free to move vertically and hinges at the centre pivot of the cyclic stick. The collective stick is equipped with a twist-grip throttle control. The main rotor blade pitch angle is controlled by the cyclic stick and the collective stick.

1.6.2.4.2 The cyclic and the collective control systems are assisted by three hydraulic servos connecting to the three push-pull tubes that support the main rotor swashplate. The hydraulic pump is powered by the main gearbox so that hydraulic pressure is maintained as long as the main rotor is rotating.

1.6.2.4.3 Directional control is effected by varying the collective pitch of the tail rotor blades using yaw pedals which are connected to the tail rotor blades by push-pull tubes and bellcranks.

1.6.2.5 Engine Controls

1.6.2.5.1 The engine power is controlled by a twist-grip throttle located on either of the two interconnected collective sticks. The throttle actuates the butterfly valve on the carburettor through a system of push-pull tubes and bellcranks. When the engine revolutions per minute (RPM) is above 80%, the electronic governor will be activated to maintain a constant rotor RPM for various flight control inputs and helicopter manoeuvres. While the governor drives the whole throttle system, including the twist-grip, the pilot may override the governor with the twist-grip through a friction clutch in the linkage between the governor and the whole throttle system.

1.6.2.5.2 The governor system consists of two major components, namely the governor controller and the governor assembly. The governor controller is a solid-state analogue-circuit control unit which senses engine RPM via tachometer points in the engine right magneto and provides a corrective signal to the governor assembly. When activated by the governor controller, the governor motor drives a friction clutch connected to the throttle to maintain a constant rotor RPM.

1.6.2.5.3 The R44 Pilot's Operating Handbook (POH) specifies that flight with the governor selected 'OFF' is prohibited, except in the case of in-flight malfunction of the system or for emergency procedures training.

1.6.3 Performance and Centre of Gravity

The helicopter was within both longitudinal and lateral centre of gravity limits. The Maximum Approved Gross Weight of the helicopter is 2,400 lb; the take-off weight of the helicopter was calculated to be approximately 2,200 lb at the time of the accident.

1.6.4 Fuel

The fuel on board was sufficient for the flight.

1.7 Meteorological Information

1.7.1 Weather Forecast and Observations

1.7.1.1 Weather Information issued by the Hong Kong Observatory

1.7.1.1.1 The Hong Kong Observatory (HKO) issues Aerodrome Routine Meteorological Report (METAR) at half-hour intervals and Local Aviation Forecasts for 100 nautical miles radius around Hong Kong at six-hour intervals. The METARs and Local Aviation Forecasts available to the pilot during his self-briefing in the morning (see Paragraph 1.7.3.1) included, amongst others, the METARs issued between 0000 hrs (0800 hrs) and 0200 hrs (1000 hrs), and the Local Aviation Forecast at 2230 hrs (0630 hrs) on the HKO website. The relevant information is as follows:

(i) METARs at the Hong Kong International Airport issued between 0000 hrs (0800 hrs) and 0200 hrs (1000 hrs):

0000 hrs (0800 hrs):
“VHHH 0000 24007KT 220V280 9999 FEW016 30/25 Q1002 NOSIG=”

0030 hrs (0830 hrs):
“VHHH 0030 24009KT 210V280 9999 FEW016 SCT300 30/25 Q1002 NOSIG=”

0100 hrs (0900 hrs):
“VHHH 0100 26009KT 9999 FEW016 SCT300 31/25 Q1002 NOSIG=”

0130 hrs (0930 hrs):
“VHHH 0130 26008KT 9999 FEW020 SCT090 31/25 Q1002 NOSIG=”

0200 hrs (1000 hrs):
“VHHH 0200 25008KT 9999 FEW022 SCT080 31/24 Q1002 NOSIG=”

(ii) Extracts of the Local Aviation Forecast issued at 2230 hrs (0630 hrs) for the period from 0000 hrs (0800 hrs) to 1000 hrs (1800 hrs):

Surface wind: 220º 10 knots, TEMPO VRB 25 knots, gust 35 knots in thunderstorm.
Offshore wind: 250º 15 knots
Temperature: Offshore 28º C - 33º C
Weather: Hot with sunny periods and isolated showers. There will also be a few isolated squally thunderstorms later
Cloud (AMSL): FEW 2000 feet, SCT 4000 feet, TEMPO FEW 1000 feet, SCT CB 1500 feet, BKN 5000 feet
Visibility: 10 KM, TEMPO 3000 M in showers, TEMPO 1500 M in thunderstorm
Further Outlook: Moderate southwesterly winds. Mainly cloudy with isolated showers

1.7.1.1.2 The HKO also issued a Local Aviation Forecast at 0430 hrs (1230 hrs) as follows:

Extracts of the Local Aviation Forecast issued at 0430 hrs (1230 hrs) for the period from 0600 hrs (1400 hrs) to 1600 hrs (2400 hrs):

Surface wind: 220º 10 knots, TEMPO VRB 25 knots, gust 35 knots in thunderstorm. Offshore wind: 250º 15 knots

Temperature: Offshore 34º C - 28º C

Weather: Mainly fine. There will also be a few isolated showers and squally thunderstorms inland

Cloud (AMSL): FEW 2000 feet, SCT 8000 feet, TEMPO FEW 1000 feet, SCT CB 1500 feet, BKN 5000 feet

Visibility: 10 KM, TEMPO 3000 M in showers, TEMPO 1500 M in thunderstorm

Further Outlook: Moderate southwesterly winds. Mainly cloudy with isolated showers

1.7.1.2 After the accident, the HKO submitted the following information on the general weather conditions in Sai Kung area around the time of the accident:

"Hong Kong was under the influence of southwest monsoon. Around the time of the incident, winds were southwesterlies and around 5 – 10 knots in the Sai Kung area and 10 – 15 knots over Waglan. The weather was generally fine and the visibility good."

1.7.1.3 As regards the weather conditions at Pak A, the HKO submitted the following information:

"Winds and temperatures over the eastern coast (near Pak A) at 0620 UTC were southwesterly 5 – 10 knots and 32 – 33 degree."

"Winds over Hong Kong picked up slightly around 1400 HKT. As Pak A was surrounded by hills to its east and west, winds at Pak A is likely to be affected by its local topography and could be somewhat different from its surrounding area, especially under light to moderate wind conditions."

1.7.2 Meteorological Information Available at the HKAC

The HKAC is a subscriber of the Aviation Meteorological Information Dissemination System of the HKO. This system displays, inter alia, METAR, Local Routine Report, Local Aviation Forecast and Winds around Hong Kong to facilitate the provision, dissemination and display of meteorological information to users. In addition, the HKAC has access to the HKO internet website which provides information on aviation weather observation and forecast.

1.7.3 Meteorological Information Obtained by the Pilot

1.7.3.1 The pilot mentioned in his statement that he had carried out a self-briefing in the morning prior to the series of flights by checking the HKO internet website for weather information that consisted of the actual and forecast weather for aviators, sunrise and sunset, high and low tide times.

1.7.3.2 From the self-briefing, the pilot gathered that the weather conditions in general were fine with light and variable winds, mainly southwesterly; and temperature was 30°C with good visibility.

1.7.4 Pilot’s Assessment of Wind Conditions at Pak A

1.7.4.1 The pilot stated in his statement that when he made the approach to Pak A for the landing in the morning, the wind was light, between 220° and 240° at 5 to 10 knots, and that he was mindful of tailwind on approach to landing.

1.7.4.2 He also described that the wind was from the southwest just before the accident.

1.8 Aids to Navigation

The flight was conducted in day time under VFR and the helicopter was appropriately equipped with navigation aids for such a flight.

1.9 Communications

1.9.1 The accident took place at Pak A within Port Shelter, which is one of the seven Uncontrolled Airspace Reporting Areas (UCARA) in Hong Kong (see Appendix B). In UCARA, 'Hong Kong Information' is the Hong Kong Air Traffic Service (ATS) unit that provides flight information service (FIS) and alerting service to aircraft.[Note 1] In accordance with the provisions of the Hong Kong Aeronautical Information Publication issued by the Civil Aviation Department Hong Kong (CAD), local flights are permitted to take place under VFR in UCARA, but with an additional requirement for two-way radio communication with 'Hong Kong Information' on the designated VHF frequency 122.4 MHz.

1.9.2 The helicopter was fitted with a VHF radio communication equipment and the radio was serviceable on the day of the accident. The helicopter had been maintaining satisfactory communication with 'Hong Kong Information' within UCARA. The last communication with 'Hong Kong Information' made by the helicopter was at 0610 hrs (1410 hrs) when the pilot reported lifting off at Pak A shortly before the accident. This transmission was acknowledged by 'Hong Kong Information'.

Note 1: FIS refers to a service provided for the purpose of giving advice and information useful for the safe and efficient conduct of flights. Alerting service refers to a service provided to notify appropriate organizations regarding aircraft in need of search and rescue aid, and assist such organizations as required.

1.10 Aerodrome Information

The accident took place at an open area at Pak A within UCARA Port Shelter. Aerodrome information is not relevant.

1.11 Flight Recorders

The helicopter was not fitted with any flight recorder and there was no requirement for this class of helicopter to be so fitted.

1.12 Wreckage and Impact Information

1.12.1 The impact point was approximately 10 m to the northeast of the lift-off position (see Photograph 1). The wreckage rested on a slightly sloping sandy-grassed surface with the fuselage toppled to the left.

1.12.2 The engine remained attached to the airframe but was slightly deformed as a result of the impact with the ground. The fuel tanks were intact.

1.12.3 Damage to the helicopter as a result of the impact was as follows (see Photograph 2). Additional photographs showing the damage to the helicopter are included in Appendix C.

(a) The left skid was substantially damaged.

(b) The main rotor blades remained attached to the helicopter but were significantly bent and twisted.

(c) Both blades of the tail rotor were severed. One of the two tail rotor blades was subsequently recovered at approximately 2 m from the tail rotor hub whereas the other piece could not be located despite extensive search of the accident site.

(d) The tail boom was severely fractured, locally twisted and bent to the starboard near the tail rotor drive shaft damper bearing.

(e) The perspex canopy was extensively damaged.

Photograph 2 Helicopter Wreckage

1.12.4 The left yaw pedal was found at the full forward position in the post-accident examination.

1.12.5 The flight controls for the left front seat were found undamaged, adjacent to the storage compartment underneath the left front seat normally used for stowing the flight controls.

1.13 Medical and Pathological Information

1.13.1 The Pilot

1.13.1.1 The pilot was in possession of a valid Class 2 Medical Certificate and he operated the helicopter from the right front seat. There was no evidence to suggest that he was suffering from any pre-existing illness that might have contributed to the accident. According to the pilot's statement, he was not taking any medicines prescribed by a doctor or purchased over the counter.

1.13.1.2 The pilot was diagnosed with compression (burst) fracture of the first lumbar spinal vertebra. There were no other significant injuries. The spine injury was wholly compatible with the mechanism of trauma caused by the helicopter's vertical deceleration forces in the accident.

1.13.1.3 Blood and urine tests for drugs and alcohol using automated liquid chromatography were conducted after the accident.

1.13.1.4 There was no evidence to suggest that the performance of the pilot had been affected by tiredness, alcohol, drugs, physiological factors or incapacitation.

1.13.2 Left Front Seat Passenger

This passenger sustained a compression fracture of the first lumbar spinal vertebra.

1.13.3 Left Rear Seat Passenger

1.13.3.1 The passenger, a R44 type rated helicopter pilot herself, had assisted the pilot in escorting the other passengers into and out of the helicopter during flights. She sustained a compression fracture of the second lumbar spinal vertebra.

1.13.3.2 She was not entrapped in the wreckage but she decided to remain inside the helicopter until she was attended to by the emergency service personnel. She was subsequently evacuated from the helicopter after part of the roof of the helicopter was cut away by the Fire Services Department (FSD) personnel.

1.13.4 Right Rear Seat Passenger

This passenger was not injured in the accident and was not admitted to hospital. At the time of helicopter impact with the ground, he was momentarily leaning forward off his seat in an attempt to comfort the left front seat passenger. He was not entrapped in the accident and managed to vacate the wreckage without assistance.

1.14 Fire

No fire occurred in the accident.

1.15 Survival Aspects

1.15.1 Search and Rescue (SAR)

The accident took place at 0612 hrs (1412 hrs), and about 5 minutes later a member of the public telephoned to report the occurrence to the Kowloon Regional Command & Control Centre (RCCC/K) of the Hong Kong Police (HKP), who then informed the Marine RCCC (RCCC/M) of the HKP and the Fire Services Communication Centre (FSCC) of the FSD to take corresponding actions. Emergency service personnel of the HKP, FSD and Government Flying Service (GFS) were subsequently notified and dispatched in the rescue operation. A summary of the emergency handling of the rescue operation is contained in Appendix D.

1.15.2 Aircraft Survivability

Crashworthiness survivability analyses were conducted which included an assessment of the container, restraints, environment, energy absorption features and post-crash factors.

1.16 Tests and Research

1.16.1 Components affecting engine controls and flying controls were inspected. For those components that required the use of specialist instruments and equipment to verify the integrity and functionality, they were further tested in the laboratory by the aircraft manufacturer in the United States and an independent metallurgical laboratory in Hong Kong.

1.16.2 Four components, namely the hydraulic pump, the right magneto, the governor controller and the governor motor were sent to the aircraft manufacturer for detailed examination under the supervision of the United States National Transportation Safety Board (NTSB).

1.16.3 An independent metallurgical laboratory conducted an analysis of the tail rotor drive shaft, the tail rotor hub and the blades of the tail rotor of the helicopter. Stereomicroscopic examinations were carried out on the drive shaft, rotor hub and broken tail rotor blades to ascertain whether there was any pre-impact damage and to establish the cause of the breakage.

1.17 Organization and Management Information

The helicopter was registered in Hong Kong under the ownership of Topjet Aviation Limited with a Certificate of Airworthiness in the Private Category. Aircraft maintenance services and hangarage of the helicopter were provided by the HKAC.

2. ANALYSIS

2.1 Flight Operations and Aircraft Airworthiness

2.1.1 Vibration and Noise

The pilot did not report noticing any abnormal vibration, unusual noise, illumination of warning lights or sounding of warning horn from the moment of lift-off until the impact. Furthermore, according to the statement of the left front seat passenger, she did not notice anything abnormal in the cockpit such as flashing lights on the instrument panel or warning sounds after lift-off. This indicated that the helicopter did not experience any system failure or malfunction from the moment of lift-off until the steady hover.

2.1.2 Flying Controls

2.1.2.1 Cockpit Switches

All cockpit switches were found in their normal positions for flying except the following:

2.1.2.1.1 The master battery switch was in the 'OFF' position.

When interviewed after the accident, the pilot confirmed that he had placed the master battery switch to the ‘OFF’ position after the impact.

2.1.2.1.2 The governor switch, located at the end of collective control, was found at the ‘OFF’ position (see Photograph 3).

Photograph 3 Governor Switch at ‘OFF’ Position

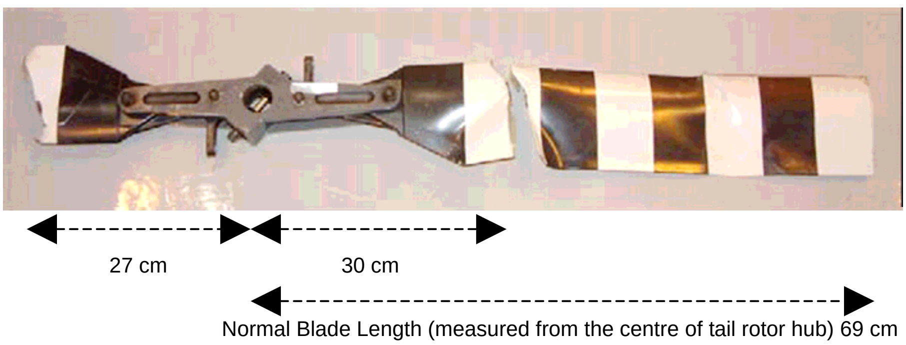
When interviewed after the accident, the pilot stated that he had been trained to memorize the preflight checklist and that as per his usual practice, he had performed the preflight checks by reciting the checklist on each take-off. The Preflight Checks as stated in the R44 POH require the governor to be selected 'ON' and verified operative before flight. As stated in Paragraph 2.1.1, the pilot did not report noticing illumination of 'GOV OFF' (indicating governor disabled). The pilot also confirmed in his statement that the helicopter had entered into a steady hover, and this was supported by the left rear seat passenger in her statement. The warning light bulb of the governor was tested after the accident and was found to be serviceable. The right magneto, governor controller and governor motor were returned to the aircraft manufacturer for functional testing and these components were found to be operating normally. All the above indicated that the governor was selected 'ON' from the moment of lift-off until the steady hover. It was reasonably believed that the governor switch was inadvertently knocked into the 'OFF' position after the accident, most probably during the evacuation of the occupants from the helicopter.

2.1.2.2 Flight Controls

As mentioned in Paragraph 1.12.5, the flight controls for the left front seat were found undamaged, adjacent to the storage compartment underneath the left front seat normally used for stowing the flight controls. This indicated that the flight controls for the left front seat were removed prior to the accident flight for single pilot operations on the right front seat (see Paragraph 1.6.2.1).

2.1.3 Tail Rotor Blades

2.1.3.1 The tail rotor blades were severed by impact with the ground. Both ends were fractured at approximately the same distance from the centre of the tail rotor hub assembly (see Photograph 4) and found to have sustained similar breakage, indicating that the tail rotor was still running when it hit the ground. Judging from the breakage of tail rotor blades, the damage to both blades was likely to be symmetrical, i.e. each of the two blades was severed into two pieces.



Photograph 4 Tail Rotor Hub and Broken Blade

2.1.3.2 Comprehensive search over an extensive area of approximately 160 m in diameter as shown in Photograph 5 was conducted in an attempt to recover the missing part of the broken tail rotor blade but it could not be located.

Photograph 5 Search Area for Missing Part of Broken Tail Rotor Blade

2.1.3.3 An independent metallurgical laboratory conducted an analysis of the tail rotor hub and the blade of the tail rotor of the helicopter. The results indicated that the tail rotor hub and the tail rotor blades did not have any pre-impact damage. In addition, the fracture surfaces of the blades did not indicate any signs of metal fatigue. The fracture of blades was most probably caused by a combination of tearing, bending and twisting forces acting on the rotating blades when they struck the ground. Had the breakage of the tail rotor blades occurred during the hover manoeuvre, the pilot would have experienced extreme vibration. Since none of the occupants reported noticing any extreme vibration or significant noise during the hover manoeuvre, it could be concluded that the tail rotor did not suffer from any damage until it hit the ground.

2.1.4 Tail Rotor Drive Shaft

The laboratory examination on the breakage of the broken ends of the tail rotor drive shaft suggested that the engine was still providing power to the tail rotor system before the impact and that the power was sufficient to have twisted the drive shaft to failure as the tail rotor was abruptly stopped from rotating upon hitting the ground (see Photographs 6a and 6b).

Photograph 6a
Broken End of Tail Rotor Drive Shaft

Photograph 6b
The Other Broken End of Tail Rotor Drive Shaft

2.1.5 Tail Rotor Control System

Post-accident examination of the tail rotor control system revealed that the yaw pedals, the associated linkages and the rotor hub of the system were functional.

2.1.6 Contact with Foreign Objects

It was believed that whilst the helicopter was in the hover, had the rotating tail rotor struck or been deformed by any foreign object such as a plastic bag, some marks would have been left on the surface of the tail rotor and unusual noise and vibration would have been generated and noticed by the occupants. A laboratory examination of the broken tail rotor system did not reveal any foreign object damage and there was no trace of plastic bags on the remaining rotor blade. Furthermore, none of the occupants reported noticing any unusual noise or significant vibration from the moment of lift-off until the impact. It could therefore be concluded that the tail rotor had not come into physical contact with any foreign object in flight.

2.1.7 Hydraulic Pump, Right Magneto, Governor Controller and Governor Motor

The hydraulic pump, the right magneto, the governor controller and the governor motor were subjected to detailed examination by the aircraft manufacturer under the supervision of NTSB. The examination results indicated that these components functioned properly.

2.1.8 Surface Wind Conditions and Topographic Effects at Pak A

2.1.8.1 As mentioned in Paragraph 1.7.1.3, the HKO submitted that winds at Pak A were likely to be affected by its local topography and could be somewhat different from its surrounding area, especially under light to moderate wind conditions. As shown in Map 1 and Photograph 7, the accident site was situated along the coast of Pak A with hills to the east and the west, and a narrow valley running to the north towards the High Island Reservoir. With the prevailing southwesterly wind conditions of 5 to 10 knots from the sea as reported by the pilot, it was likely that the accident site could be subjected to 'valley effect', such that pilots would usually expect an increase in the strength of the surface winds as the winds were funneled towards the narrow valley.

Map 1 Geographical Location of Pak A

Photograph 7 Topography at Pak A

2.1.8.2 In the pilot's assessment (see Paragraph 1.7.4), he stated that the wind was coming from between 220° and 240° at 5 to 10 knots earlier of the day. He further stated that he initiated a slow 180° spot turn to the right, manoeuvring the helicopter to a southerly direction into wind. It was therefore evident that the helicopter had lifted off in a tailwind condition.

2.1.8.3 As regards the wind strength, the pilot stated that the wind was 5 to 10 knots in the morning. According to the reports from HKO (see Paragraph 1.7.1.3), the wind over Hong Kong had in general picked up speed in the afternoon. Combining this change with the influence of 'valley effect', a wind stronger than that anticipated by the pilot might have prevailed over Pak A at the time of the accident flight. However, in the absence of a real-time measurement of on-scene wind data, the exact surface wind conditions over Pak A at the time of the accident could not be accurately determined.

2.1.9 Aerodynamic Effects on Tail Rotor

The following is a discussion of the basic helicopter aerodynamic principles (see Paragraphs 2.1.9.1 – 2.1.9.4) and a detailed analysis of the aerodynamic effects (see Paragraphs 2.1.9.5 – 2.1.9.13) on the tail rotor of the accident flight from the initial tailwind hover to the loss of directional control of the helicopter in the yawing plane based on the following findings:[Note 2]

(a) the description of the flight by the pilot and left rear seat passenger;

(b) the wind, according to the pilot's assessment, was from a southwesterly direction;

Note 2: The diagrams within this analysis are for illustration purpose and may be out of scale. For simplicity and clarity, some of the forces acting on the aerofoil of a rotor disc are omitted in all the diagrams and the forces shown do not act from the centre of pressure.

(c) the strength of the wind, according to the information from HKO, was at 5 to 10 knots near Pak A at 0620 hrs (1420 hrs);

(d) the tail rotor drive shaft and the tail rotor were fully functional before the impact;

(e) the effectiveness of the tail rotor had not been affected by any foreign object; and

(f) the engine was providing sufficient power to the main rotor for the hover.

2.1.9.1 Helicopter Stability when Hovering Tailwind

2.1.9.1.1 As the helicopter was hovering tailwind, the wind would become turbulent after the airflow was affected by the tail rotor and the helicopter fuselage before meeting the main rotor disc. As a result, it would be more difficult to control the helicopter as compared with hovering into wind.

2.1.9.1.2 Furthermore, the helicopter by design resembles a weathervane and is subjected to weathercock effect which attempts to weathervane the nose of the helicopter into the relative wind. Once the helicopter starts to turn into the wind from the tailwind position, the rate of turn will accelerate accordingly.

2.1.9.2 Anti-Torque Effect and Tail Rotor Thrust

Figure 1 is an illustration of the Anti-Torque Effect of the helicopter in the hover. With the main rotor blades rotating anti-clockwise, the helicopter would have a tendency to turn clockwise. This phenomenon is known as the Anti-Torque Effect, which can be seen as Force Z1 and Z2 (of equal magnitude) acting on the fuselage and forcing the helicopter to yaw to the right. To prevent the helicopter from yawing to the right, the tail rotor of the helicopter would produce a Tail Rotor Thrust (i.e. Force X1 and X2) to counter the effect of Z1 and Z2.

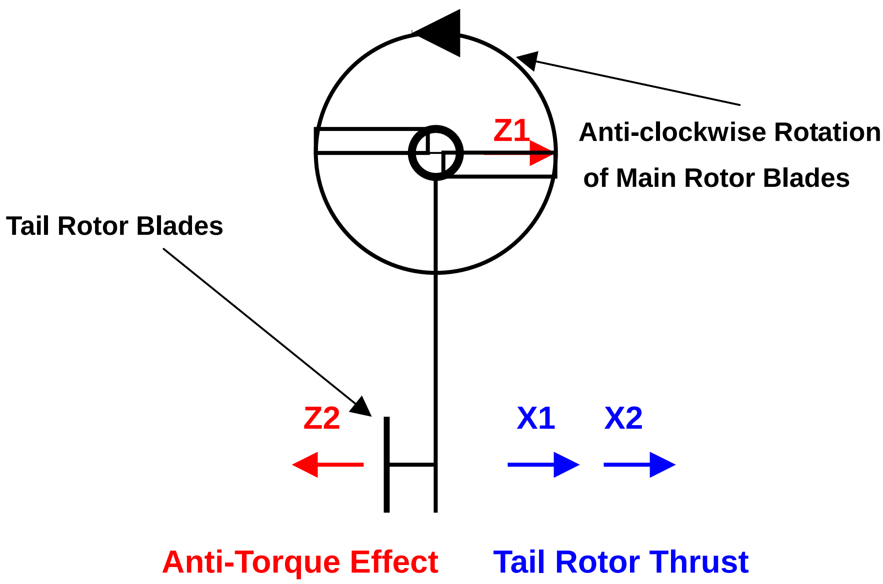


Figure 1 Anti-Torque Effect and Tail Rotor Thrust

2.1.9.3 Induced Flow and Rate of Turn Flow

2.1.9.3.1 Induced Flow

As a result of the Tail Rotor Thrust, an Induced Flow of air mass in the opposite direction would be produced as shown in Figure 2.

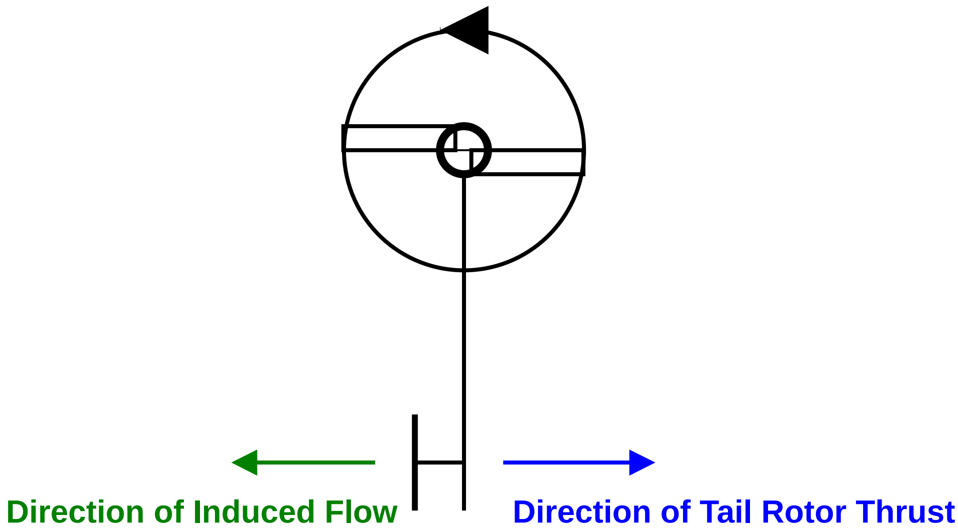


Figure 2 Induced Flow and Tail Rotor Thrust

2.1.9.3.2 Rate of Turn Flow

As the helicopter turns right in the yawing plane, an air flow acting on the tail rotor blade in the opposite direction of the Induced Flow as shown in Figure 3 will be produced. This air flow is referred to as the Rate of Turn Flow in the following analysis. The magnitude of the Rate of Turn Flow will vary with the rate of turn of the helicopter.

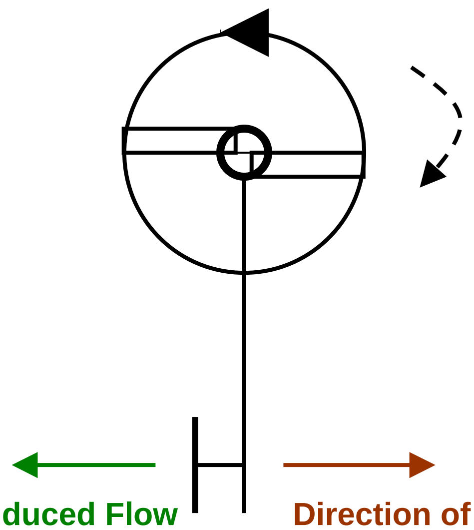


Figure 3 Induced Flow and Rate of Turn Flow during the Yaw Turn

2.1.9.4 Induced Flow and Tail Rotor Thrust

The Induced Flow (IF) had a major effect on the aerodynamics of a helicopter. The Relative Air Flow (RAF) is the resultant of the Induced Flow, Rate of Turn Flow and Rotational Air Flow along the Plane of Rotation (POR) of the rotor blades. In the following analysis, the Net Induced Flow will be resulted when the Induced Flow is greater than Rate of Turn Flow. An increase of the Net Induced Flow would result in a decrease in the Angle of Attack α (i.e. the angle between the RAF and the chord of the rotor blades), which would in turn result in a decrease in the Lift. Consequently, the Tail Rotor Thrust would be reduced as shown in Figure 4.

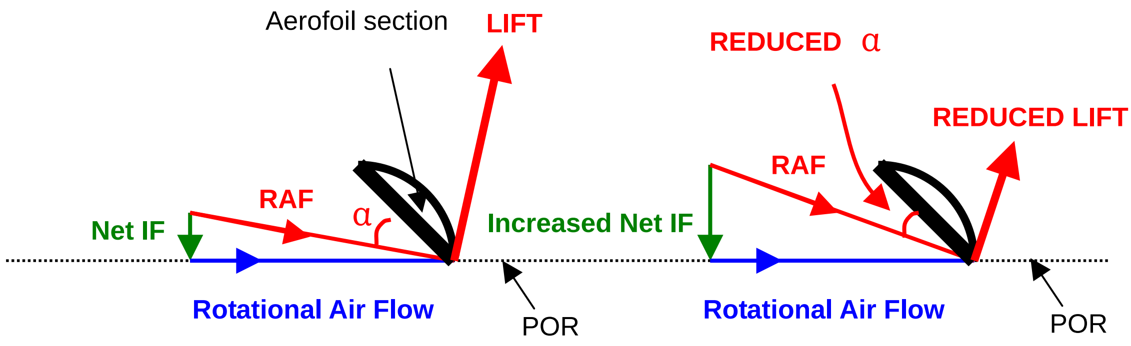


Figure 4 Aerodynamic Relationship between Induced Flow and Lift

2.1.9.5 Analysis of the Accident Flight – From Lifting-off to a Hover

2.1.9.5.1 With a high all up weight of approximately 2,200 lb (see Paragraph 1.6.3) and in a tailwind condition, the tail rotor of the helicopter had to produce more Tail Rotor Thrust. This would require a high Pitch Angle β (i.e. the angle between the tail rotor blades and the POR) of the tail rotor blades, resulting in a high Angle of Attack α, as shown in Figure 5.

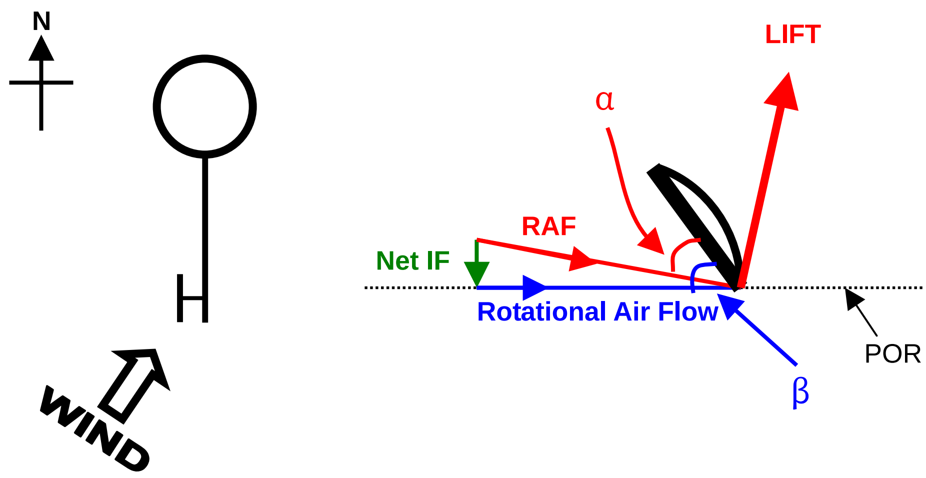


Figure 5 Hovering Tailwind with a High All Up Weight

2.1.9.5.2 As discussed in Paragraph 2.1.8, it was possible that the wind velocity at the time of the accident was greater than the wind reported in the surrounding area by the HKO due to 'valley effect' as the winds were funneled towards the narrow valley. As the helicopter lifted off tailwind with a crosswind component from the left, it would be subjected to a weathercock effect trying to turn the helicopter to the left in the yawing plane as described in Paragraph 2.1.9.1.2. In order to maintain the directional control to achieve a steady hover, it was believed that the pilot must have applied some right yaw pedal to counter the weathercock effect.

2.1.9.6 Initiation of the 180° Turn to the Right

2.1.9.6.1 Having established into a tailwind hover with a component of wind from the left, the pilot initiated a slow 180° spot turn to the right, as stated in his statement: *"… I then came up to a five-foot steady hover facing north. I did the hover checks including the RPM. I initiated a slow 180° spot turn to the right. …"*. To do this, he would have to further apply additional right yaw pedal, which would result in a reduction of the Pitch Angle and the Angle of Attack in the tail rotor. As the helicopter started to turn to the right, the relative wind gradually changed to a direct tailwind position as shown in Figure 6. At this time, the weathercock effect trying to turn the helicopter to the left in the yawing plane would disappear. Under the circumstances, the pilot would need to apply some left yaw pedal to compensate the right yaw pedal originally applied as discussed in Paragraph 2.1.9.5.2, in order to control the rate of turn of the helicopter.

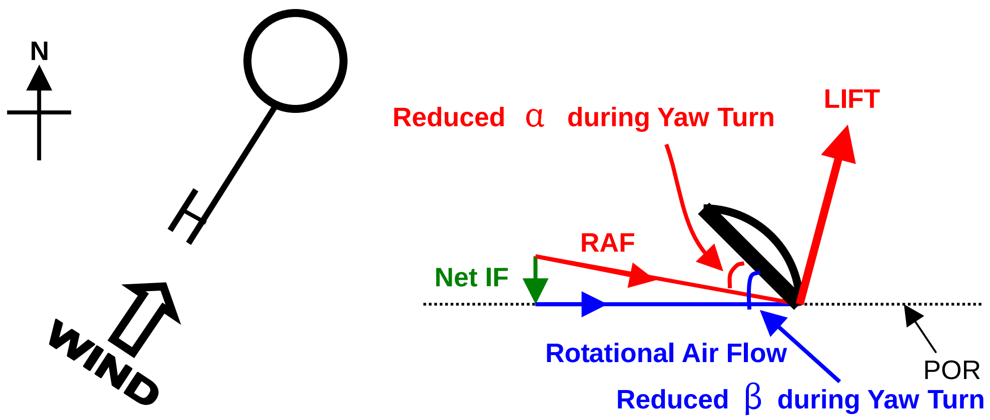


Figure 6 Application of Right Yaw Pedal to Turn Right

2.1.9.6.2 As the helicopter continued to turn right, the relative wind would now change from a tailwind position to a crosswind position with a crosswind component acting on the tail rotor from the right. This crosswind component would act in the same direction of the Induced Flow, thus increasing the magnitude of the Induced Flow. This would result in a further decrease of the Angle of Attack, and thus the Tail Rotor Thrust.

2.1.9.7 Loss of Tail Rotor Effectiveness

With the decrease in Tail Rotor Thrust, the rate of yaw to the right would increase even without any application of right yaw pedal. At the same time, the helicopter would be affected by the weathercock effect as mentioned in Paragraph 2.1.9.1.2, resulting in further acceleration in the rate of turn. The combined effect of the additional Induced Flow and weathercock effect would be at its maximum when the wind was from the 3 o'clock position as shown in Figure 7. The rate of turn of the helicopter would then continue to increase until the helicopter turned into wind. This phenomenon of the uncommanded increase and accelerating rate of turn is commonly known as Loss of Tail Rotor Effectiveness (LTE).[Note 3] Had the limitation of the maximum rate of turn of the helicopter been available to the pilot in the R44 POH, the pilot would have been better alerted to the development of LTE and possibly the subsequent Loss of Tail Rotor Thrust (LTT) arising from an uncommanded, rapid and accelerating rate of turn.

Note 3: CAD issued a letter in January 2004 to the HKAC and the other helicopter operators in Hong Kong to promulgate a Flight Operations Department Communication 1/2004 produced by the United Kingdom Civil Aviation Authority (UKCAA) on the subject of 'Loss of Tail Rotor Effectiveness' (see Appendix E).

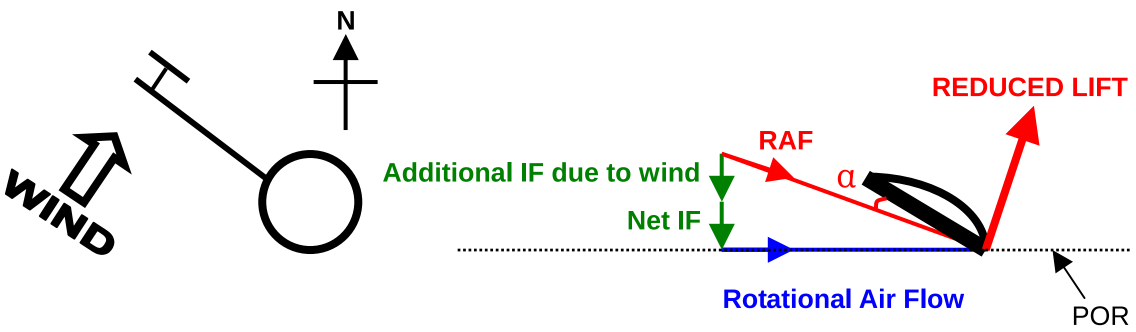


Figure 7 Wind from 3 o'clock Position

2.1.9.8 Action Required under LTE

As soon as the helicopter entered into the initial state of LTE, it would be important for the pilot to arrest the increasing rate of turn by the timely application of left yaw pedal. As mentioned in Paragraph 2.1.9.1, hovering tailwind would make it more difficult to control the helicopter and involve a relatively higher level of pilot workload. While the pilot intended to make a slow spot turn as mentioned in Paragraph 2.1.9.6, the left rear seat passenger noted a rapidly increasing rate of turn as described in the following recollection: "*… It was an abrupt spot turn to the right. It started quickly and kept accelerating. …*". There was no evidence to indicate that the pilot had taken effective action to control the unanticipated increasing rate of turn during the initial 180° spot turn.

2.1.9.9 Helicopter Turning into the Wind

2.1.9.9.1 Whilst the helicopter was in a turn, the tail rotor would be subjected to vortex ring effect due to the meeting of the Induced Flow and the Rate of Turn Flow causing vortices to form on the periphery of the tail rotor disc, spreading inboard as a result of the increasing Rate of Turn Flow. The vortices would disturb the air flow around the tail rotor, leading to the loss of Tail Rotor Thrust. Furthermore, as the helicopter was turning into the wind, the tail rotor would also be affected by the vortices created by the main rotor downwash. This would result in the further loss of Tail Rotor Thrust available to the tail rotor, aggravating the uncontrolled yaw turn situation and further accelerating the turn.

2.1.9.9.2 As the helicopter continued to yaw to the right, the wind direction relative to the helicopter changed from 3 o'clock position to 12 o'clock position. The additional Induced Flow due to wind would decrease to zero when the helicopter was into wind. In the meantime, the increasing rate of turn generated a progressively stronger Rate of Turn Flow. Consequently, the Rate of Turn Flow might be larger than the Induced Flow so that there would be a Net Rate of Turn Flow acting on the other side of the POR as shown in Figure 8. As shown in the same figure, the RAF might then act on the other side of the POR. As a result, the Angle of Attack α would significantly increase, approaching the Critical Angle of Attack (Stalling Angle of Attack).

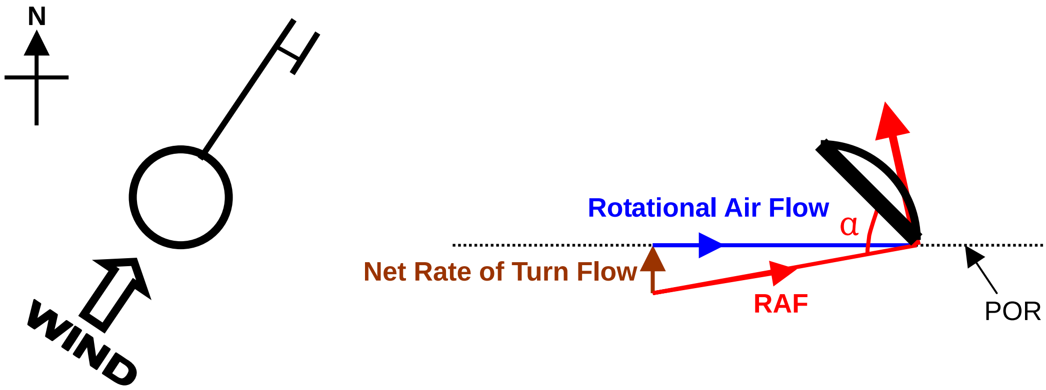


Figure 8 Helicopter Facing the Wind

2.1.9.10 Tail Rotor Stall

The pilot stated in his statement that when the helicopter was into wind, he applied left yaw pedal to stop the turn: "… *I applied left pedal, intending to stabilize the helicopter in a hover facing south before transitioning forward. However, the helicopter seemed not to respond to my pedal input. The helicopter did not stop turning on a southerly heading. The rate of turn was building up, getting faster and faster*. …". It was believed that the pilot under the circumstances had applied a substantial amount of left yaw pedal in an attempt to arrest the high rate of turn. This explained the finding that the left yaw pedal was found in the full forward position in the post-accident examination. This application of the left yaw pedal at this stage however could have inadvertently caused the Angle of Attack α to exceed the Critical Angle of Attack as shown in Figure 9. As a result, the tail rotor entered into a state of incipient stall, and had eventually stalled, resulting in a LTT situation.

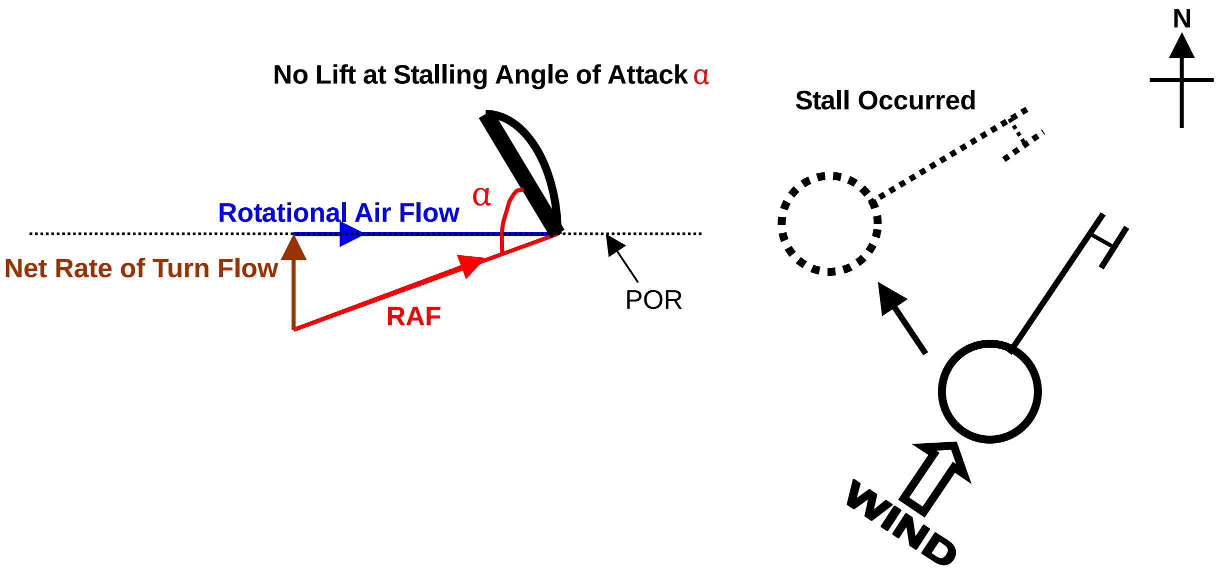


Figure 9 Tail Rotor Stall

2.1.9.11 Procedures for Loss of Tail Rotor Thrust

It was highly likely that at this time, the pilot devoted full attention to regain directional control of the helicopter, became disoriented in the uncontrolled right turns and did not realize that the helicopter might have experienced a LTT. As a result, he did not carry out the procedures as specified in the section 'LOSS OF TAIL ROTOR THRUST DURING HOVER' in the R44 POH

Page 3-5 (see Appendix F). Had the pilot realized that the helicopter had experienced LTT and followed the procedures in accordance with the R44 POH, the effect of the rapid rate of turn might not have been exacerbated once the anti-torque effect was eliminated and the pilot could have been able to cushion the forced landing by raising the collective.

2.1.9.12 Left Drift of the Helicopter due to Loss of Tail Rotor Thrust

Judging from the toppling of the helicopter wreckage on its left side and the damage to the left skid, it was believed that whilst the helicopter was yawing to the right, it had also been drifting to the left at the impact. Aerodynamically, the horizontal component of the main rotor thrust would compensate the horizontal component of tail rotor thrust to prevent the helicopter from drifting as shown in Figure 10a. The helicopter would therefore hover with left skid low. However, if there was a loss of tail rotor thrust, the helicopter would drift to the left after it had executed the first 180° turn to the right in the yawing plane, due to the horizontal component of the main rotor thrust as shown in Figure 10b. From the left drifting of the helicopter, it could be substantiated that the helicopter had experienced a loss of tail rotor thrust during the accident.

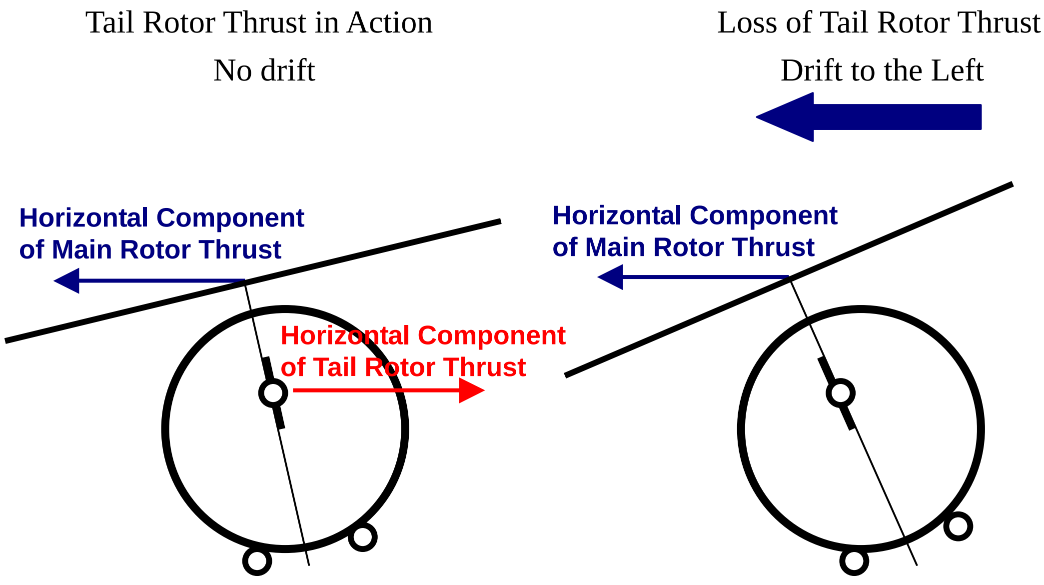


Figure 10a Figure 10b

Figure 10 Left Drift of the Helicopter due to Loss of Tail Rotor Thrust
(Viewed from the rear of the helicopter)

2.1.9.13 Although the pilot could not recall the exact number of rounds the helicopter had turned, he stated in his statement that he had "faced the sea for the second time" during the process. Based on this pilot's account of the accident, it could be deduced that the helicopter had completed at least two and a half revolutions before the eventual impact.

2.2 Meteorology

2.2.1 The pilot mentioned in his statement that he had carried out a self-briefing in the morning prior to the series of flights by checking the HKO website for weather information that consisted of the actual and forecast weather for aviators. Due to the fact that Local Aviation Forecasts are issued by the HKO once every six hours, and judging from the time of the pre-flight weather self-briefing conducted, it was highly probable that the pilot would have referred to the Local Aviation Forecast issued at 2230 hrs (0630 hrs) that covered the period from 0000 hrs (0800 hrs) to 1000 hrs (1800 hrs), within which the planned flights would take place. The next Local Aviation Forecast was issued at 0430 hrs (1230 hrs). Both the Local Aviation Forecasts issued at 2230 hrs (0630 hrs) and 0430 hrs (1230 hrs) indicated consistent surface wind condition of 220° at 10 knots varying at 25 knots, gusts 35 knots in thunderstorm. However, it should be noted that the coverage of these Local Aviation Forecasts was for 100 nautical miles radius around Hong Kong. Furthermore, it was confirmed that there was no report of thunderstorm for the period in the vicinity of Pak A.

2.2.2 At the time of the accident, the weather at or in the vicinity of Pak A where the accident occurred was generally fine with good visibility. According to the pilot’s statement, the wind in the morning was coming between 220° and 240° at 5 to 10 knots. The left rear seat passenger described that the helicopter came to a five-foot hover with a light tailwind. From the information provided by two pilots engaged in the subsequent rescue operation, and the rescue personnel on scene, as well as post-accident meteorological review made by the HKO, it could be established that the general surface wind direction in Pak A area were consistent with the forecasts at 2230 hrs (0630 hrs) and 0430 hrs (1230 hrs) and the pilot’s assessment in Paragraph 1.7.4.

2.2.3 The surface winds over Pak A were likely to be affected by the local topography according to the HKO. As analyzed in Paragraph 2.1.8, the prevailing winds at the time of the accident might have been stronger than the 5 to 10 knots as experienced by the pilot in the morning and anticipated for the flight in the afternoon.

2.3 Communications and Navigation Aids

The flight took place at Pak A within UCARA Port Shelter with satisfactory two-way radio communication with ATS units. The helicopter was appropriately equipped with navigation aids for VFR flights. Therefore, radio communications and navigation aids did not contribute to this accident.

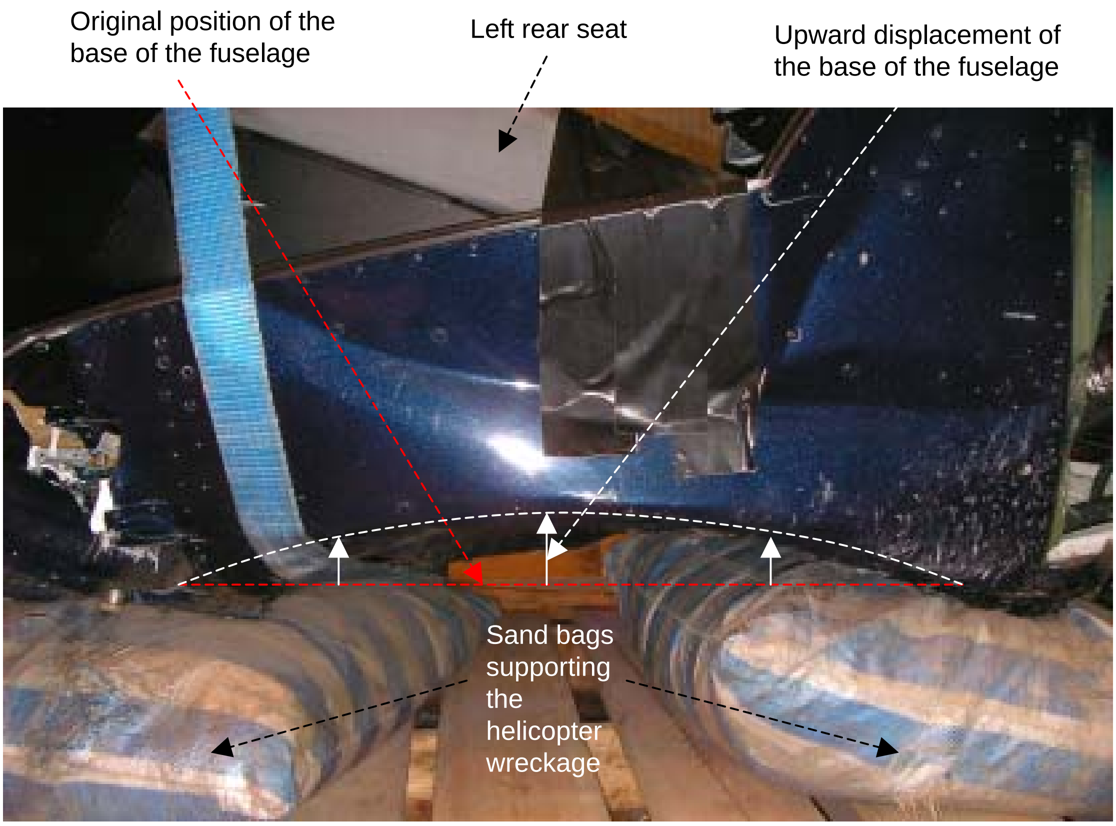
2.4 Aircraft Survivability

2.4.1 Crashworthiness survivability analyses were conducted which included the following aspects:

(a) Container – structural airframe crash resistance, cockpit and cabin space integrity, resistance to incursion by external objects
(b) Restraints – occupant harnesses
(c) Environment – whole body deceleration, limb protection, impact with cockpit structures
(d) Energy Absorption Features – design of seats and aircraft structure
(e) Post-Crash Factors – exits, entrapment, escape, fire and smoke, search and rescue organization.

2.4.2 Container

Although the general shape and dimensions of the cockpit and occupant space were preserved, the perspex canopy was extensively damaged following the impact. Impact damage to the left underside of the fuselage (see Photograph 8) resulted in approximately 1 cm upward displacement of the left rear seat. This damage reflects the significant vertical deceleration forces applied to the occupants, and which caused the spine injuries. There was no evidence of any other significant injury to the pilot or passengers attributable to the structural damage or to intruding external objects.



Photograph 8 Deformation of the Left Underside of the Fuselage due to the Accident (Left Side View)

2.4.3 Restraints

The three-point inertia-reel harnesses restrained the pilot and passengers. These harnesses were attached wholly to the helicopter cockpit frame structure and were fastened by standard flap release buckles mounted on short straps attached to the frame. According to the pilot's statement, he had checked that the passengers were all secured in their seat belts before the take-off of the accident flight. Statements of the passengers confirmed that their harnesses were fastened at the time of the impact. The pilot and passenger seats were constructed integrally with the floor and comprised a pressed-sheet aluminium frame and seat cushion backed by aluminium plate. It was concluded that the three-point harnesses functioned normally and did not contribute to any injury or entrapment of the occupants.

2.4.4 Environment

There was no evidence of any injury caused by protruding objects within the cabin, nor of any malfunction causing injury. There was no post-crash fire or smoke, nor any clear evidence of fuel, lubricant or hydraulic fluid leakage that might have presented a toxic or physical hazard within the cabin.

2.4.5 Energy Absorption Features

Standards pertaining to this helicopter are based on the United States' Federal Aviation Regulations (FAR) – FAR 27.561 effective 01/02/1965 which requires that occupants have a reasonable chance of escaping when impact forces applied to them do not exceed those in the following table:

Load Directions \ Requirements	FAR 27.561 effective 01/02/1965
Upward	1.5 g
Forward	4 g
Sideward	2 g
Downward	4 g

It was not possible to accurately determine the actual crash forces in this accident from the available evidence.

2.4.6 Post-Crash Factors

2.4.6.1 Escape/Exits

The accident occurred at 0612 hrs (1412 hrs). The pilot and two passengers escaped from the helicopter, two of them through the broken canopy and the other through the right side cockpit door. Escape via the left side door was impossible, as the helicopter was lying on its left and this door was obstructed by contact with the ground.

2.4.6.2 Entrapment

There was no evidence of physical entrapment of the pilot or the passengers, but the left rear seat passenger decided to remain in the cabin. After the roof of the helicopter was cut away by the emergency service personnel, she was released from the wreckage at approximately 0730 hrs (1530 hrs), i.e. 1 hour 18 minutes after the accident.

2.4.6.3 Fire and Smoke

There was no post-crash fire.

2.4.6.4 Search and Rescue

At 0617 hrs (1417 hrs), a ‘999’ caller alerted the emergency services to the location of the accident. The first resource to arrive on-scene was a GFS AS332 L2 helicopter at approximately 0632 hrs (1432 hrs). The injured pilot and the injured left front seat passenger were airlifted by GFS helicopter at 0649 hrs (1449 hrs) and 0659 hrs (1459 hrs) respectively. The last injured person (i.e. the left rear seat passenger who remained in the cabin) was attended to by a doctor of the GFS and airlifted from the scene at 0741 hrs (1541 hrs).

2.4.7 Based on the above analysis, it was concluded that the accident was fully survivable.

2.5 Air Traffic Service

2.5.1 The helicopter received FIS from ‘Hong Kong Information’ and the provision of such service was appropriate.

2.5.2 On receipt of a ‘999’ call, FSCC alerted the duty Aerodrome Supervisor of the accident who then initiated subsequent alerting actions in accordance with CAD Air Traffic Management Division Emergency Procedures Manual. The provision of alerting service by ATS units was in order.

2.6 Emergency and Rescue Services

2.6.1 The accident site was remote and not easy to access by road. Rescue personnel attended to and arrived at the site by air, sea and land as detailed in Appendix D. The injured persons were then evacuated from the helicopter, attended to by the medical personnel on-scene and subsequently airlifted to the hospital in a prompt manner.

2.6.2 The alerting action, emergency response and level of attendance of the emergency service personnel were efficient and effective.

3. CONCLUSIONS

3.1 Findings

3.1.1 The pilot held a valid Private Pilot's Licence (Helicopters) on type with a valid Class 2 Medical Certificate. (Paragraph 1.5)

3.1.2 There was no evidence to suggest that the performance of the pilot had been affected by tiredness, alcohol, drugs, physiological factors or incapacitation. (Paragraph 1.13.1.4)

3.1.3 The pilot conducted a self-briefing on the weather conditions of the Hong Kong area prior to the series of flights and was aware of tailwind on approach to landing. (Paragraphs 1.7.3.1 and 1.7.4)

3.1.4 The pilot checked that the passengers were all secured in their seat belts before the take-off of the accident flight. (Paragraph 2.4.3)

3.1.5 The pilot had operated into and out of Pak A before the accident on the same day. The accident occurred in the afternoon during departure on the second run from Pak A with three passengers on board. (Paragraphs 1.1.1 and 1.1.2)

3.1.6 On departure of the accident flight, the pilot brought the helicopter to a tailwind hover and then made a right yaw turn with the intention of turning the helicopter 180° into wind for the take-off. However, the pilot was not able to arrest the accelerating rapid rate of turn. (Paragraphs 2.1.8, 2.1.9.6 and 2.1.9.7)

3.1.7 The tail rotor stalled after the helicopter had first turned through the southwesterly wind and the helicopter subsequently entered into uncontrolled right turns. (Paragraphs 2.1.9.10 and 2.1.9.11)

3.1.8 The helicopter made at least two and a half revolutions before it impacted on the ground. (Paragraph 2.1.9.13)

3.1.9 Three persons (i.e. the pilot, left front seat passenger and left rear seat passenger) sustained lumbar spine injuries. The right rear seat passenger was uninjured. (Paragraphs 1.2 and 1.13)

3.1.10 No occupants were entrapped in the accident. The injured left rear seat passenger decided to remain inside the helicopter until she was subsequently evacuated from the helicopter by the emergency service personnel. (Paragraphs 1.13.3.2 and 2.4.6.2)

3.1.11 The accident was survivable. (Paragraph 2.4.7)

3.1.12 All injured persons were airlifted to hospital by rescue helicopters without undue delay. (Paragraph 2.6.1)

3.1.13 The surface wind direction at Pak A area was southwesterly and its strength was assessed and anticipated by the pilot as 5 to 10 knots. However, the prevailing wind strength at the time of accident might have been in excess of 5 to 10 knots due to the 'valley effect'. (Paragraphs 1.7.4, 2.1.8 and 2.2.3)

3.1.14 The flight was conducted in day time under VFR and the helicopter was appropriately equipped with navigation aids for such a flight. (Paragraph 1.8)

3.1.15 Communications between the pilot and the ATS units were satisfactory. (Paragraph 2.3)

3.1.16 The alerting actions, response and attendance by the ATS units and emergency service personnel were efficient and effective. (Paragraphs 2.5, 2.6 and Appendix D)

3.1.17 The helicopter had a valid Certificate of Airworthiness and was maintained in accordance with the approved maintenance schedule. (Paragraph 1.6.1)

3.1.18 The main rotor blades remained attached to the helicopter but were significantly bent and twisted as a result of impact with the ground. (Paragraph 1.1.3)

3.1.19 The fuel tanks of the helicopter were intact in the accident and there was no leakage of fuel. (Paragraph 1.12.2)

3.1.20 Both tail rotor blades of the helicopter were severed on impact with the ground, and one piece of the severed blades could not be found. (Paragraphs 1.12.3 and 2.1.3)

3.1.21 The tail rotor had not come into physical contact with any foreign object in flight and it did not suffer from any damage until it hit the ground. (Paragraphs 2.1.3.3 and 2.1.6)

3.1.22 The tail boom of the helicopter was severely fractured, locally twisted and bent to the starboard near the tail rotor drive shaft damper bearing. (Paragraph 1.1.3)

3.1.23 The helicopter had no outstanding defects prior to the accident flight and was fully serviceable in all respects. (Paragraph 1.6.1.2)

3.1.24 The POH did not specify the maximum rate of turn limitation of the helicopter. (Paragraph 2.1.9.7)

3.2 Cause

3.2.1 The helicopter experienced, during a yaw turn to the right after lift-off, a loss of tail rotor effectiveness that led to the stalling of the tail rotor. (Paragraph 2.1.9)

3.3 Contributing Factors

3.3.1 The pilot lifted off in tailwind, followed by a right turn in the yawing plane. (Paragraph 2.1.9.6)

3.3.2 The effect of the wind on the tail rotor compounded by the weathercock effect contributed to the acceleration of the rate of turn to the right in the yawing plane in the initial 180° of the right turn. (Paragraphs 2.1.9.1, 2.1.9.7, 2.1.9.8 and 2.1.9.9)

3.3.3 The pilot did not adequately appreciate the wind effect associated with the tailwind hover, and the additional weathercock effect in the subsequent right yaw turn. (Paragraphs 2.1.9.1, 2.1.9.7, 2.1.9.8 and 2.2.3)

3.3.4 The timing and the magnitude of left yaw pedal input applied by the pilot, when the helicopter was into wind, to arrest the rapid and increasing rate of turn inadvertently caused the tail rotor to stall, resulting in LTT. (Paragraphs 2.1.9.7, 2.1.9.8, 2.1.9.9 and 2.1.9.10)

3.3.5 During the increasing rate of turn to the right, the pilot became disoriented in the uncontrolled right turns and did not realize that the helicopter might have experienced a LTT. (Paragraph 2.1.9.11)

4. SAFETY RECOMMENDATIONS

4.1 Recommendation 2007-1

It is recommended that the personnel providing helicopter ground school training should strengthen pilots' awareness of LTE phenomenon, in particular the risk associated with a fast uncontrolled spot turn in a LTE situation, and the possibility of LTE developing into LTT due to the stalling of the tail rotor. (Paragraphs 3.3.1, 3.3.2, 3.3.3, 3.3.4 and 3.3.5)

4.2 Recommendation 2007-2

It is recommended that the aircraft manufacturer specifies in the R44 POH the maximum rate of turn permitted for the helicopter in the yawing plane. (Paragraphs 3.1.24 and 3.3.4)

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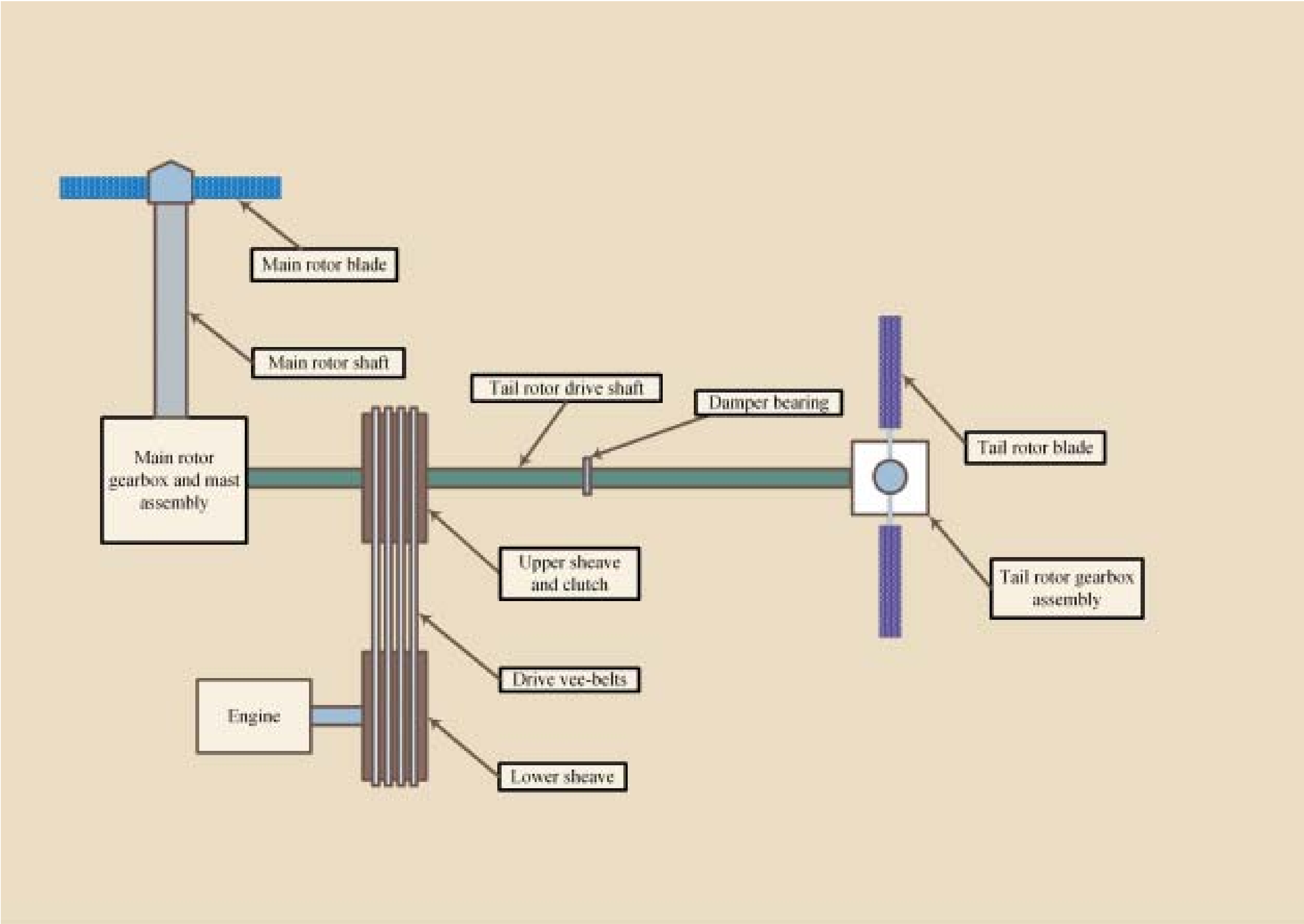
Appendix A
Simplified Schematic Diagram of the Powerplant and Transmission System of R44 Helicopter



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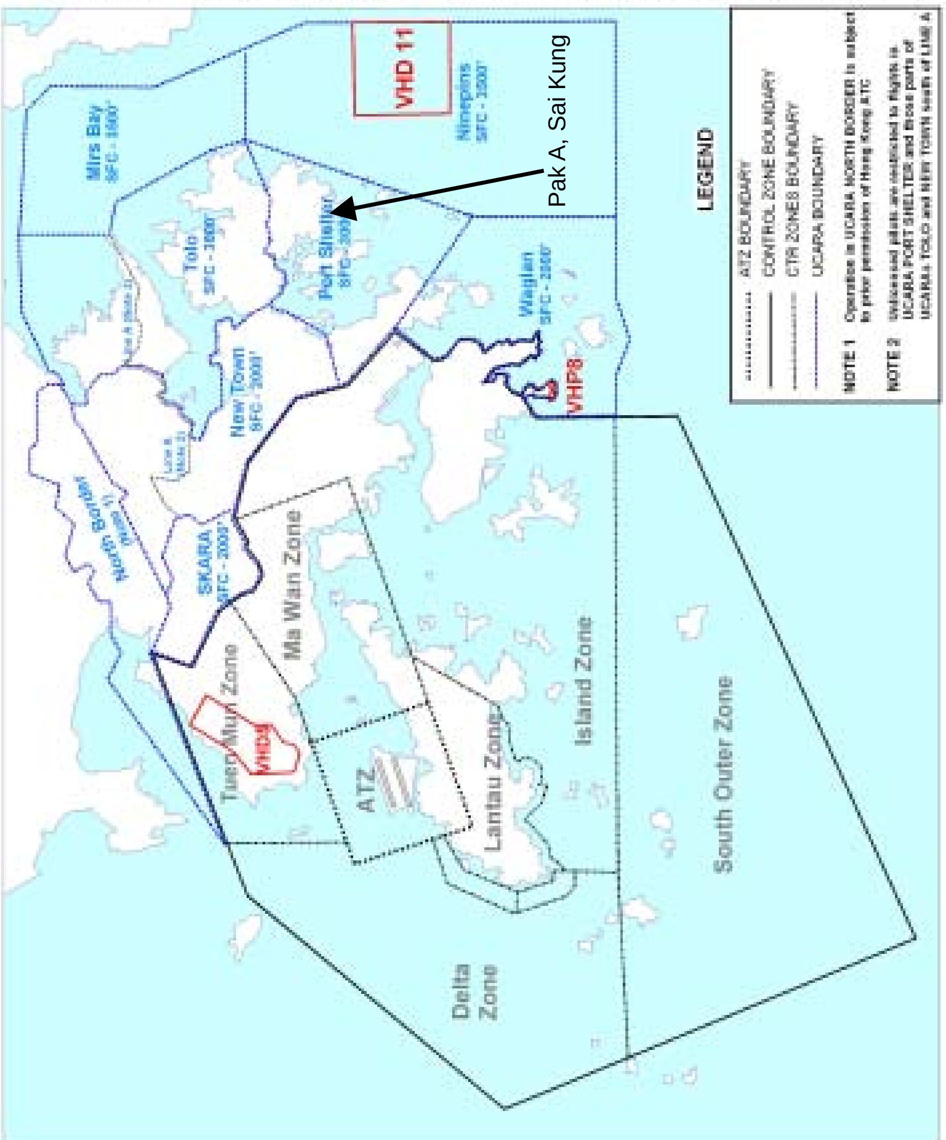
Appendix B
Location of Pak A, Sai Kung in UCARA

AIP HONG KONG

AD2 - VHHH - 102
(1 November 2001)

Subdivisions of the Control Zone (CTR Zones) and Uncontrolled Airspace Reporting Areas (UCARAs)



Civil Aviation Department
Hong Kong

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Appendix C
Damage to the Helicopter

Helicopter Wreckage (viewed from the rear of the helicopter)

Helicopter Wreckage (viewed from the right rear of the helicopter)

Helicopter Wreckage (viewed from the right front of the helicopter)

Helicopter Cabin
(perspex canopy removed by emergency service personnel during rescue operation)

Appendix D

Summary of Emergency Handling of the Helicopter Accident on 11 June 2005

(All times in Hong Kong Local Time)

Responses / Organizations/Units	Number of Personnel Attending the Accident Site	Time Alerted	Alerted by	Time of Arrival at the Accident Site	Time Taken to Arrive at the Accident Site	Task(s) Involved	Stand Down Time	Remarks
Kowloon Regional Command & Control Centre (RCCC/K) of Hong Kong Police (HKP)	-	1417 hrs	A member of the public	-	-	Alerting, Command and Coordination	1648 hrs	The first unit alerted of the accident.
Marine Regional Command & Control Centre (RCCC/M) of HKP	-	1418 hrs	-	-	-	Alerting, Command and Coordination	1648 hrs	-
Police officers of Emergency Unit, Kowloon East, HKP (Police Vehicle EU51)	9	1418 hrs	-	1445 hrs	27 minutes	Accident Site Cordoning and Search	1523 hrs	Part of the access to the accident site was via footpath.
Marine Police (MarPol) officers of Police Launch (PL) PL62, HKP	3	1419 hrs	-	1434 hrs	15 minutes	Accident Site Cordoning and Rescue	1525 hrs	PL62 was on duty patrol close to the accident site at the time of the accident and it arrived off the coast near Pak A at around 1429 hrs from which Police Vessel (PV12) was launched to take three police officers onshore to access the accident site.

Organizations/Units \ Responses	Number of Personnel Attending the Accident Site	Time Alerted	Alerted by	Time of Arrival at the Accident Site	Time Taken to Arrive at the Accident Site	Task(s) Involved	Stand Down Time	Remarks
MarPol officers of Police Launch PL55, HKP	4	1419 hrs	-	1445 hrs	26 minutes	On-scene Command and Coordination	1650 hrs	PL55 was the MarPol on-scene command unit from which PV65 was launched to take four police officers onshore to access the accident site.
MarPol officers of Police Launch PL30, HKP	2	1419 hrs	-	1447 hrs	28 minutes	Accident Site Cordoning and Rescue	1520 hrs	PL30 was tasked at 1436 hrs and it arrived off Pak A around 1440 hrs. Two police officers were dispatched from the launch at 1442 hrs to access the accident site.
Fire Services Communication Centre (FSCC) of Fire Services Department (FSD)	-	1419 hrs	RCCC/K	-	-	Alerting, Command and Coordination	1648 hrs	-
Duty Aerodrome Supervisor, Air Traffic Control Tower, Civil Aviation Department (CAD)	-	1420 hrs	FSCC & RCCC/M	-	-	Alerting and Coordination	1648 hrs	Once alerted by FSCC, the Duty Aerodrome Supervisor tasked a GFS helicopter (Helicopter 86) that was operating near Pak A to proceed to scene to verify the accident.

Responses / Organizations/Units	Number of Personnel Attending the Accident Site	Time Alerted	Alerted by	Time of Arrival at the Accident Site	Time Taken to Arrive at the Accident Site	Task(s) Involved	Stand Down Time	Remarks
Air Command Control Centre (ACCC) of Government Flying Service (GFS)	-	1421 hrs	RCCC/M	-	-	Command and Coordination	1648 hrs	-
Fire services & ambulance officers of FSD (other than Sai Kung Station)	20 (including 3 ambulance units)	1422 hrs	-	*1520 hrs (*arrival of the first batch)	*58 minutes	Rescue and Casualty Evacuation	1608 hrs	Some of the personnel accessed the accident site via footpath while others were transported to the scene by Police launch or GFS helicopter.
Police officers of Sai Kung Division, HKP	11	1424 hrs	-	1448 hrs	24 minutes	Accident Site Cordoning and Rescue	Afternoon on 12 June 2005	Part of the access to the accident site was via footpath. (Note: The wreckage was guarded until its removal in the afternoon on 12 June 2005)
Commanding officers of Sai Kung Division, HKP	3	1424 hrs	-	1501 hrs	37 minutes	On-Scene Command	1645 hrs	Part of the access to the accident site was via footpath.
Fire services officers of Sai Kung Station, FSD	15	1426 hrs	-	1501 hrs	35 minutes	Rescue	1608 hrs	Part of the access to the accident site was via footpath.

Organizations/Units \ Responses	Number of Personnel Attending the Accident Site	Time Alerted	Alerted by	Time of Arrival at the Accident Site	Time Taken to Arrive at the Accident Site	Task(s) Involved	Stand Down Time	Remarks
Crew of Helicopter 86, GFS	4 (2 pilots + 2 crewmen)	1427 hrs	Control Tower, CAD	1432 hrs	5 minutes	Rescue and Casualty Evacuation	1524 hrs	Helicopter 86 was tasked by the Duty Aerodrome Supervisor in the Control Tower to join the rescue operation whilst engaging in other flying duty. It was the first emergency service unit that arrived at the accident scene, and it airlifted the first injured person to arrive Pamela Youde Nethersole Eastern Hospital (PYNEH) at 1454 hrs.
Helicopter 83, GFS (Crew + Medical Team)	6 (2 pilots + 2 crewmen and 1 doctor + 1 nurse)	-	-	1450 hrs	20 minutes (flight time)	Casualty Evacuation	1531 hrs	Helicopter 83 departed GFS base at 1430 hrs and arrived the scene at 1450 hrs. It then departed Pak A at 1459 hrs with the second injured person and arrived PYNEH at 1504 hrs.

Organizations/Units \ Responses	Number of Personnel Attending the Accident Site	Time Alerted	Alerted by	Time of Arrival at the Accident Site	Time Taken to Arrive at the Accident Site	Task(s) Involved	Stand Down Time	Remarks
Crew of Helicopter 47, GFS	2 (1 pilot + 1 crewman)	-	-	1528	20 minutes (flight time)	Casualty Evacuation	1551 hrs	Helicopter 47 departed GFS base at 1508 hrs and arrived the scene at 1528 hrs. It then departed Pak A at 1541 hrs with the third (last) injured person and arrived PYNEH at 1546 hrs.
Crew of Fixed-Wing Aircraft (Jetstream) Rescue 38, GFS	2 pilots	-	-	-	-	Air Command and Coordination	1549 hrs	Rescue 38 was tasked to join the rescue operation whilst engaging in other local flying duty. It reported in Sharp Peak area near the accident scene at 1445 hrs, and assisted the rescue operation by keeping other emergency units informed of the development on scene.
Commanding officers of New Territories East Division, FSD	2	1428 hrs	-	1503 hrs	35 minutes	On-Scene Command	1608 hrs	Part of the access to the accident site was via footpath.

Organizations/Units \ Responses	Number of Personnel Attending the Accident Site	Time Alerted	Alerted by	Time of Arrival at the Accident Site	Time Taken to Arrive at the Accident Site	Task(s) Involved	Stand Down Time	Remarks
Hospital Authority	-	1433 hrs	FSCC	-	-	To alert hospitals	1648 hrs	All three injured persons were airlifted by GFS helicopter to PYNEH where the first injured person arrived at 1454 hrs.
Pamela Youde Nethersole Eastern Hospital (PYNEH)	-	1448 hrs	RCCC/M	-	-	Medical Service to Injured Persons	1552 hrs	Took over the last injured person from GFS helicopter at approximately 1547 hrs.

Notes:

1. The Regional Command & Control Centre, Kowloon (RCCC/K) of the Hong Kong Police (HKP) was the first emergency service unit notified of the helicopter accident at 1417 hrs by a member of the public at Pak A through emergency telephone line '999'.
2. The Fire Services Communication Control Centre (FSCC) of the Fire Services Department (FSD) informed the Duty Aerodrome Supervisor of the Civil Aviation Department of this accident at 1420 hrs. The Aerodrome Supervisor thence took alerting actions as per standard procedures and tasked a GFS helicopter (Helicopter 86), which was operating in the vicinity of Pak A at the time, to proceed to scene to verify the accident.
3. Helicopter 86 confirmed the accident and landed at an open area near the accident site at 1432 hrs. Two crewman officers approached the wreckage and found three injured persons on scene.
4. Three Marine Police officers deployed from Police Launch (PL62) arrived the scene at 1434 hrs, followed by more HKP and FSD officers arriving within the next 30 minutes in batches.

5. Apart from one passenger who was uninjured in the accident, the pilot and two passengers sustained spine injuries, and they were subsequently airlifted via three separate GFS helicopter flights to Pamela Youde Nethersole Eastern Hospital (PYNEH). Details on the rescue and injured persons are as follows:

Details of Injured Persons	Time of Accident	Time of Airlift from Accident Scene	Time of Arrival PYNEH	Time of Registration	Time Admitted to Ward
Pilot; male; spine injury	1412	1449	1454	1503	1533
Passenger; female; spine injury	1412	1459	1504	1510	1550
Passenger, female; spine injury	1412	1541	1546	1554	1625

6. The passenger at the rear left seat who was injured in the accident decided to remain in the helicopter cabin until being attended to by the rescue personnel. It took the FSD personnel approximately 1 hour and 18 minutes to cut off the roof of the cabin and evacuate her out of the wreckage to the GFS helicopter for airlift to PYNEH.
7. All three injured persons were provided with on-scene medical treatment to stabilize their injuries before airlift to hospital by helicopter.
8. PYNEH was given prior notice about the accident and the take-over of the injured persons from the GFS helicopter was satisfactory.
9. A total of 29 Police officers, 37 FSD officers (including ambulance officers) and 14 GFS officers (including pilots, crewmen and medical personnel) attended to the accident.
10. On-scene commands were satisfactorily effected and coordinated by the HKP and FSD officers concerned.
11. Rescue equipment and means of communication used by various emergency service units in this accident were effective.
12. The injured persons were satisfied with the services provided by the emergency service units concerned.

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Appendix E

Letter Issued by CAD in January 2004 on UKCAA Flight Operations Department Communication 1/2004

民航處 *Civil Aviation Department*

飛行標準及適航部 Flight Standards and Airworthiness Division

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10th Floor, Commercial Building, Airport Freight Forwarding Centre, 2 Chun Wan Road, Hong Kong International Airport, Lantau, Hong Kong.

檔案編號 OUR REF.	來函編號 YOUR REF.	電話 TEL.	圖文傳真 FAX.	航空專用電訊 AFTN
(33) in A/OPS/REC/1 IV		2769 7548	2362 4250	VHHHYAYC

28 January 2004

[Name Intentionally Deleted]

Hong Kong Aviation Club
Sung Wong Toi Road
Kowloon
Hong Kong

Dear Sir,

Loss of Tail Rotor Effectiveness

A number of recent accidents in light helicopters have been attributed to loss of tail rotor effectiveness (LTE).

The enclosed information is intended to highlight the need for a deeper understanding by pilots of this aerodynamic flight condition and should be brought to their attention. You should also consider covering this topic during recurrent ground training. Please ensure that pilots are made aware of the difference between genuine LTE and other 'pedal stop' events such as overpitching and consequent loss of yaw control.

Yours faithfully,

(Captain M.L. Webber)
for Director-General of Civil Aviation

Encl

致力於安全及有效率的航空系統 *Committed to a Safe and Efficient Air Transport System*

DCA 155 (1/2003)

SAFETY REGULATION GROUP

FLIGHT OPERATIONS DEPARTMENT COMMUNICATION

Flight Operations Department, Aviation House, Gatwick Airport South, Gatwick West Sussex, RH6 0YR
Website address: http://www.caa.co.uk/publications

1/2004

IN THIS ISSUE

1 LOSS OF TAIL ROTOR EFFECTIVENESS (LTE)

1.1 Introduction

1.1.1 A recent accident investigation conducted by the Air Accidents Investigation Branch has led to the belief that the pilot experienced Loss of Tail Rotor Effectiveness (LTE) and was unable to prevent the helicopter from completing several revolutions before impacting the ground.

1.1.2 The purpose of this FODCOM is to bring to the attention of all Commercial Helicopter Pilots the latest information on LTE.

1.2 History

1.2.1 The following statements have all come from real accident or incident reports, from both private and professional helicopter pilots working in a variety of environments.

- The pilot reported that he was on approach to a ridgeline landing zone about 70 ft above ground level decelerating through about 20 kt. Suddenly a gust of wind induced a loss of directional control. The helicopter began to rotate rapidly about the mast and impacted the ground.
- The pilot reported that he made a low pass over a mountain peak into a 40 kt headwind before losing tail rotor effectiveness. He then lost directional control and struck the ground.
- The pilot was manoeuvring the helicopter at about 300 ft AGL at slow speed when the aircraft entered an uncontrolled descending turn. Unable to regain control the pilot closed the throttle and attempted an emergency landing.

1.2.2 In all the cases described above, the helicopters were all correctly rigged, maintained and fully serviceable prior to the incidents and were carrying no significant defects that affected the flight in any way. They all, however, experienced phenomena known as Loss of Tail Rotor Effectiveness.

1.3 What is LTE?

1.3.1 LTE can be described as a critical low speed aerodynamic flight condition that can result in an uncommanded rapid yaw rate that does not subside and which can result in the loss of an aircraft if it remains unchecked.

1.3.2 LTE is the result of a control margin deficiency; it is not a maintenance malfunction.

1.3.3 LTE is an aerodynamic condition that can affect all single rotor helicopters that utilise a conventional tail rotor. Whilst the design of main and tail rotor blades and the tail boom assembly can affect the characteristics and susceptibility of a helicopter to LTE, it will not nullify the phenomenon entirely. Tail rotor capability is a factor and a helicopter type that is prone to reaching full pedal when, for example, hovering out of wind Inside Ground Effect (IGE) is more likely to suffer LTE due to high power (high, but in limits, gearbox torque or engine power) than a helicopter with good pedal margins in the same situation. Pilots should be aware of the characteristics of the helicopter they fly and be particularly aware of the amount of tail rotor pedal typically required for different flight conditions.

1.3.4 LTE can occur on helicopters with either anti-clockwise or clockwise rotating main blades, but the direction of the relative wind that makes them susceptible to LTE will differ. Thus an American design will be susceptible with the relative wind from the front left arcs, whilst French designs will be susceptible with relative winds from the front right arcs.

1.3.5 LTE is a condition that occurs when the flow of air through a conventional tail rotor is altered in some way, either by, altering the angle or speed at which the air passes through the rotating blades of the tail rotor system. An effective tail rotor relies on a stable and relatively undisturbed airflow in order to provide a steady and constant anti-torque reaction. The pitch, and inevitably the angle of attack of the individual blades will determine the thrust output of the tail rotor. A change to any of these criteria will inevitably alter the amount of thrust generated. When a pilot makes a yaw pedal input he will effect a thrust reaction from the tail rotor. Altering the amount of thrust delivered for the same yaw input will create an imbalance. Taking this imbalance to the extreme will result in the loss of effective control in the yawing plane and LTE will occur.

1.3.6 This alteration of tail rotor thrust can be effected by numerous external influences. The main influences, hence the main contributing factors to LTE are:

- Airflow and downdraft generated by the main rotor blades interfering with the airflow entering the tail rotor assembly;
- Main blade vortices developed at the main blade tips entering the tail rotor; and
- Turbulence and other natural phenomena affecting the airflow surrounding the tail rotor.

1.3.7 Wind tunnel tests have shown that the aerodynamic turbulence induced with all three phenomena above are both complex and interrelated however three conditions appear to be contributory factors to LTE.

- Firstly, a high power setting, hence large main rotor pitch angle, induces considerable main rotor blade downwash and hence more turbulence than when the helicopter is in a low power condition;
- Secondly a slow forward airspeed, typically at speeds where translational lift is in the process of change, where airflow around the tail rotor will vary in direction and speed; and
- Thirdly the airflow relative to the helicopter, the worst case being when the relative wind is within ±15° of the 10 or 2 o'clock position (American/French types respectively) when the generated vortices can be blown directly into the tail rotor.

1.3.8 Certain flight activities lend themselves to being more at high risk to LTE than others; for example powerline and pipeline patrol sectors, low speed aerial filming as well as in the Police and Helicopter Emergency Medical Services (HEMS) environments can find themselves in low and slow situations over geographical areas where the exact windspeed and direction are hard to determine.

1.4 How can LTE be avoided?

1.4.1 The exact parameters described above will vary from type to type depending on rotor orientation (clockwise or anti), the size of the machine and the geometric and aerodynamic relationship between the main and tail rotors. However there are certain flight phases where LTE is more likely to occur regardless of the type. The following is a general 'how to avoid LTE' list:

Whenever possible, AVOID combinations of:

- Low and slow flight outside of ground effect;
- Winds from ±15° of the 10 o'clock (American) or 2 o'clock (French) position;
- Tailwinds that may alter the onset of translational lift hence induce high power demands;
- Low speed downwind turns;

- Large changes of power at low airspeeds; and
- Low speed flight in the proximity of physical obstructions that may alter a smooth airflow.

1.4.2 Pilots should be aware that if they enter a flight regime where combinations of the above occur, then they are entering a potential LTE situation. In this case they should realise the possibility of experiencing LTE, recognise its onset and be prepared to react very quickly to it before it builds up.

1.5 What to do if LTE is encountered

1.5.1 The exact actions to be taken having encountered the phenomenon will vary according to the circumstances, but gaining forward airspeed will remove the problem. Awareness of LTE to assist in early detection of it, followed by firm corrective action to counter the effect will always pay dividends. Early identification followed by the immediate application of corrective action by getting the nose forward to regain airspeed is the key to a safe recovery - hence the need for the pilot to ensure he has the height and space available to recover. Understanding the phenomenon is by far the most important factor, and the ability and option to either 'go around' if making an approach (positive airspeed will always counter the effects of LTE) or pull out of a manoeuvre safely and re-plan, is always the safe option. Having the ability to 'fly away' down a safe route and re-think should always be part of a pilot's planning process in all phases of flight.

1.5.2 Helicopter pilots should be aware of LTE and should avoid entering into the flight phases where LTE could occur. The specific wind directions and speeds may vary with helicopter types and in some cases the danger arcs indeed overlap so detection may not be easy.

1.6 Recommendation

1.6.1 Helicopter operators should bring the details of this FODCOM to the attention of all their flight crew, and should consider covering the topic of Loss of Tail Rotor Effectiveness during recurrent ground training.

Captain D J Chapman
Head Flight Operations Department
9 January 2004

Recipients of new FODCOMs are asked to ensure that these are copied to their 'in house' or contracted maintenance organisation, to relevant outside contractors, and to all members of their staff who could have an interest in the information or who need to take appropriate action in response to this Communication.

Appendix F

Emergency Procedures for Loss of Tail Rotor Thrust during Hover

LOSS OF TAIL ROTOR THRUST DURING FORWARD FLIGHT

1. Failure is usually indicated by nose right yaw which cannot be corrected by applying left pedal.
2. Immediately enter autorotation.
3. Maintain at least 70 KIAS if practical.
4. Select landing site, roll throttle off into detent spring, and perform autorotation landing.

NOTE

When a suitable landing site is not available, the vertical fin may permit limited controlled flight at low power settings and airspeeds above 70 KIAS; however, prior to reducing airspeed, re-enter full autorotation.

LOSS OF TAIL ROTOR THRUST DURING HOVER

1. Failure is usually indicated by right yaw which cannot be stopped by applying left pedal.
2. Immediately roll throttle off into detent spring and allow aircraft to settle.
3. Raise collective just before touchdown to cushion landing.

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