Contents

Note: This bulletin contains many references to BASI, even though BASI has been integrated into the ATSB. These references were correct at the time the original documents were issued, and so they have not been updated in the interests of historical accuracy.

Commonly used abbreviations

AA	Airservices Australia
ACAS	Airborne Collision Avoidance System
ADC	Aerodrome Controller
AGL	Above Ground Level
AMSL	Above Mean Sea Level
APU	Auxiliary Power Unit
ASIR	Air Safety Incident Report
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
ATS	Air Traffic Services
ATSB	Australian Transport Safety Bureau
BASI	Bureau of Air Safety Investigation
CASA	Civil Aviation Safety Authority
CAVOK	Generally speaking, good general weather conditions prevail
CRM	Crew Resource Management
CTA	Control Area
CTAF	Common Traffic Advisory Frequency
CTR	Control Zone
CVR	Cockpit Voice Recorder
DME	Distance Measuring Equipment
ELT	Emergency Locator Transmitter
ESIR	Electronic Safety Incident Report
ETA	Estimated Time of Arrival
FDR	Flight Data Recorder
FIR	Flight Information Region
FL	Flight Level
FMS	Flight Management System
FS	Flight Service
FSO	Flight Service Officer
FTC	Failure To Comply
ft	Feet
ft/min	Feet Per Minute
GAAP	General Aviation Aerodrome Procedure
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
LLZ	Localiser
m	Metre
MBZ	Mandatory Broadcast Zone
MTOW	Maximum Take-Off Weight
NDB	Non-Directional Beacon
NM	Nautical Mile
NOTAM	Notice To Airmen
OCTA	Outside Controlled Airspace
PAN	Radio code indicating uncertainty or alert
RAS	Radar Advisory Service
RFFS	Rescue and Fire Fighting Service
RPM	Revolutions Per Minute
SAR	Search and Rescue
SID	Standard Instrument Departure
SSR	Secondary Surveillance Radar
STAR	Standard Terminal Arrival Route
TAAATS	The Australian Advanced Air Traffic System
TCAS	Traffic Alert and Collision Avoidance System
VCA	Violation (penetration) of Controlled Airspace
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VOR	Very High Frequency Omni-Directional Radio Range

Introduction

The Australian Transport Safety Bureau has commenced the publication of a safety bulletin for the helicopter industry. This follows an external review of the Bureau undertaken in 1999. The review contained a number of recommendations, from which the production of this bulletin has emerged.

The bulletin will be published twice yearly. From time to time additional bulletins will be published in response to requests for information on specific subjects from the industry. If a particular problem becomes evident from the ATSB's monitoring of trends in various areas, this too will be included in the bulletin.

The bulletin is composed of 6 parts. These parts are:

- Current accident and incident trends covering the helicopter industry. Also trends in various areas will be presented.
- Selected occurrence reports from the Bureau's database that involve helicopter operations.
- Safety Recommendations that are likely to either directly or indirectly affect helicopter operations and the background behind the recommendation.
- A summary of CAIR reports.
- Selected overseas occurrences that have either a safety message or are of interest to the helicopter industry.
- Information about the ATSB website and other activities that the Bureau is undertaking that are of interest to the helicopter industry.

Your feedback to the ATSB on what you would like to see included in the bulletin is most welcome. Also any feedback or comments on areas that you, the industry, are particularly concerned about and would like to see a "special issue" dedicated to is also welcome.

To facilitate this, you can use any of the following methods to provide the feedback:

Australian Transport Safety Bureau
Attention: Helicopter Operations Safety Bulletin
PO Box 967
Civic Square ACT 2608

Internet Email - hosb@atsb.gov.au
Fax - (02) 6247 1290

I hope you find the bulletin informative and of use in operations.

Carol Boughton
Director Safety Investigations
Australian Transport Safety Bureau

1. Investigation Model and Statistical Summary

Systemic Incident Analysis Model

The Australian Transport Safety Bureau (ATSB) uses the Systemic Incident Analysis Model (SIAM) to record and analyse all aviation safety occurrences. This innovative safety information system is a powerful tool for accident prevention and systems safety enhancement. SIAM provides an indication of where the overall system, in this case the aviation system, is most vulnerable. An informed judgement can then be made as to where and how to best allocate resources to obtain the most effective safety return for the system.

Air safety occurrences by definition mean that something in the system has gone wrong. Something serious may have *really* happened, such as an accident, or something more serious could *potentially* have happened if the situation had deteriorated further; for example, if an aircraft enters controlled airspace without a clearance, a potential outcome could be a mid-air collision. Sometimes, something may have *appeared* to happen, but in reality did not. Such instances may result in a false alarm – for example, a cargo compartment fire warning displayed to the cockpit crew in the absence of an actual fire.

Although all aviation accidents and incidents are entered into SIAM, the model has been designed primarily to capture basic statistical information on systems safety from aviation incidents, in particular from high volume, low detail aviation incidents (referred to by the Bureau as Category 5 incidents). This is the only category of incident in Australia in which there are sufficient numbers to make in-depth statistical analysis both possible and productive. SIAM maximises the safety value of these incidents by enabling areas of vulnerability in the safety defences to be identified, reviewed and rectified before they contribute to accidents or serious incidents.

The basic concepts incorporated in SIAM were derived from the Reason Model. The model uses the notion of *hazards*. These are things that have the potential to cause harm in some way - to people, equipment, or assets. Under normal circumstances, hazards are contained, controlled and managed so that the system is protected, and harmful events do not occur.

The components of a system which are intended to manage and control hazards are termed *defences*. Defences can take the form of 'hard', or engineered, safety features such as automatic ground proximity and airborne collision avoidance systems. These contrast with 'soft' defences, such as standard operational procedures, or particular skills, such as navigation.

A safety occurrence happens when a system's defences are breached.

Defences are never 100% reliable. They may contain unknown latent failures and/or they are subject to the actions of people. A latent failure in a defence is a condition that is imposed on an operation. They can be as simple as a system malfunction. Latent failures are often present in the system long before an incident or accident occurs. An active failure is an error or violation that is committed by pilots, air traffic controller or other operational personnel.

To counter this, several layers of defences are typically put in place so that a failure in one defence is likely to be caught by another defence. Very occasionally, all the defences will be breached simultaneously resulting in an accident or serious incident. More often, only a few of the defences fail and a major accident is prevented by at least one defence operating which results in an incident. However, as more defences fail, the potential for an accident to occur becomes more likely and the incident is viewed as more severe.

Recovery measures can be classified in two groups. The first is a detection role in which a recovery measure actually brings the problem to the attention of the crew such as the activation of a TCAS. The other role is in limiting the consequences of the occurrence. This can be through the use of on board equipment such as a fire extinguisher or may just be as simple as that there was no other traffic in the area.

Within the aviation system itself, there are two basic hazards – the first being the potential for loss of controlled flight and the second being the potential for colliding with something while in controlled flight. By taking such a simple view of aviation hazards and outcomes, it is possible to provide a context in which all the elements of the aviation system directed at safety are in fact defences for one or both of these hazards. Subsequently, the majority of Outcomes are structured to come under either 'Loss of normal flying capability / function (ultimately a collision when out of control) or 'Collision (controlled aircraft / vehicle operations). A third type of outcome is also included; 'Injury to non-operational person (controlled operation) which covers situations such as oxygen and cabin depressurisations where passengers are harmed in the course of controlled operations.

In essence, applying SIAM to an occurrence falls into five parts:

- specifying the occurrence's primary event or outcome;
- specifying the type of outcome (either apparent, potential or real);
- specifying (where possible) one or more defences which failed creating the occurrence situation;
- specifying the type of failure; and
- specifying (where possible) one or more recovery measures which limited the ultimate consequences.

To summarise, for each air safety occurrence report, the outcome is categorised in SIAM as real, potential or apparent and events categorised into different levels.

In future bulletins, the ATSB will present selected occurrences with the full SIAM outcome and failed defence indicated, along with the summary of the occurrence.

Statistical Summary

Over the period from 1990 to 1999 there were 425 accidents and 1466 incidents involving helicopters reported to the Bureau. Both the monthly and annual trend of accidents over this time period have shown a gradual decrease. The trends for incidents has remained constant over the same period. (Figures 1 & 2.)

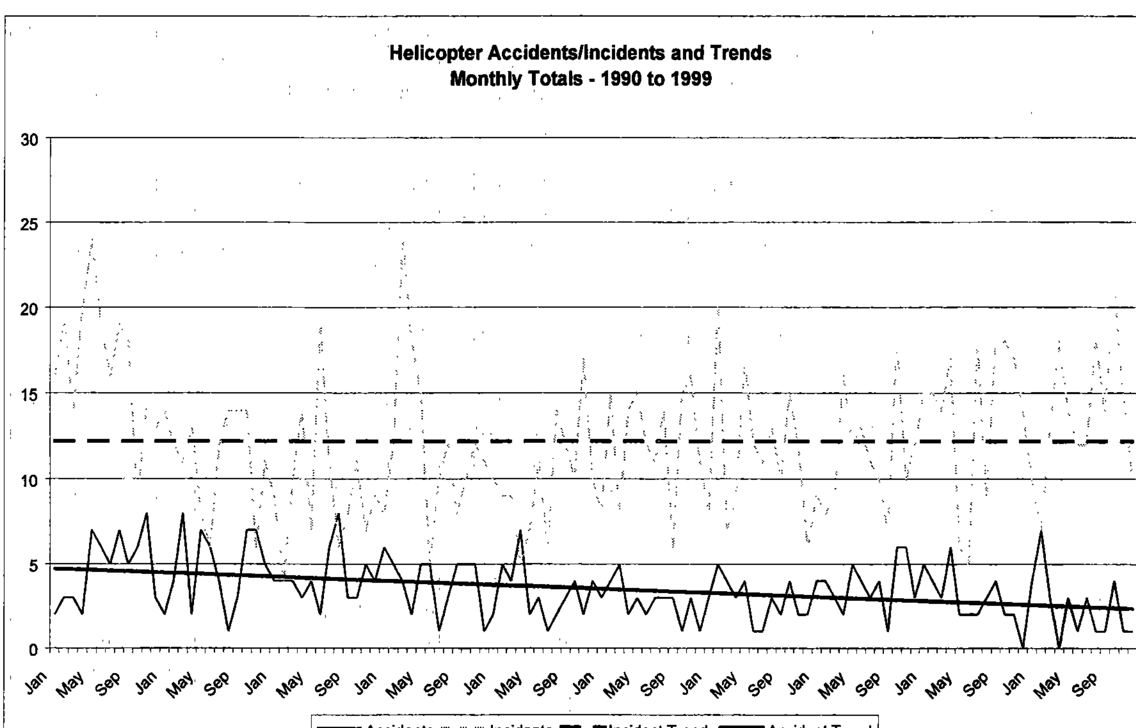

Figure 1 - Helicopter Accidents/Incidents and Trends Monthly Totals - 1990 to 1999

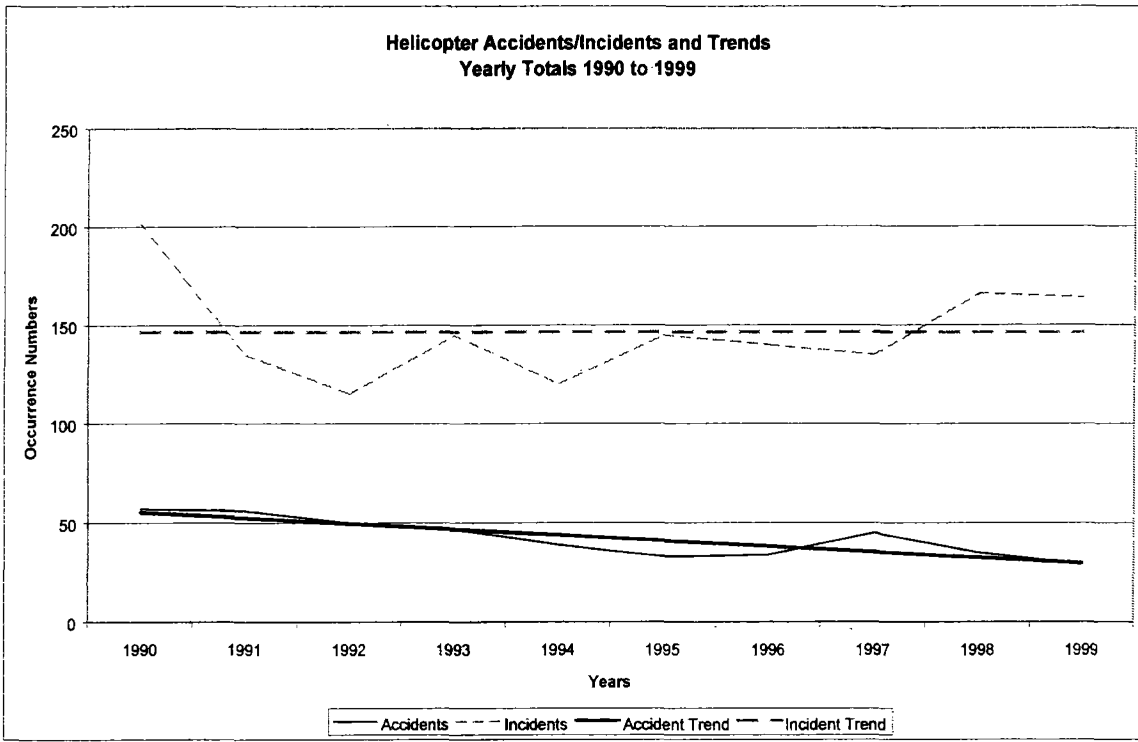

Figure 2 - Helicopter Accidents and Incident with Trends Yearly Totals 1990 to 1999

When the data is analysed for the period 01 January 1999 to 31 December 1999 (Figure 3), the decreasing trend in accidents identified in Figures 1 and 2 clearly continue through 1999. While an increasing trend is shown for incidents the sample size is too small to establish wether this is a real shift from the trend evident in Figures 1 and 2.

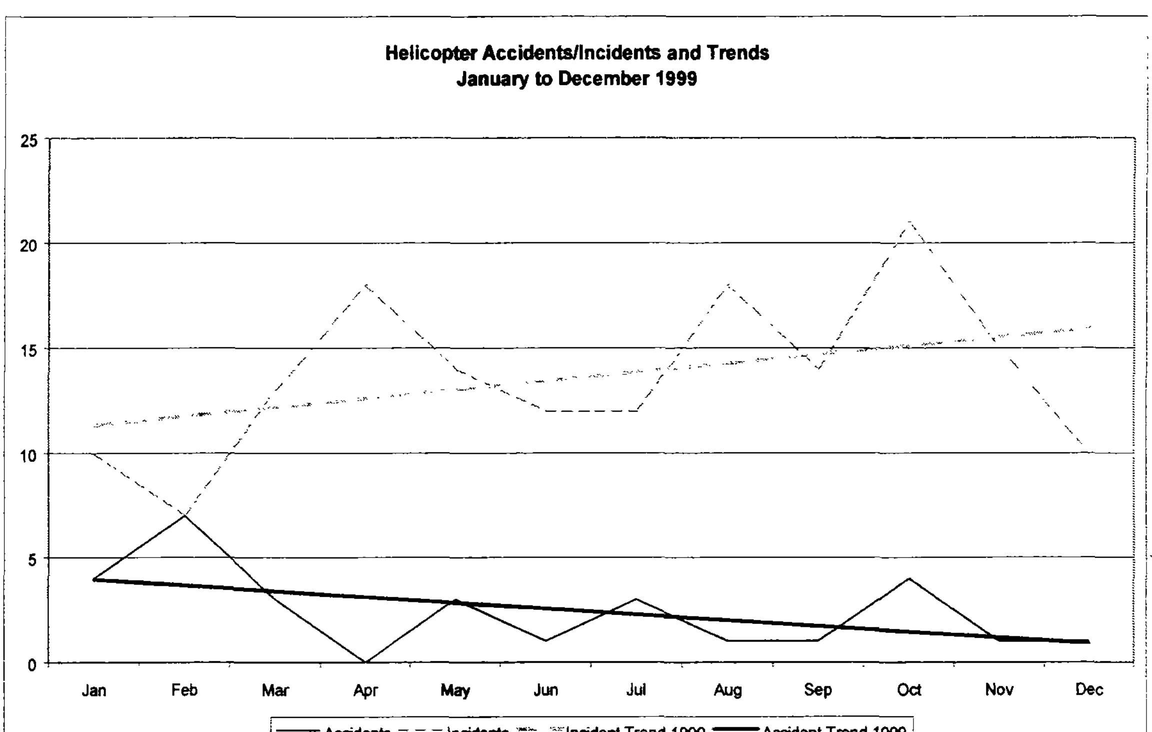

Figure 3 - Helicopter Accidents/Incidents and Trends January 1999 to December 1999

The most common real outcome reported to the ATSB involved an engine malfunction (Table 1.). The second most common outcome was a collision with the ground. The most reported potential outcome was a collision with another aircraft in controlled airspace.

OUTCOME	OUTCOME TYPE REAL	POTENTIAL	APPARENT
Loss of normal flying capability/function			
Airframe			
Internal fixture/fitting problem	0	0	0
Landing gear problem	4	0	1
Flight control/surface problem	3	0	1
Structural problem	1	0	0
Door or window problem	0	1	0
Powerplant			
Engine malfunction	25	4	4
Propeller/rotor malfunction	5	1	1
Engine accessory malfunction	2	1	0
Systems			
Electrical failure	6	0	0
Hydraulic failure	3	0	0
Fuel system failure	2	0	0
Avionics system failure			
Navigation system failure	0	0	0
Communications systems failure	1	0	0
Automatic flight systems failure	1	0	0
Instruments failure	1	0	0
Life support systems failure			
Crew injury/incapacitation	2	0	0
Fire, explosion or fumes	1	0	1
Cargo problems	3	0	0
Balance/ CoG problem	0	0	0
Collision (controlled a/c / vehicle ops)			
Objects and moveable features			
Collision with animal	2	0	0
Birdstrike	5	0	0
Collision with moveable equipment	0	0	0
Collision with person	0	0	0
Terrain and fixed features			
Natural			
Collision with ground	21	11	0
Collision with water	2	0	0
Collision with foliage/tree	6	0	0
Man-made			
Collision with building	0	0	0
Collision with powerline/wire	4	0	0
Collision with man-made feature	1	0	0
Other aircraft			
Other is airborne			
Collision with a/c in controlled airspace	0	61	2
Collision with a/c OCTA	2	8	0
Other aircraft is on the ground			
Collision with stationary aircraft	0	0	0
Collision with moving aircraft on the ground	0	6	0
Injury to non-op personnel (controlled operation)			
Passengers (inc parachutists)	1	1	0
Bystanders	0	0	0

Table 1 - SIAM Outcomes - 1 January to 31 December 1999

2. Selected Occurrences

The following occurrence reports from 1999 were selected for inclusion in this bulletin on the basis of the potential for safety lessons to be learned, and their general interest.

Occurrence Date : 05/01/1999
Location : 43km NNW Dajarra. Aerodrome
Manufacturer : Robinson Helicopter Co
Model : R22 BETA
Occurrence Summary : The pilot reported that the helicopter had been engaged in fence line inspections in a flooded area. After departing from a repair site, the helicopter climbed to about 60 ft AGL to clear the surrounding trees. As the helicopter was accelerating through a speed of 25-30 kts, the rotor rpm began to decay. The pilot was unable to recover the rpm and probably over-pitched the main rotor blades, as the helicopter descended. The helicopter landed on uneven ground at the side of a creek and rolled onto its side. The tail boom was severed by the main rotor. The pilot and passenger were not injured.

The pilot later reported that wind conditions on the ground were calm but that the helicopter was probably subjected to a tail wind once it rose above the trees.

Occurrence Date : 26/01/1999
Location : Perth
Manufacturer : Aerospatiale
Model : AS.350BA
Occurrence Summary : FACTUAL INFORMATION

The Squirrel helicopter was being used to carry an underslung load of operating fireworks during the Perth Australia Day fireworks display. The helicopter's flight path followed the Swan River, remaining clear of spectators. After the fireworks were ignited, some projectiles from the fireworks appeared to pass through or close to the left side of the helicopter's main rotor disc. The helicopter was not damaged.

The helicopter operator had approached the local District Office of the Civil Aviation Safety Authority (CASA) for an approval to conduct the display. The operator was of the understanding that the fireworks were non-projectile and advised this to the local CASA officers. Although the company fitting the fireworks had advised the event promoter that the fireworks included eight-shot Roman Candles, eight-shot Crosette Candles, Flares and Silver Fountains, the event promoter, the local CASA officers, and the operator expected a cascading type display with nothing ejecting from the helicopter's underslung load.

Because it was the first display of its type in Australia, the local CASA officers sought advice from CASA officers in Canberra. Although the Canberra based officers advised against approving the display, the local CASA officers considered that because the fireworks were non-projectile, the display could be conducted safely if the operator met certain guidelines. The helicopter operator was also required to demonstrate that the rig, on which the fireworks were mounted, could be safely flown as an underslung load. The local officers reported that CASA officers in Canberra advised that because the fireworks were being flown as an underslung load, they were not regarded as dangerous goods.

The rig on which the fireworks were mounted, was a large circular metal frame attached to the helicopter by web-type slings. When flown, the rig demonstrated good flying qualities and the local CASA officers reported that the mechanisms securing the fireworks to the rig appeared sound. However, the assessment flight was done without the fireworks attached or a test firing of the fireworks. A Flying Operations Inspector from the local CASA district office granted conditional approval for the flight. The conditions included requirements to remain a minimum distance of 300 m from the shoreline and that the display was not to be flown over any person or boat.

The helicopter lifted the load from a pad near the Swan River and while it was flying along the river, the fireworks were ignited electrically from a control box operated by a pyro-technician sitting in the cabin. The pilot reported that he was surprised when the first fireworks ignited, that they were red flares that ejected from the rig. However, they operated without incident. The cascading-type fireworks also operated without incident but when the Roman Candles fired, some of the shots fired upwards towards the helicopter. The pilot reported that he had felt the rig moving in response to the igniting fireworks but this movement did not affect the controllability of the helicopter. He was unaware that any of the shots had come close to the helicopter until the copilot later reported that some had appeared to do so.

After the helicopter landed, it was found that eight rounds of the Roman Candles had dislodged during the flight and fallen from the rig. The recoil generated by the shots ejecting from the rounds appeared to have caused the rounds to move up and out of the securing straps. As the rounds fell from the rig, they tumbled and the shots continued, some of which passed close to the helicopter. The company that fitted the fireworks reported that the strength of the recoil generated by the Roman Candle had been underestimated.

During the investigation, it became apparent that there were differing opinions as to whether an underslung load was considered to be part of the helicopter with respect to dangerous goods requirements. CASA subsequently informed the investigation that anything attached to an aircraft is considered to be part of the aircraft and that dangerous goods carried as an underslung load must be treated no differently from dangerous goods carried inside the aircraft. CASA also advised that dangerous goods carried differently to that which is required by the Civil Aviation Regulations must be subject to written permission issued by CASA.

There was a misunderstanding among the pyro-technicians, event organiser, helicopter operator and local CASA officers in relation to the types of firework being carried by, and fired from, the helicopter. As a result, the approval given by CASA for the display was based on incorrect information. The mechanisms that secured the Roman Candle rounds to the rig did not prevent the rounds from dislodging from the airframe and were therefore inadequate for the purpose.

As a result of this occurrence, the Bureau of Air Safety Investigation is investigating a perceived safety deficiency involving the interpretation and advice given to helicopter operators concerning dangerous goods being carried as underslung loads.

Any recommendation issued as a result of this deficiency analysis will be published in the Bureau's Quarterly Safety Deficiency Report.

Occurrence Date : 18/01/1999
Location : Sydney, Aerodrome
Manufacturer : Agusta, SPA, Construzioni Aeronautiche
Model : A109C
Occurrence Summary : The helicopter pilot had flown a practice ILS to runway 07 at Sydney Airport, NSW and was instructed by the Aerodrome Controller (ADC) to remain west of runway 16R. Runway 34 was the operating runway direction. There were taxiing aircraft crossing runway 07 on taxiways B and C that lie parallel to runway 34L on its eastern side.

The pilot read-back the instruction to hold west of runway 16R correctly but failed to comply with this instruction . He crossed runway 34L and overflew the taxiing aircraft.

The pilot stated that at the time he believed the requirement was to hold short of the other (parallel) runway 34R even though he had not received a clearance to cross runway 34L. He still believed he was conforming to the instruction even after the ADC informed him that the requirement he had been given was to hold west of runway 16R. He later realised his mistake.

The pilot attributed his loss of situational awareness to a relaxation of concentration following a high workload manoeuvre and his confusion resulting from the controller's use of the reciprocal runway direction when issuing an instruction to hold short of an active runway.

Significant factors

1. The helicopter pilot crossed an active runway without a clearance.
2. The intersecting runway was one of a parallel runway layout.
3. The controller correctly identified the runway when issuing the "hold short" instruction to the helicopter pilot.
4. There was no terminology convention that required the controller to use the same direction as the the runway in use, although this may have aided the pilot's situational awareness.
5. The helicopter pilot probably experienced a loss of situational awareness.

Occurrence Date : 11/02/1999
Location : 9km NE Sedco
Manufacturer : Aerospatiale
Model : AS.332L
Occurrence Summary : While on final approach to an oil rig, the crew armed the helicopter's flotation system. The crew and passengers then heard a loud bang and the helicopter's flotation system deployed without being activated by the crew. The approach was continued and the helicopter landed without further incident.

The operator reported that the subsequent maintenance inspection found that co-pilot's collective flotation firing switch had a very low resistance across the internal contacts. When the flotation system was armed, power was applied to one side of the firing switch. Because of the low resistance across the contacts, the flotation system activated.

The helicopter has been operating in heavy rain and high humidity. The operator reported that this was the second such occurrence of uncommanded activation of the flotation system. The first activation was caused by corrosion of the switch contacts. The operator reported that similar switches are used in other aircraft systems.

CASA has requested that the operator submit an defect report.

Occurrence Date : 26/01/1999
Location : Ayr, Aerodrome
Manufacturer : Robinson Helicopter Co
Model : R22 BETA
Occurrence Summary : The operator advised that the pilot had turned downwind while conducting low level spraying operations and the helicopter "settled with power" on to the sugar crop. The helicopter sustained substantial damage to the main and tail rotor during the impact sequence. The pilot was not injured. The operator advised that the pilot's low experience level was probably a factor in the development of the accident.

Occurrence Date : 14/02/1999
Location : Near Cockatoo
Manufacturer : Aerospatiale
Model : SA.365C-1
Occurrence Summary : The police helicopter was engaged in an ambulance flight. After loading a patient the pilot performed a category A takeoff. At about 100 ft AGL while climbing steeply backwards at about 200 ft per minute, the helicopter commenced to vibrate. The pilot continued the climb for about another 50 ft but the vibration worsened so he performed a rejected takeoff. The vibration persisted until the helicopter landed. A second takeoff was rejected because in the hover the helicopter began to vibrate again. The pilot cancelled the ambulance flight and grounded the aircraft.

Engineers subsequently inspected the aircraft. They noticed small creases on the right hand stabiliser which were deemed to be within prescribed limits for flight. The pilot and engineers stripped the helicopter of surplus gear and flew it back to Essendon with no further vibrations.

The helicopter owner/ maintenance company, the operator and the CASA test pilot have since conducted an investigation into possible causes of the vibrations. The maintenance company also hired the services of a CAR 35 aeronautical engineer to study the creases in the stabiliser. The maintenance company's qualified test pilot has also conducted flight trials. The helicopter has flown many hours since this occurrence without a repeat of the vibration problem.

Occurrence Date : 01/03/1999
Location : Melton
Manufacturer : Aerospatiale
Model : SA.365C-1
Occurrence Summary : The pilot was conducting an ambulance flight. After loading the patient at Melton the helicopter performed a normal takeoff and climb. Then as the airspeed increased through 100 kts. the helicopter began to vibrate to an extent that the instruments were slightly blurred. The pilot reported that the vibration appeared to emanate from the rear of the helicopter. He decreased the power and reduced airspeed to 70 kts and the vibration reduced in severity but did not disappear. He then disengaged the stability augmentation system which appeared to have an immediate effect in further reducing the vibration. He then increased airspeed to 90 kts and the vibration did not recur. After about 30 seconds he re-engaged the stability augmentation system; no increase in vibration was observed. As he increased airspeed to about 105 kts the vibration returned. He then disengaged the stability augmentation system again and the vibrations immediately ceased. The flight was continued to the Children's Hospital with the stability augmentation system disengaged. On departure from the hospital for Essendon he felt some binding in lateral cyclic control; he continued to Essendon.

Engineers subsequently replaced a trim motor to fix the cyclic binding problem. They also conducted considerable trouble-shooting in an attempt to reproduce, isolate and eliminate the vibration problem. An electronic spectrum analysis of the vibrations in the helicopter was conducted. All vibration levels measured in flight were within acceptable tolerances. The vibrations reported on the ambulance flight were not reproduced. As a precaution engineers replaced the auto pilot gyro and worked on the instrument panel to ensure it was not bumping against the centre pillar. They considered that contact between the instrument panel and the pillar could have disrupted the auto pilot gyro and possibly triggered the vibrations described by the pilot.

Although a positive cause of the vibrations has not been determined, vibrations were not reproduced during subsequent test flights. The helicopter has since flown several hours with no reports of unusual vibrations. The operator and the separate owner/engineering company are monitoring the helicopter because of previous reports of vibrations in February 1999 (BASI incident investigation 9900999). As part of the previous investigation, the CASA test pilot asked the operator to turn off the stability augmentation system if vibrations recurred in flight.

Occurrence Date : 25/03/1999
Location : Camden, Aerodrome
Manufacturer : Robinson Helicopter Co
Model : R22 BETA
Occurrence Summary : While in the Camden area, the helicopter sustained a birdstrike to the main rotor. A post-flight inspection revealed no damage.

Occurrence Date : 30/03/1999
Location : 30km SW Sydney, Aerodrome
Manufacturer : Robinson Helicopter Co
Model : R44
Occurrence Summary : The helicopter was observed by radar operating in Restricted Area R555C without authorisation. The helicopter was identified as it entered the Bankstown circuit.

Occurrence Date : 03/04/1999
Location : Lady Elliott Island, (ALA)
Manufacturer : Bell Helicopter Co
Model : 412EP
Occurrence Summary : During approach, the pilot observed a bird fly up through the rotor disk. An inspection revealed bird debris on top of a rotor blade but no damage to the blade.

Occurrence Date : 08/04/1999
Location : 6km NE Leongatha
Manufacturer : Bell Helicopter Co
Model : 206B (III)
Occurrence Summary : The helicopter was flying at 500 ft AGL en route from La Trobe Valley to Leongatha. At approximately 6 km north-east of Leongatha, the pilot noticed the engine spooling down and elected to commence an autorotative descent into a paddock. The autorotation was completed successfully, no-one was injured and the helicopter appeared to be undamaged. The weather was VMC.

Subsequent investigation revealed that that the engine had spooled down because the PC lines had cracked at the flared collar and had eventually broken. The PC lines control bleed air to operate the governor which controls N2 RPM and allows the engine to roll back to idle. There was some minor damage to the isolation mount as a result of the landing.

Occurrence Date : 27/04/1999
Location : Bankstown, Aerodrome
Manufacturer : Robinson Helicopter Co
Model : R22 BETA
Occurrence Summary : VH-HFO was cleared to depart the helipad tracking via "Choppers South" which tracks overhead the runway complex. VH-WEC was cleared for an immediate take off from runway 11L due to another aircraft on final approach. As WEC started the take-off run HFO had just departed from the helipad. The pilot of HFO had observed WEC on the runway and departed overhead the helipad via a left circuit to avoid the conflict. There was an infringement of separation standards.

Occurrence Date : 19/04/1999
Location : Essendon, Aerodrome
Manufacturer : Aerospatiale
Model : SA.365C-1
Occurrence Summary : The pilot noticed oil pressure fluctuations followed by an oil pressure loss on number one engine in flight. He shut down the engine, declared a PAN and performed a single engine run-on landing at Essendon.

Engineers subsequently discovered that that the oil scavenge line from the engine's rear bearing was clogged with carbon. Engine oil had been pumped past a labyrinth seal and into the bearing vent line. Carbon associated with the rear bearing is a known problem. By performing a flow check of the scavenge line at the 50 hourly inspections, the operator usually predicts the problem and removes the carbon in accordance with the manufacturer's directions. At the last 50 hourly flow check, which was carried out two hours before this incident, the rate of oil flow was acceptable.

Occurrence Date : 07/04/1999
Location : 22km NW Sydney, Aerodrome
Manufacturer : Bell Helicopter Co
Model : 206A
Occurrence Summary : The aircraft was observed to enter controlled airspace 12 NM north-west of Sydney, and then exit into the lane of entry. There was no infringement of separation standards.

Occurrence Date : 12/05/1999
Location : Bankstown, Aerodrome
Manufacturer : Aerospatiale
Model : AS.355F
Occurrence Summary : After joining the helicopter circuit on mid downwind, the pilot reported that the number one engine had failed. The helicopter was cleared to land immediately on the main helipad and emergency services were notified. The helicopter subsequently landed safely.

The operators maintenance facility reported that the left engine tubine had failed and the engine had been removed for investigation and repair. The turbine modules for both engines had been fitted about 900 hours prior to the incident.

Occurrence Date : 12/05/1999
Location : Shoalwater Bay, (ALA)
Manufacturer : Aerospatiale
Model : AS.350BA
Occurrence Summary : An aircraft reported 100 NM north of Gladstone requesting the area QNH. The aircraft was identified at 2,000 ft inside R687A/B and R695A/B, without a clearance.

Occurrence Date : 11/05/1999
Location : 83km SE Charters Towers, (ALA)
Manufacturer : Robinson Helicopter Co
Model : R22 ALPHA
Occurrence Summary : The pilot advised that the helicopter's engine lost power briefly and then stopped completely, while the aircraft was in the cruise at about 600 ft AGL. The aircraft sustained major impact damage in the subsequent heavy landing; the pilot was not injured.

Examination by maintenance staff showed that the mixture control cable inner wire (single strand) had broken near the carburetor end fitting. The mixture control safety spring which drives the mixture control to the full rich position in the event of a cable failure, had fouled or caught on the left edge of the airbox cable mount bracket. That allowed the mixture control arm to move towards the full lean/engine shut off position, causing the subsequent engine stoppage. The operator reported that they were unable to determine how the spring became fouled on the edge of the mounting bracket. The only way it was possible to replicate the fouling was to pull the spring coil towards the edge and then force it onto the bracket. Several operators of the helicopter type were contacted for advice of any previous similar event. None were aware of any. A check of the BASI data base also showed no record of a previous similar occurrence for the helicopter type.

Occurrence Date : 31/05/1999
Location : 25km E Katherine
Manufacturer : Robinson Helicopter Co
Model : R22 ALPHA
Occurrence Summary : The pilot reported that after refuelling the helicopter, he forgot to remove the bowser hose that was laying over the front of the left skid. When the pilot attempted to fly the helicopter from the hover into forward flight, the helicopter yawed violently to the left and pitched nose down. It then spun 180 degrees before moving backwards and the tail rotor struck the ground. The helicopter then rolled onto its right side and the main rotor blades struck the ground.

There was no fire but the helicopter was destroyed. The pilot, who was the sole occupant, was not injured.

Occurrence Date : 12/06/1999
Location : Gatton, (ALA)
Manufacturer : Unknown
Model : Helicopter
Occurrence Summary : The drop zone safety officer reported that a helicopter was observed flying directly overhead the airfield while two parachutists were on descent under canopy. The safety officer indicated that the helicopter passed in close proximity, between the two parachutists. Neither the zone safety officer of the pilot of the parachute jump aircraft heard a response to the pre-jump broadcasts made on the area VHF frequency.

The helicopter pilot indicated that he had overflown the parachute drop zone at an altitude of 1,500 ft. He stated that he had received no response in relation to his broadcast of tracking intentions on the area VHF frequency as he departed from a nearby landing area. Approaching the parachute drop zone he reported observing two parachute canopies on descent. The helicopter pilot considers that he passed at a safe distance overhead the canopies, with at least 500 ft vertical and 200 m lateral separation.

Occurrence Date : 02/06/1999
Location : Darwin, Aerodrome
Manufacturer : Robinson Helicopter Co
Model : R22 BETA
Occurrence Summary : The tower controller had just issued the crew of a departing Metro with a take-off clearance when he observed that a Robinson R22 helicopter had become airborne, without a clearance, in the vicinity of the southern GA apron. The helicopter pilot appeared to be tracking the aircraft in a south easterly direction. The crew of the Metro were instructed to hold position while attempts were made to establish communication with the helicopter pilot.

A controller had previously issued, on the airways clearance delivery frequency, the helicopter pilot with an airways clearance to depart the control zone. The pilot of the R22 subsequently reported that he had broadcast his airborne call to the tower and had thought it unusual that he had not been given an instruction to call the tower when ready for take-off. Air traffic control report that communication with the helicopter pilot was re-established on the airways clearance delivery frequency and the helicopter departed the zone without further incident.

The helicopter pilot appeared to have misunderstood the context of the airways clearance issued and did not recognise the requirement to obtain an individual clearance for take-off. In addition, the pilot appeared to have been unaware of the existence of a separate frequency for airborne operations within the control zone.

Occurrence Date : 26/06/1999
Location : 4km E Nowra, Non Directional Beacon
Manufacturer : Bell Helicopter Co
Model : 206A
Occurrence Summary : A helicopter was on the final leg of a runway 26 NDB approach at 1,700 ft when a Cessna 421 (C421), maintaining 2,000 ft, passed 0.5 NM in front of the helicopter. The aerodrome controller (ADC) did not apply visual separation. There was an infringement of separation procedures.

The pilot of the C421 was conducting an NDB approach to runway 21 and was number two in the approach sequence to the helicopter. The approach controller coordinated with the ADC for the C421 to make a visual approach to left base for runway 21. The ADC concurred and assigned the C421 descent to not below 2,000 ft.

The Nowra ATC investigation found that the ADC had been distracted and while the controller did acknowledge the coordination from approach, the individual did not appreciate the change in the type of approach. The ADC was operating under the perception that the C421 was still conducting the NDB approach to runway 21 and consequently assigned that aircraft descent to 2,000 ft. However, this did to ensure the maintenance of vertical separation between the two aircraft and visual separation was not being used at that time.

As a result of this occurrence, Nowra ATC is planning to review NDB and airspace procedures to ensure safety is maintained in future.

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3. Safety Outputs

The ATSB is responsible for issuing interim recommendations, recommendations and safety advisory notices as the result of substantiated aviation safety deficiencies identified either by personnel involved in the aviation industry or during occurrence investigations and safety projects. The following safety outputs represent some of the safety outputs that were issued by ATSB (formerly BASI) during 1999. While many of the specific occurrences described do not involve helicopter operations, the subjects and issues identified do have the potential to apply to such operations.

A complete summary of all recommendations issued by the ATSB is available in the Quarterly Safety Deficiency Report for each selected quarterly reporting period.

Output Number : R19980241
Issue Date : 30/03/1999
Deficiency Summary : SUBJECT - NORMAL CATEGORY ROTORCRAFT FUEL FILTER

SAFETY DEFICIENCY

The ability to detect fuel contamination between the fuel tank and the engine on Boeing Rotorcraft Light Helicopter Division Model 369 and 500N has been significantly reduced because of the approved removal of the fuel filter drain valve.

Note: This aircraft was previously McDonnell Douglas Helicopter Company (MDHC) 369 and 500N.

FACTUAL INFORMATION

Occurrence 9800067

A Boeing 369D helicopter was engaged in a sling operation to lift a powerline to the top of a transmission tower. The pilot was hovering the helicopter about 60 ft above the 30 ft tower, and had just passed the powerline to the linesman when the engine experienced a total loss of power. The pilot immediately banked the helicopter to the right to avoid personnel on and below the tower, and attempted a landing in light scrub. The helicopter came to rest on its right side, incurring substantial damage, and slightly injuring the pilot.

A maintenance investigation found that the engine fuel system was contaminated with water, discoloured fuel, and particle debris. After the engine fuel system was cleaned, the engine was successfully ground-run. The helicopter had recently spent 45 hours engaged in firefighting operations in the 60 hours since the last maintenance inspection. During the firefighting operations, refuelling was routinely undertaken from an assortment of drum and mobile bowser fuel sources. Hot refuelling also accounted for a significant proportion of those refuelling operations. It is probable that the fuel system was contaminated during that period; however, the investigation was not able to conclusively prove when or how water and other contaminants entered the fuel system.

The pilot reported that he was not forewarned of a fuel filter problem and did not recall seeing the amber fuel filter differential pressure warning light during the accident sequence. The first warning light that he recalled was the red engine-out light at the time the engine failed. He explained that functional tests had been carried out on the fuel filter differential pressure warning system during the pre-flight sequence. The system had been functioning normally.

Fuel system design and maintenance requirements

The Boeing 369D fuel tanks are lined with a bladder. As bladders rarely sit smoothly and flat on the tank floor, some water may be trapped between the ripples in the bladder and consequently may not be drained from the fuel tank drain valve. In addition, the fuel system is fitted with a fuel filter differential pressure warning system to alert pilots of filter contamination and an impending bypass of the filter. The flight manual provides the following instructions regarding the fuel filter indicator:

"Amber fuel filter indicator illuminated indicates clogged filter; turn start pump on, monitor instruments and continue flight; the lighted indicator indicates that the pressure through the filter is 0.8 psi differential or more";

"Warning, after the fuel filter indicator has lighted, and following the completion of the flight in progress, additional flight is prohibited until the fuel filter has been serviced".

The fuel system filter is readily accessible for drain purposes, as the engine cowls, behind which the fuel filter is located, are easily unlatched. However, the aircraft maintenance manual provides the following warning:

"Air in the fuel system will cause a power reduction or flameout. Do a fuel system vacuum leak check and system air bleed after opening the fuel system to atmosphere and prior to releasing helicopter for flight".

This maintenance must be carried out any time that the fuel system filter is removed either for inspection or replacement. In most cases, pilots are not appropriately qualified to perform this maintenance.

The manufacturer does not call for scheduled inspection of the filter, only its replacement every 300 hours. In addition, the fuel filter housing is not transparent. Therefore, unless the fuel filter differential pressure warning system alerts the pilot to a developing problem, contamination of the filter may only be detected by dismantling the fuel filter for a visual inspection.

In this occurrence, a certificate of airworthiness was issued for the aircraft on 26 September 1997 at 2,751 hours aircraft total time in service. The fuel filter was not inspected or changed at the subsequent 100-hourly inspection on 23 December 1997, prior to the accident on 7 January 1998. The fuel filter had been in service for 160 hours.

Design and subsequent modification of the Boeing 369D fuel filter

The helicopter manufacturer was issued a Federal Aviation Administration (FAA) type certificate against Civil Aviation Regulation (CAR) 6. CAR 6.427 states that:

"a strainer incorporating a sediment trap and drain shall be provided in the fuel system between the fuel tanks and the engine and shall be installed in an accessible position. The screen shall be easily removable for cleaning".

The helicopter fuel system in this occurrence had been subsequently modified in accordance with a mandatory MDHC Service Information Notice No: HN-237, dated 26 September 1994, which approved the removal of the engine fuel filter drain valve. The FAA approved this modification in accordance with the later design requirement of Federal Aviation Regulation (FAR) 27.997(b). This regulation states that:

"there must be a fuel strainer or filter between the fuel tank outlet and the inlet of the first fuel system component which is susceptible to fuel contamination, including but not limited to the fuel metering device or an engine positive displacement pump, whichever is nearer the fuel tank outlet. This fuel strainer or filter must have a sediment trap and drain except that it need not have a drain if the strainer or filter is easily removable for drain purposes".

The manufacturer elected to remove the filter drain valve to prevent engine flameouts suspected to be the result of air entering via the firewall and filter drain valves, pooling in the filter and forming an air slug. This possibility was apparently not proven in laboratory simulation. Another manufacturer overcame the possible air slug scenario by establishing the tolerance level of the engine to air in the fuel, and installing a calibrated air bleed in the filter to remove the air safely.

Fuel system inspection requirements

Civil Aviation Order (CAO) section 20.2 refers to safety precautions before flight. Paragraph 5.1 (b) recommends that all fuel system filters and collector boxes be checked for water contamination at frequent intervals. The intent of the order is to check for the presence of water before the start of each day's flying and after each refuelling. However, CAO 20.2 paragraph 5.1 A states that "paragraph 5.1 does not apply to helicopters that are being hot refuelled in accordance with section 20.10".

CAO section 20.10 refers specifically to requirements for hot refuelling in helicopters. The note in paragraph 1A.1 states that "operators and pilots should note the provisions of paragraph 5.1 of section 20.2 of the CAO's relating to the inspections and tests for the presence of water in an aircraft's fuel system before the start of each day's flying are applicable to helicopters to which this section applies".

ANALYSIS

Quality control of fuel entering the fuel system is a valuable defence against the consequences of contaminated fuel. However, the ability of the pilot to detect contamination of the fuel system during routine inspections is an equally important safety defence. These two safety defences should not be considered mutually exclusive. Analysis of this occurrence revealed a design deficiency in Boeing 369D helicopters manufactured without, or modified to remove, the fuel filter drain valve. The removal of this drain significantly reduces the ability of the pilot to detect contamination of the fuel system in either daily or post-fuelling inspections.

Fuel system design and maintenance requirements

Water and other contaminants could have accumulated in the filter for a total of 160 hours prior to the accident. Whilst it could not be conclusively proven, it is most likely that the water contaminated the fuel system during the refuelling operations that took place during fire-fighting activities. Ash particles found in the fuel filter during the post-accident inspection are consistent with fuel contamination at that time. Further, water in the fuel that may not have drained from the tank sump drain valve, possibly because of retention in ripples in the tank bladder, may have continued to accumulate in the filter during the 15 hours subsequent to the firefighting refuelling operations.

In view of this occurrence, and the CAO 20.2 recommendation for safety precautions before flight that checks for the presence of water in the fuel filter be conducted at frequent intervals, the Bureau considers that the replacement schedule of 300 hours for this fuel filter does not meet with the intent of the recommendation. Changing the fuel filter in accordance with this maintenance schedule, and with no provision for a daily filter contamination inspection, does not provide an adequate safety defence for fuel system integrity.

The Bureau also considers that allowing the removal of the filter drain valve on this aircraft on the basis of easy removal of the filter for drain purposes, is flawed logic. Removal of the filter for drain purposes is a good feature; however such maintenance action would only normally be carried out if there were a known contamination problem. In addition, in order to prevent subsequent engine flameout, the fuel system must be bled and tested for air leaks prior to releasing the helicopter for flight. Pilots are not normally approved to perform this maintenance. None of this may be accomplished easily for any gas turbine engine installation, especially if the helicopter is operating in a remote region and in hostile refuelling conditions. Provision of a fuel filter drain would enable a pilot to readily conduct a check for contaminants, without requiring further maintenance to return the aircraft to service.

Fuel filter warning system

The pilot did not see the fuel filter differential pressure amber warning light. However, had the pilot been alerted to an impending problem by the warning light, the flight manual stated that the flight may continue. In this occurrence, there was very little warning, if any, before the engine flamed out. This accident demonstrated that the fuel filter warning light could not be relied upon to provide adequate warning of the possible consequences of filter contamination and an impending bypass. A red warning light and a requirement to land immediately may be more appropriate in order to alert pilots to take immediate precautionary action against an uncertain outcome.

Fuel system inspection requirements

Pilots reading CAO 20.2 paragraph 5.1A may wrongly assume that the paragraph 5.1 requirements for fuel system inspection before the start of each day's flying do not apply to helicopters that are being hot-refuelled. The note in CAO 20.10 paragraph 1A.1 however, states that it is applicable. This ambiguity in what is a critical safety check should be removed.

Output : The Bureau of Air Safety Investigation recommends that the Civil Aviation Safety Authority review the design standard for rotor craft in the normal category to ensure that fuel filter drains are a requirement, particularly for gas turbine helicopters, and that they be retrospectively fitted to all affected helicopters.

The Bureau simultaneously issues the following recommendations:

R980242

The Bureau of Air Safety Investigation recommends that the Federal Aviation Administration review the design standard of FAR part 27.997 (b) to ensure that fuel filter drains are a requirement, particularly for gas turbine helicopters, and that they be retrospectively fitted to all affected helicopters.

R980244

The Bureau of Air Safety Investigation recommends that Boeing Helicopter Systems review the fuel filter warning light colour and the appropriateness of the Flight Manual instructions that allow a flight to be completed after such a warning.

R980245

The Bureau of Air Safety Investigation recommends that Boeing Rotorcraft Light Helicopter Division review McDonnell Douglas Helicopter Systems mandatory Service Information Notice No: HN-237 with a view to restoring the removed filter drain valves and resolving the suspected air problem by other means.

R980246

The Bureau of Air Safety Investigation recommends that the Civil Aviation Safety Authority amend CAO section 20.2 paragraph 5.1A to accord with the note in section 20.10 paragraph 1A.1 to ensure that appropriate inspections for water in the fuel are conducted prior to the commencement of operations.

Output Number : R19980279
Issue Date : 04/02/1999
Deficiency Summary : The following recommendation R980284 was issued to the Civil Aviation Safety Authority as a result of the investigation into the accident involving Cessna 185, VH-HTS at Calabash Bay, NSW on 26 July 1998.

The recommendation was released as part of the final report of this investigation. This report can be obtained by viewing the ATSB website located at http://www.basi.gov.au or by contacting the Bureau on 1 800 020 616.

A pilot could legally act as pilot in command under supervision (ICUS) of an aeroplane under the supervision of another pilot who was not required to have any additional qualification other than a commercial pilot license and an endorsement on the aeroplane type and, if applicable, a rating for the type of flying being undertaken. Furthermore, the pilot conducting the ICUS was not required to have demonstrated flying proficiency in the aeroplane type from other than the command seating position and did not require an assessment of competency for this type of training or have to meet a minimum level of experience on type prior to undertaking such flights.

Output : The Bureau of Air Safety Investigation recommends that the Civil Aviation Safety Authority:

(i) formulate requirements for inclusion into the documentation of Air Operators Certificate holders conducting in command under supervision training flights, specific instructions relating to the conduct of those flights; and

(ii) specify the minimum levels of relevant type experience, training and approval of pilots conducting the supervisory element of in command under supervision flights.

4. CAIR Reports

The Confidential Aviation Incident Reporting (CAIR) system helps to identify and rectify aviation safety deficiencies. It also performs a safety education function so that people can learn from the experiences of others. The reporter's identity remains confidential. To make a report, or discuss an issue you think is relevant, please call the CAIR office on 1800 020 505 or complete a CAIR form which is available at the end of this bulletin or from the Internet at www.atsb.gov.au

A selection of confidential reports involving helicopter operations is reproduced below.

Occurrence Date : 31/03/1999
Manufacturer : Aerospatiale
Model : AS.355F2
CAIR Report : I was flying south over the (xxxx) Radio Control Society, passing through 1,500 feet on descent. I sighted a radio controlled glider at the same level and 20 metres to my left.

This is the third time I have seen these models at this level or higher in this location. The club should be reminded of height restrictions.

CAIR note:

The reporter suggested no action against the club other than a reminder of the dangers involved.
A de-identified copy of the report was forwarded to the Civil Aviation Safety Authority to consider.

Occurrence Date : 22/04/1999
Manufacturer : Bell Helicopter Co
Model : 206B
CAIR Report : Helicopters operate a significant number of flights in the Porpoise Point/Broadwater area of the Gold Coast. There have been a number of near misses between the helicopters and other aircraft in this area, probably due to Porpoise Point being a VFR reporting/entry point for Coolangatta.

What, if any, are the alternatives at Porpoise Point? Perhaps a higher transit altitude might alleviate the congestion.

CAIR note:

The VTC chart does include a very clear caution note. Nevertheless, the reporter is concerned that an accident is imminent and is keen to see if the Civil Aviation Safety Authority or Airservices Australia can suggest anything further to make the area safer.

Advice from Airservices staff at Coolangatta airport and Brisbane centre indicates that the procedures operating in the Porpoise Point area were developed in accordance with a comprehensive process of consultation with local helicopter operators.

A clearance to transit the area inside controlled airspace is normally available, however, a clearance is invariably not required as the affected aircraft (joy flights) prefer the lower transit altitudes. Anecdotal evidence from air traffic controllers indicates that aircraft do at times transit at levels contrary to recommended procedures despite warnings on the VTC chart; ie. 500ft nose to nose.

Airservices is analysing the potential benefits of the following strategies aimed at addressing this situation:

- a recommendation that single radio aircraft call for clearance earlier; eg. Jumpinpin
- inclusion of a prominent cautionary notice on the VTC advising of "high density joyflight activity between Coolangatta and Southport";
- a recommendation that joyflights operate at a higher level (still providing altitude segregation nose to nose) in this area.

Additionally, Airservices will raise this issue as an agenda item at the next Brisbane RAPAC meeting and seek industry support and advice.

5. Overseas Occurrences

The ATSB will endeavour to provide the finalised investigation report into this occurrence in a later bulletin.

On the 9th of May 2000 a Bell 212 carried out an emergency landing following severe in-flight vibration. There were no injuries to crew or passengers. On further investigation one of the main rotor head grips Part Number 204-011-121-121 was found with the lower tang cracked chord-wise from under the blade bolt bush outwards to the leading and trailing edges of the grip. When the blade bolt was removed the broken piece of the tang fell off.

The main rotor hub is currently being shipped to the manufacturer, Bell, via Farnborough UK for detailed investigation.

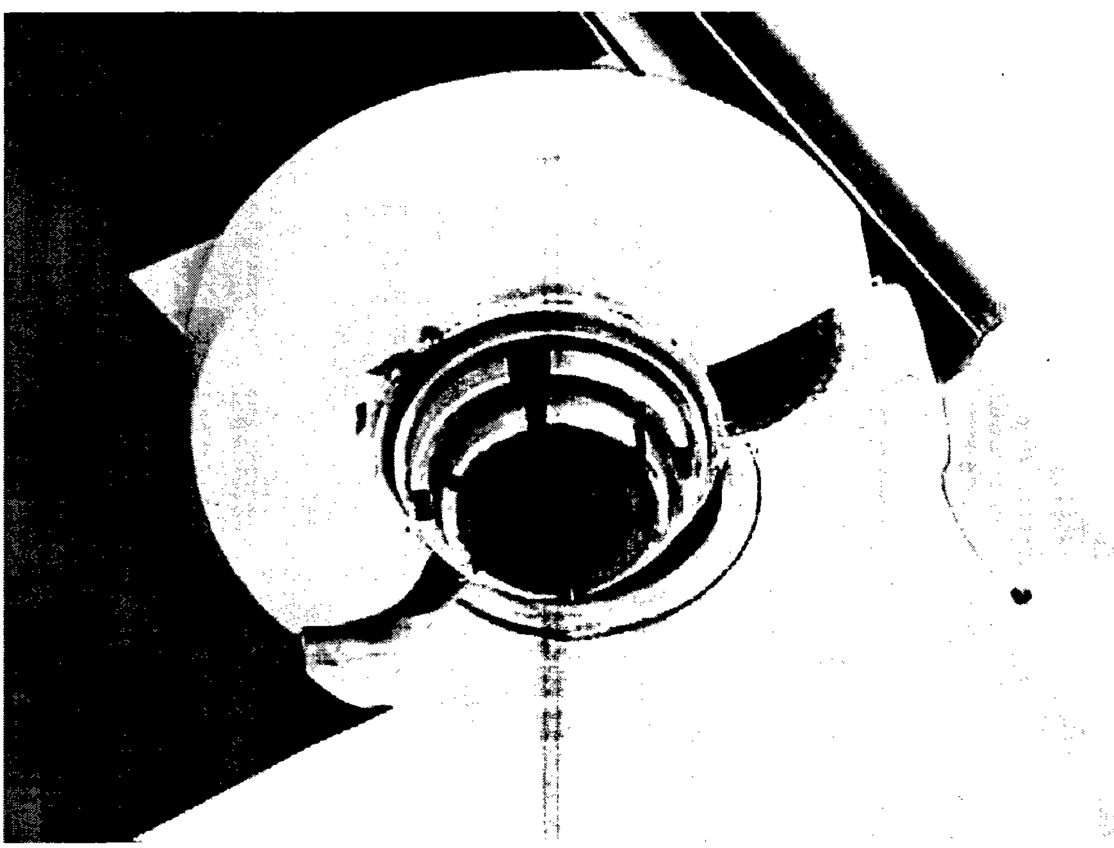

Figure 1 - The blade grip as found insitu.

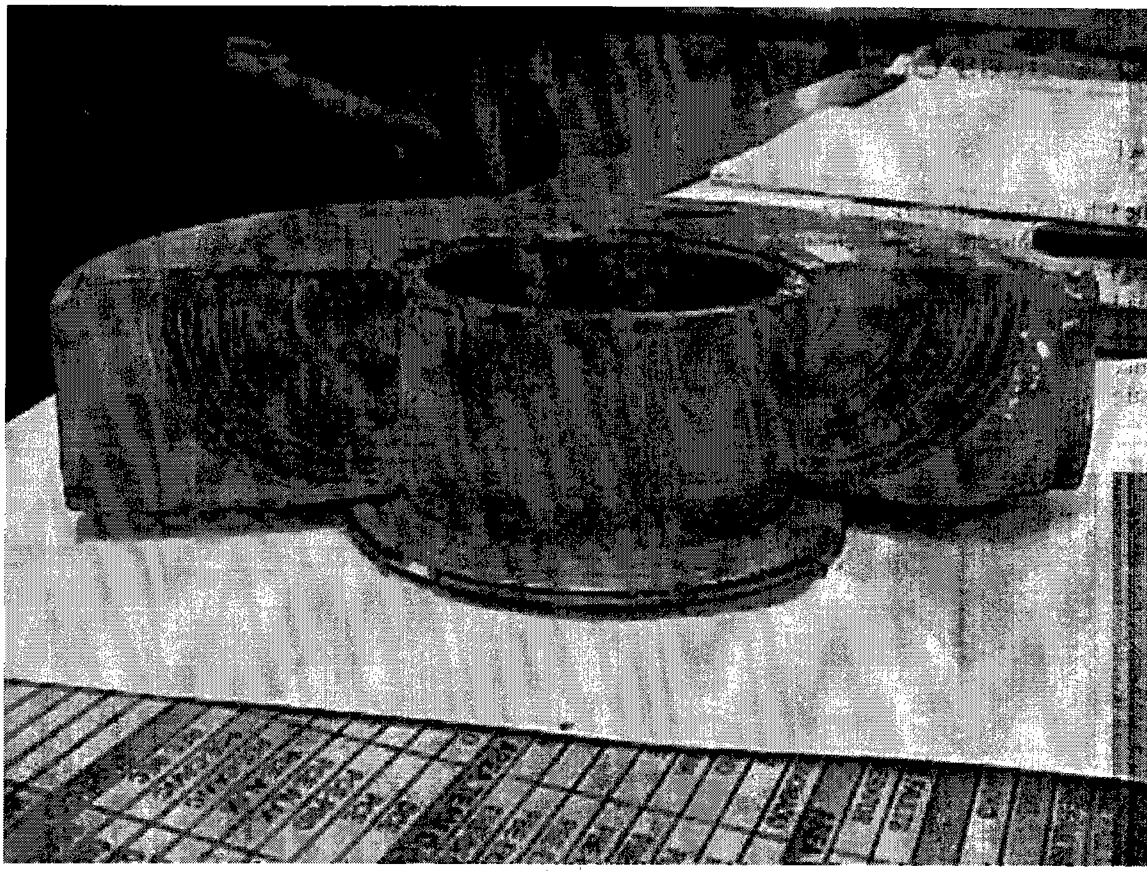

Figure 2 - Cross section of the failed area showing the characteristic "beach marks" of a fatigue failure.

Figure 3 - The Bell 212 following the landing.

The following investigation report was obtained from the NTSB.

The following investigation report highlights the importance of using standard operating procedures and the use of effective CRM techniques.

HISTORY OF FLIGHT

On June 14, 1999, at 2208 Eastern Daylight Time, a Sikorsky S-76A, N2743E, operated by Petroleum Helicopters Incorporated (PHI), was destroyed when it collided with terrain in Jackson, Kentucky. The two certificated commercial pilots and two medical personnel were fatally injured. Instrument meteorological conditions prevailed for the positioning flight, which had departed from Julian Carroll Airport (JKL), Jackson, Kentucky, and was destined for University of Kentucky heliport (37KY), Lexington, Kentucky. The flight was conducted on an instrument flight rules (IFR) flight plan under 14 CFR Part 91.

The flight crew was on the fourth day of a seven-day rotation when the accident occurred. They had logged on duty at 1100.

According to records recovered at the accident site, the helicopter departed 37KY at 1356, and arrived at JKL at 1426. While at JKL, the pilots and medical crew had access to a lounge area for rest. While on the ground, the helicopter was serviced with 35 gallons of Jet-A with prist. According to the airport manager, the pilots refueled the helicopter.

The pilots had a computer with a direct user access terminal system (DUATS) in their flight lounge, which had been used to check weather and file flight plans.

According to records from the Federal Aviation Administration (FAA), the pilot-in-command (PIC) accessed DUATS three times prior to the accident flight.

The first time occurred at 1912, when the pilot requested an abbreviated weather briefing for the State of Kentucky. He specifically requested aviation routine weather reports (METAR) and aerodrome forecasts (TAF). Included was the data on Lexington, Kentucky (LEX) and JKL.

The second contact occurred at 2005. The pilot filed an IFR flight plan for a direct flight from JKL to the LEX VOR. He did not request any weather data.

The third contact occurred at 2121. Again, the pilot requested an abbreviated weather briefing for the State of Kentucky. He specifically requested METARs, and TAFs. The JKL weather included winds calm, visibility 1/2 mile, sky obscured, vertical visibility 100 feet, weather fog, temperature and dewpoint 18 C. The LEX weather was visibility 10 miles, sky clear below 12,000 feet, temperature 24 C, and dewpoint 18 C.

The airport manager observed the flight crew walk to the helicopter. He reported that visibility was reduced by fog and he could not recognize the pilots, but only saw vague shapes as they boarded the helicopter.

At 2154:31, the flight crew checked the JKL automated surface observation system (ASOS). The helicopter was equipped with a cockpit voice recorder (CVR). According to the CVR transcript, the weather recorded by the CVR was: "...Carroll airport Jackson Kentucky. automated weather observation, zero one five four zulu, visibility less than one quarter, fog, sky condition overcast two hundred, temperature one eight Celsius, dewpoint one eight Celsius, altimeter three zero zero six, remarks density altitude one thousand niner hundred...."

Following the weather, which was played through several times, the flight crew proceeded to prepare for an instrument departure. No comments were recorded about the visibility being less than 1/4 mile.

The flight crew made initial radio contact with Indianapolis Air Traffic Control Center, Hazard Radar (AZQ), and at 2159:51, AZQ transmitted, "november ah seven two seven four three echo, you're cleared ah to lexington from julian carroll as filed, climb and maintain four thousand, squawk four two six two, contact indy center on this frequency on departure, and clearance is void if not off by zero two...one zero if not off by zero two one zero then advise center no later than one five of intentions." This was acknowledged and read back by the flight crew.

A certified weather observer at the National Weather Service facility at JKL observed the takeoff and reported:

"...When they rolled onto the runway I walked out to watch them takeoff. At the runway/taxiway intersection, they turned left for runway 19 and pulled up into a hover about 20 feet above the runway. They then proceeded down runway 19. I lost them in the fog about halfway between the taxi/runway intersection and the end of the runway. As a certified weather observer I concur with the ASOS visibility of [less than] <1/4 mile. I estimate that the visibility was about 1/8 of a mile or slightly more...."

At 2205:51, the CVR recorded the pilot-in-command (PIC) transmitting on UNICOM frequency, "...we'll be a uh... south departure right turn we, be uh west out of the area." The airport manager acknowledged this.

At 2206:18, the CVR recorded the second-in-command (SIC) on interphone, "I'm gonna lift to a hover, and we'll un get sixty knots before we get solid in it I guess. Try to keep it within the lights down here." The PIC acknowledged this.

At 2206:51, the PIC stated, "airspeed's alive, positive rate of climb.", and the PIC subsequently said, "your at thirty [knots]", and then "heading one nine zero." This was followed by the PIC stating, "I'm gonna kill the landing....[lights]." The SIC acknowledged this.

At 2207:22, the CVR recorded the PIC on interphone, "and you're at eighty... wanna hold eighty. Or Vbroc [Velocity best rate of climb] rather." The SIC acknowledged this.

At 2207:32, the PIC transmitted, "indy center sikorsky ah two seven four three echo we're ah passing one thousand six hundred for four thousand." AZQ replied, "november two seven four three echo indy center roger, and ah understand climbing to four thousand say altitude leaving.", to which the PIC replied, "one thousand six hundred for ah four thousand." This transmission was acknowledged by AZQ.

At 2207:51, the PIC was heard to say, "go ahead and stay on your heading.", after which two unidentified intercom transmissions were recorded, "alright.", and then, "its ok, you got five hours."

At 2208:03, the PIC stated, "ok your in a right hand turn and descending." There was no acknowledgement from the SIC.

At 2208:05, the SIC stated, "ok I think my gyro just quit." There was no acknowledgement from the PIC.

At 2208:10, the SIC asked, "you have the controls?" There was no acknowledgement from the PIC.

At 2208:11, the PIC stated, "you're in a left hand turn and descending...turn turn back and level level us off. There was no acknowledgement from the SIC.

At 2208:16, the CVR recorded an increase in ambient noise level through the microphone-summing amplifier.

At 2208:18, the PIC stated, "right hand turn.....right hand turn." There was no acknowledgement from the SIC.

At 2208:24, the CVR recorded the initial sound of impact and ceased operation.

A witness located near the accident site reported:

"The sky was foggy...I heard a helicopter coming, it sounded different than normal. I was outside and tried to see it but did not see any lights. Next the sound shifted as it went behind the hill. I then heard a pop in the distance. I knew what happened and jumped in my jeep to go and call 911. It was about 30 to 45 seconds into my trip, about 1/8 of a mile I saw the explosion to my left. I continued and called 911."

In a follow-up interview conducted by a FAA Inspector, the witness explained the helicopter sounded different because it was at a lower than normal altitude.

The accident occurred during the hours of darkness at 37 degrees, 33.945 minutes north latitude, and 83 degrees, 17.462 minutes west longitude.

PERSONNEL INFORMATION

Pilot-In-Command

The PIC held a commercial pilot certificate with rotorcraft-helicopter and instrument helicopter ratings. He was last issued a second class airman medical certificate on January 2, 1999, with a limitation to carry corrective lenses for near vision.

According to employment records from PHI, the pilot had received his initial rotorcraft flight training in the US Army, and was employed by PHI on October 27, 1984. His total flight experience was 6,859 hours, with 2,319 hours in the S-76A. His total instrument flight experience of 382 hours, which included 111 hours in simulators, and 39 hours of actual instrument time.

The PIC's initial checkout in the S-76A was as a SIC in February 1990, with no problems noted. On March 29, 1996, during a 6 month recurrent instrument flight check, one item, Stabilized Approach Concept, was marked U/S. The form noted that the pilot failed to call for a missed approach with the airspeed 25 knots slow. On September 8, 1996, he was upgraded to PIC on the S-76A with no problems noted. On March 30, 1997, the PIC failed a 6-month recurrent instrument flight check. He was rated unsatisfactory in the following areas: use of checklists; emergency procedures; flight planning; ILS approaches; VOR approaches; and missed approach. He took another checkride on March 31, 1997, and passed all items. He subsequently passed checkrides on September 26, 1997, and April 11, 1998, with no problems noted.

The PIC had been in Cleveland, Ohio, and elected to return to Gulf of Mexico flight operations. He transferred to Lafayette, Louisiana, and received offshore training in the S-76A. While there, he received training in the Bell 412, and took a checkride on June 21, 1998. The flight check form showed all areas satisfactory. However, the form also noted that he was only qualified as a SIC, and not as a PIC for the Bell 412. The training form noted several areas of deficiency found during the training. The PIC re-qualified in the S-76A on September 5, 1998, and subsequently transferred to Lexington on October 9, 1998, as a PIC. He took a 6-month instrument flight check on February 8, 1999 with no problems noted.

A review of the PIC's training file with copies of all checkrides from date of employment to date of accident revealed no other discrepancies.

Second-In-Command

The SIC held a commercial pilot certificate with airplane, single and multi-engine land, and rotorcraft helicopter ratings. In addition, he held an instrument rating for airplanes and helicopters. He also held a flight instructor certificate (expired) for single engine land airplanes, and a mechanic certificate with airframe and powerplant ratings. He was last issued a first class airman medical certificate on August 14, 1998. His total flight experience was 7,739 hours with 6,574 hours in helicopters. His total instrument flight experience was 181 hours, which included 92 hours of actual instrument time. He had passed his last instrument flight check on February 7, 1999.

According to employment records from PHI, he was initially hired as a mechanic in 1976. He then participated in a company upgrade program to transition to a pilot. He started flying the Bell 206 in 1982, and subsequently left the company in 1987. He returned to PHI as a pilot on February 23, 1990.

The SIC's initial checkout in the S-76A occurred on May 17, 1997. The upgrade and two subsequent 6-month instrument flight checks, September 27, 1997, and April 4, 1998 were accomplished with no problems noted. On May 30, 1998, the SIC took a PIC checkride in the S-76A. He failed the oral exam and the flight check was not conducted. According to training records, he was weak in several areas related to instrument procedures and flight planning. He took another oral exam on June 1, 1998, and re-qualified in the S-76A as a SIC. He then transferred from Cleveland, Ohio, to Lexington on October 12, 1998. He passed 6-month instrument flight checks on September 16, 1998, and February 7, 1999, with no problems noted.

A review of the SIC's training file with copies of all checkrides from date of employment to date of accident revealed no other discrepancies.

Interviews

Interviews were conducted with other pilots from the Lexington base where the accident pilots were assigned. The interviews disclosed the accident pilots were paired as a team and normally flew with each other. While other pilots had flown with them, it was not on a regular schedule. Both pilots were reported to have demonstrated varying degrees of assertiveness in the cockpit. No negative comments were generated for either pilot. However, one pilot did report that the SIC told him he felt uncomfortable flying with the PIC under IFR conditions. No specifics were given for the reported statement of the SIC.

AIRCRAFT INFORMATION

The helicopter was equipped with three sets of attitude indicators and directional gyros. The primary sets were at each pilot station, and a standby set was located on the center instrument panel. Each cockpit indicator had its own gyro supplying information to the cockpit indicator, and the information could not be shared with another indicator.

PHI operated a fleet of 24 S-76s. According to company records, in the 6 months that preceded the accident, fleetwide, there had been a total of 40 vertical gyro replacements on 15 helicopters, and a total of 11 attitude indicator replacements on 7 helicopters. On N2743E, in the preceding 6 months, there were two attitude indicators, and three vertical gyros replaced. According to company records, fleetwide, in the preceding 6 months, the maximum number of attitude indicators replaced on a helicopter was three, and maximum number of vertical gyros replaced was six.

According to a representative of Sikorsky, the manufacturer of the helicopter, the landing lights will extinguish when the landing gear is unlocked for retraction, and will not illuminate until the landing gear is down and locked. The Chief Pilot of PHI reported that the landing gear lights had not been modified, and worked as described by Sikorsky.

AIDS TO NAVIGATION

The helicopter was equipped with dual very high frequency omni directional radio range (VOR) receivers, distance-measuring equipment (DME), and an IFR approved global positioning navigation system (GPS). The planned departure did not require the pilot to navigate to the Hazard VOR (AZQ). The chief pilot of PHI reported that once airborne from JKL, the Lexington VOR (LEX) would be received and the pilots could navigate towards LEX. AIRDROME INFORMATION (Departure) Julian Carroll Airport (JKL) was an uncontrolled airport on the top of a hill with a published field elevation of 1,381 feet. There was one fixed base operation, which sold fuel and performed minor maintenance.

According to the US Terminal Procedures, Southeast, Volume 1 of 4, takeoff criteria were published for a runway 1 departure due to an obstruction located off the departure end of the runway. However, no criteria were published for a runway 19 departure. The runway was equipped with medium intensity runway edge lights. There was a VOR/DME and GPS Runway 1 approach. The AZQ VOR was located 12.4 nautical miles on a bearing of 172 degrees magnetic. Weather observations were obtained from an on-airport US Weather Bureau Office, and an ASOS.

A check of the fuel supply at the JKL airport revealed that the fuel filter was absent of debris. A check of the underground storage tank for water revealed none present.

FLIGHT RECORDERS

The cockpit voice recorder was recovered and forwarded to the Safety Board vehicle recorder laboratory for readout. After a review of the data, a transcript was made of the departing flight. During the investigation, it was discovered the helicopter was not equipped with a cockpit area microphone (CAM), nor was it required. The helicopter was equipped with continually energized lip microphones at the first and second pilots' stations.

RADAR AND OTHER REMOTELY RECORDED DATA

Radar data was received from Indianapolis Air Traffic Control Center (ARTCC) in the NTAP format. The data was overlaid on a computer generated topographic map. The data revealed the helicopter initially climbed to 1,600 feet, and while turning left, it descended. The final radar contact occurred at 2208:14, at an altitude of 1,300 feet.

WRECKAGE AND IMPACT INFORMATION

On-site investigation revealed the helicopter had impacted rising terrain on a tree-covered slope, at an elevation of about 1,000 feet. The tops of the trees on the top of the ridge were estimated to be about 1,200 feet high. The average slope of the terrain was between 45 degrees and 55 degrees. Broken tree limbs and branches at the accident site were fractured in a 10-15 degree downward attitude, with the left side of the broken branches about 10-15 degrees lower than the right side. The approximate magnetic heading between the broken branches and the debris field at the accident site was 060 degrees magnetic.

The helicopter was fragmented and burned. Debris was spread uphill and along the face of the slope for about 150 feet from the initial impact point. Two heavy items, the main rotor head and transmission were found about 250 feet laterally from the initial impact point.

Two light bulbs, powered by the non-essential electrical bus were found with filament stretch. One was a white navigation light from the tail rotor vertical fin, and the other a logo light from the left side horizontal stabilizer.

Both engines had sustained impact damage. The throttles on the fuel controls were found set to 100 percent on both engines. The compressor and turbine sections of the left engine could be rotated. The right engine could not be rotated. The impellers of both engines had blades that were bent opposite of the direction of rotation. There was no evident of foreign object damage (FOD) in the turbine section of either engine.

The main rotor head had separated from the helicopter. Three of the spindles for blades were present. All blades were broken off within 12 inches of their respective blade grip. One blade spindle had separated from the rotor hub and was recovered at the accident site. The internal shaft between the spindle and hub was bent opposite of the direction of rotation on the missing spindle. All dynamic counterweights from the rotor head were accounted for at the accident site. All pitch link control rods were fractured.

The main transmission was fractured open and the faces of several gears were visible. The transmission was rotated and gear continuity for the gears present was confirmed. The "bull" gear had been ejected from the transmission during the breakup, and was recovered in the debris field. The freewheeling clutches for power input from the engines were checked and found to freewheel in one direction, and apply torque to the transmission in the opposite direction.

A short section of tail rotor drive shaft, which had received impact damage, was identified. The intermediate gearbox was identified with short sections of drive shaft on each end. When the drive shafts were rotated, the opposite ends moved. The 90-degree gearbox with remnants of the tail rotor blades was recovered.

Force applied to the tail rotor drive shaft rotated the gearbox and tail rotor control head.

Breakup of the helicopter precluded a check of flight control continuity.

MEDICAL AND PATHOLOGICAL INFORMATION

The toxicological testing report from the FAA Toxicology Accident Research Laboratory, Oklahoma City, Oklahoma, was negative for drugs and alcohol for both the PIC and SIC.

Autopsies were conducted on the occupants by the Office of the Associate Chief Medical Examiner, Frankfort, Kentucky, on June 16 - 17, 1999.

TESTS AND RESEARCH

Safety Board Materials Laboratory

Several items were retained and forwarded to the Safety Board Materials Laboratory for further examination. According to the metallurgists factual report:

"The submitted instruments were examined with a bench binocular microscope. Examination of the needle indicator for the attitude direction indicator (item 7) showed that it was pointing to a position between level flight and a 2-degree right roll when received. Disassembly of the housing for item 7 revealed no further transfer marks with regard to the position of the artificial horizon. No transfer mark was found on the faceplate of the other instruments that would have specifically indicated the position of a needle or attitude with respect to a faceplate."

According to the examination of the caution/advisory panel:

"...The examination disclosed that no elongation was found in any of the light bulb filaments...."

Global Positioning System - Trimble

The global positioning system (GPS) was forwarded to Trimble, the manufacturer for examination. According to their report, the system was on and tracking. The following information was obtained.

Database - Current at time of accident, expired by time of GPS examination.
Last Update - June 14, 1999 - 2208:36.422.
Last Position - 37,33.944N latitude and 83, 17.488W longitude.
Distance and Bearing to JKL Airport - 2.09 NM at 329 degrees.

ADDITIONAL INFORMATION

PHI operated two medivac helicopters from the University of Kentucky Hospital heliport. One helicopter (UK1) remained at the heliport and was on call 24 hours a day. The second helicopter (UK2) was on a 12-hour contract. The flight crew would report for duty at 1100, and go off duty at 2300. During the on-call time, the helicopter would be positioned at JKL. Prior to going off duty, the flight crew would return the helicopter to 37KY. Normal manning for each helicopter was two pilots, and two medical personnel.

PHI Air Taxi Operations Manual

Examination of the manual found it applied to 14 CFR 135 flights, and there was no guidance for flights that were conducted under 14 CFR Part 91. In a telephone interview, the Chief Pilot reported that he expected his pilots to follow the guidance contained in the Air Taxi Operations Manual, even if the flight was being conducted under 14 CFR Part 91.

Interviews conducted with captains and co-pilots at the Lexington base, revealed they all believed the IFR section of the manual, including takeoff minimum's would apply even to positioning flights that were conducted under 14 CFR Part 91. When questioned, several pilots pointed out this was covered as a regular part of the their recurrent training.

IFR Takeoff Criteria

According to the section for IFR Operations, the following criteria were published for IFR takeoff when the departure airport had visibility less than the published landing minimum's.

"...1/4 statute mile or Touchdown-Zone RVR 1200 may be used, if either HIRL [High Intensity Runway Lights], CL [Centerline Lights], RCLM [Runway Centerline Markings], or adequate visual reference to continuously identify the takeoff surface of the runway and maintain directional control throughout the take-off run is available."

In the Air Taxi Operations Section, the following was found:

"Transfer of Controls"

"Transfer of aircraft control will be positive with the statement, 'You have the controls', 'I have the controls'. Do not use the phrase, 'I have it.'"

"Crew Cross-Checking"

"The PNF [pilot not flying] must, without hesitation, call attention to deviations outside given tolerances or procedures. The PF [pilot flying] must invite and accept cross-monitoring, and cross-checking. The keys to advanced crew coordination are mutual confidence, early detection, immediate verification, and correction of error. The crew must work together, avoiding overconfidence or complacency."

In the IFR Operations Section, Stabilized Approach Concept, the following was found:

"any time two unstabilized missed approach callouts are unanswered, the PNF shall assume that the PF is incapacitated and shall take the controls and execute the missed approach."

The concept of taking the controls after two unanswered callouts was only found in the stabilized approach section.

Cockpit Resource Management Training

PHI developed their own cockpit resource management (CRM) training program. The training consisted of video presentations and handouts. Both pilots had received initial and recurrent CRM training. Included in the training were several scenarios directed toward the assertiveness of pilots, working as a team in the cockpit, and monitoring each other's actions. The training also included exposing them to situations where the non-flying would monitor the flying pilot's actions to the extent that transfer of control could always take place if needed.

6. ATSB Website

The ATSB website, **http://www.atsb.gov.au**, now incorporates the BASI website. The website now provides an online notification facility. Operators and individuals can submit mandatory occurrence notifications quickly and easily. The submitted information is encrypted and an immediate acknowledgement of receipt is issued. Online notification continues to be an effective communication channel into the aviation industry. The online notification form can be found at **https://www.basi.gov.au/m3vco6t/notiffrm.cfm** or alternatively you can use the link on the homepage to go directly to the notification form.

The website contains finalised accident and incident reports ranging from high-profile investigations to less serious occurrences that may still have safety significance.

The site also contains outputs such as safety deficiencies, interim recommendations, recommendations, safety advisory notices and safety programs research reports. The Regional Airlines Safety Bulletin is produced concurrently on the website.

Pages covering Confidential Aviation Incident Reporting (the CAIR program), accident statistics, short industry advisories and topical magazine articles such as 'Black Boxes' are also presented.

The site carries organisation and methodology information about Bureau operations, annual reports, contact details and links to related sites.

Aviation-oriented web users may wish to check the site frequently as new information is added to the site on most working days.

Air Safety Accident or Incident Reporting form

This Air Safety Accident or Incident Reporting form is to be used to report all occurrences. Accidents and serious incidents which affect the safety of aircraft must, in the first instance, be reported to ATSB by telephone **1800 011 034** free call.

When you have completed the report, please forward it to ATSB by one of the methods detailed below.

The Australian Transport Safety Bureau collects information for the purposes of enhancing aviation safety. The information is collected under the authority of sections 19BA and 19BC of Part 2A of the *Air Navigation Act 1920*. AIP also refers.

No postage stamp is required if this form and any other material are mailed.

RETURN TO ATSB
Mail address:
Reply Paid 50
Australian Transport Safety Bureau
PO Box 967
Civic Square, ACT 2608

Contact telephone number:
Australia-wide 24-hour toll-free
1800 011 034

Facsimile number:
(02) 6274 6434

Website:
Incidents may be notified on-line through:
www.atsb.gov.au

Air Safety Accident or Incident Report

ATSB
Australian Transport Safety Bureau

Particulars:

Date of accident | Local time | Location e.g. 27 NM west of Bowral, NSW (include latitude & longitude if possible)

Aircraft registration | Flight number | Aircraft manufacturer and model

Family name and initials of pilot in command | Type of licence held | Licence number

Enclose additional crew details where applicable.

Aircraft operator e.g. company name | Aircraft owner | Aircraft hirer (if any)

Type of operation:

- ☐ Air transport – passenger
- ☐ Flying training – solo
- ☐ Businesses
- ☐ Gliding
- ☐ Sports aviation
- ☐ Air transport – cargo
- ☐ Flying training – dual
- ☐ Agricultural
- ☐ Private
- ☐ Military
- ☐ Charter
- ☐ Other

Flight rules:

☐ VFR ☐ IFR

Flight conditions:

☐ VMC ☐ IMC

Number of persons on board:

☐ Crew ☐ Passengers

Number of injuries resulting from occurrence:

☐ Fatal ☐ Serious ☐ Nil/minor

Weather conditions:

Visibility | Wind | Cloud | Altitude of occurrence

Last departure point of flight | Time of departure (Local) | Next intended point of landing

Briefly describe aircraft damage

Indicate the phase in which the occurrence happened:

☐ Aircraft standing ☐ Taxiing ☐ Takeoff ☐ En-route ☐ Manoeuvring ☐ Approach ☐ Landing

Airspace designation

Please fully describe the accident or incident:

All relevant documentation should be forwarded to BASI. Include your suggestions as to how this type of occurrence could be prevented.

Please enclose additional page/s as necessary

Your name | **Date**

Address

Telephone | **Facsimile** | **Internet email**

When complete, post to: Reply Paid 50, ATSB, PO Box 967, Civic Square, ACT 2608. No postage stamp required.

Confidential Aviation Incident Reporting form

This Confidential Aviation Incident Reporting form may be used instead of the yellow Air Safety Accident or Incident Report form to report an incident or a safety deficiency (not accident) if the reporter has a particular reason to seek confidentiality.

When you have completed the report, please forward it to CAIR by one of the methods detailed below.

The Australian Transport Safety Bureau collects information for the purposes of enhancing aviation safety. The information is collected under the authority of section 19BA and 19BC of Part 2A of the *Air Navigation Act 1920.*

The Director of Air Safety Investigation (ATSB) guarantees to keep your identity confidential. Your personal details will not be recorded and receipt of your report will be acknowledged.

To enable us to contact you for clarification of details, to discuss what action to take on this report, to determine how best to de-identify your report, and acknowledge receipt, please provide your name and contact details.

Do not include contact details (such as a work phone number) that you do not wish us to call you on and please indicate if we are not to leave a message on an answering machine. Include the best times for phone contact.

No action is taken on anonymous reports.

No postage stamp is required if this form and any other material are mailed.

RETURN TO ATSB
Mail address:
Reply Paid 22
The Manager
PO Box 600
Civic Square, ACT 2608

Contact telephone number:
Australia-wide 24-hour toll-free
1800 020 505

Facsimile number:
(02) 6274 6461

Internet email:
cair@atsb.gov.au

Confidential Aviation Incident Report

ATSB
Australian Transport Safety Bureau

Particulars:

Date of Incident | Local time | Location e.g. 27 NM west of Bowral, NSW (include latitude & longitude if possibl

Aircraft registration | Flight number | Aircraft manufacturer and model

Your position (e.g. pilot, ATS, LAME, FA) | Pilot. Your total hours | Non-pilot experience yr/mth

Aircraft operator e.g. company name | Aircraft owner | Aircraft hirer (if any)

Type of operation:

- [ ] Air transport – passenger
- [ ] Flying training – solo
- [ ] Businesses
- [ ] Gliding
- [ ] Sports aviati
- [ ] Air transport – cargo
- [ ] Flying training – dual
- [ ] Agricultural
- [ ] Private
- [ ] Military
- [ ] Charter
- [ ] Other

Flight rules:

- [ ] VFR
- [ ] IFR

Flight conditions:

- [ ] VMC
- [ ] IMC

Number of persons on board:

- [ ] Crew
- [ ] Passengers

Weather conditions:

Visibility | Wind | Cloud | Altitude of occurrence

Last departure point of flight | Time of departure (Local) | Next intended point of landing

Indicate the phase in which the occurrence happened:

- [ ] Aircraft standing
- [ ] Taxiing
- [ ] Takeoff
- [ ] En-route
- [ ] Manoeuvring
- [ ] Approach
- [ ] Landin

Airspace designation

Please fully describe the occurrence:
All relevant documentation should be forwarded to CAIR. Include your suggestions on how to prevent similar occurrences.

Please enclose additional page/s as necessar

Your name | **Date**

Address

Telephone | **Facsimile** | **Internet email**

When complete, post to: Reply Paid 22, The Manager, PO Box 600, Civic Square, ACT 2608. No postage stamp required.

May 2000