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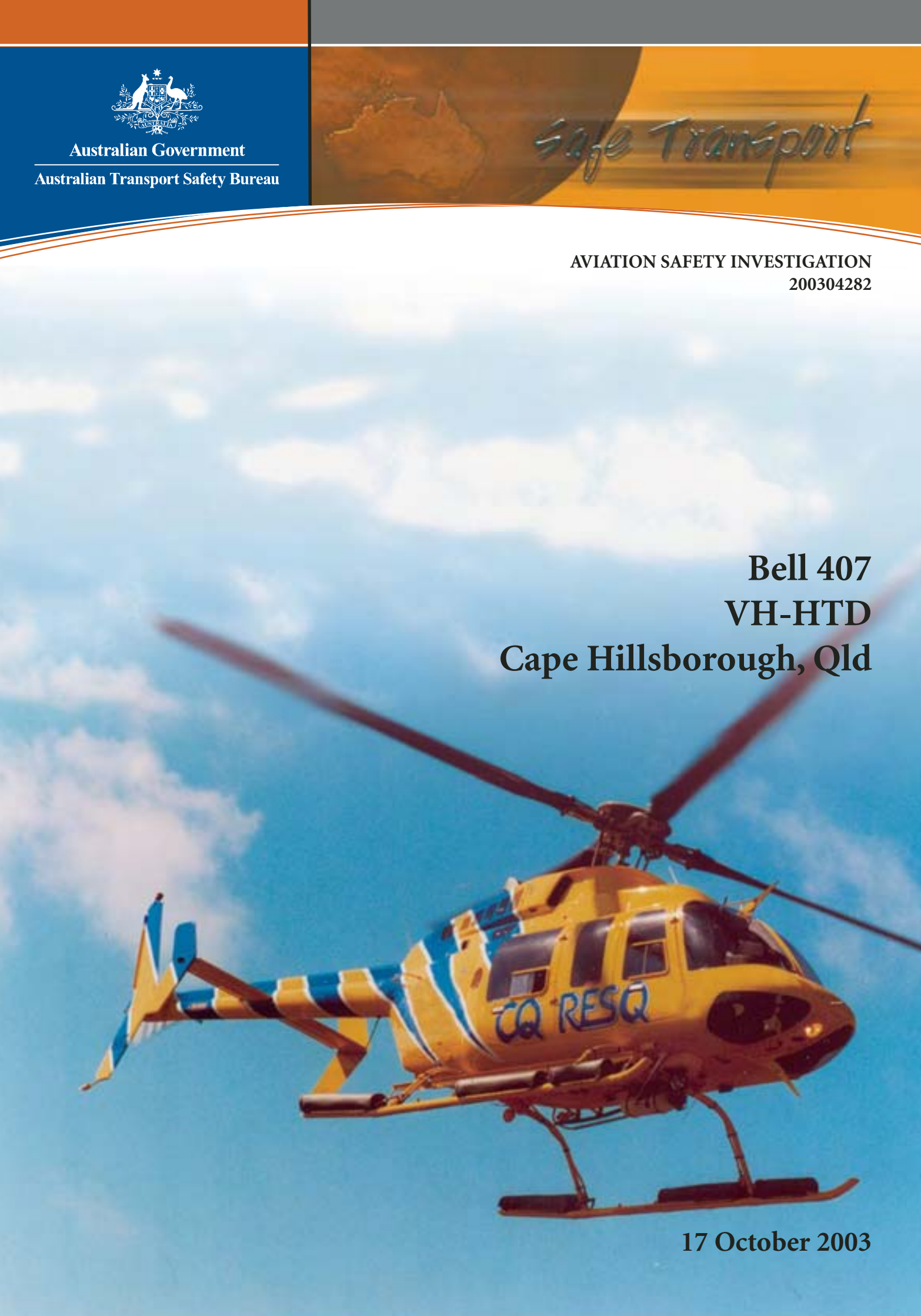
Australian Transport Safety Bureau

Safe Transport

AVIATION SAFETY INVESTIGATION
200304282

Bell 407
VH-HTD
Cape Hillsborough, Qld



17 October 2003

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Media release

Final ATSB report into fatal EMS helicopter accident near Mackay, Qld.

The ATSB's final report into the tragic helicopter accident near Mackay that killed all three crewmembers found that spatial disorientation of the pilot was likely and includes a number of safety recommendations to prevent a recurrence.

The Bell 407 helicopter, operating under the night Visual Flight Rules (VFR), was en-route from Mackay to Hamilton Island, to pick up a patient, when it crashed into the sea.

The report found that the circumstances of the accident combined most of the risk factors known to be associated with helicopter Emergency Medical Services (EMS) accidents. These included pilot experience and training, organisational and operating environment issues.

While the ATSB could not conclusively determine why the helicopter departed controlled flight, it found that spatial disorientation of the pilot in dark night conditions over water was likely.

As a result of the investigation, safety improvements related to helicopter EMS operations, particularly operations at night, have been taken or are planned by the organisations involved in the operation and oversight of the flight.

These include:

- a revision of standard operating procedures for helicopter emergencies and the requirement for pilots to hold a command instrument rating, have received crew resource management training
- the establishment of centralised clinical coordination and tasking of aero-medical operations for Southern Queensland through a centre in Brisbane with a parallel system planned for North Queensland by July 2005.

The ATSB is bringing this report to the attention of the Australian Health Ministers' Advisory Council and copies of the report (Aviation Safety Investigation Report 200304282) can be downloaded from the internet site at www.atsb.gov.au, or obtained from the ATSB by telephoning (02) 6274 6478 or 1800 020 616.

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INTRODUCTION

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal Bureau within the Australian Government Department of Transport and Regional Services. ATSB investigations are independent of regulatory, operator or other external bodies.

The ATSB is responsible for investigating accidents and other safety occurrences involving civil aircraft operations in Australia, as well as participating in overseas investigations involving Australian registered aircraft. A primary concern is the safety of commercial air transport, with particular regard to fare-paying passenger operations. Accordingly, the ATSB also conducts investigations and studies of the aviation system to identify underlying factors and trends that have the potential to adversely affect safety.

The ATSB performs its aviation functions in accordance with the provisions of the Transport Safety Investigation Act 2003. The object of an occurrence investigation is to determine the circumstances to prevent other similar events. The results of these determinations form the basis for safety action, including recommendations where necessary. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations.

It is not the object of an investigation to determine blame or liability. However, it should be recognised that an investigation report must include factual material of sufficient weight to support the analysis and conclusions reached. That material will at times contain information reflecting on the performance of individuals and organisations, and how their actions may have contributed to the outcomes of the matter under investigation. At all times the ATSB endeavours to balance the use of material that could imply adverse comment, with the need to properly explain what happened, and why, in a fair and unbiased manner.

Central to ATSB's investigation of aviation occurrences is the early identification of safety deficiencies in the civil aviation environment. While the Bureau issues recommendations to regulatory authorities, industry, or other agencies in order to address safety deficiencies, its preference is for organisations to make safety enhancements during the course of an investigation. The Bureau is pleased to report positive safety action in its final reports rather than make formal recommendations. Recommendations may be issued in conjunction with ATSB reports or independently. A safety deficiency may lead to a number of similar recommendations, each issued to a different agency.

The ATSB does not have the resources or role to carry out a full cost-benefit analysis of each recommendation. The cost of a recommendation must be balanced against its benefits to safety, and aviation safety involves the whole community. Such analysis is a matter for the body to which the recommendation is addressed (for example the Civil Aviation Safety Authority in consultation with the industry).

The 24-hour clock is used in this report to describe the Mackay, Queensland local time of day, Eastern Standard Time (EST), as particular events occurred. Eastern Standard Time was Coordinated Universal Time (UTC) + 10 hours.

ABBREVIATIONS

ACC	Ambulance Communication Centre
AD	Airworthiness Directive
AFM	Aircraft Flight Manual
AIP	Airservices Australia Aeronautical Information Publication
AMSL	Above Mean Sea Level
ATSB	Australian Transport Safety Bureau
AusSAR	Australian Search and Rescue
BoM	Australian Bureau of Meteorology
CAAP	Civil Aviation Advisory Publication
CASA	Civil Aviation Safety Authority
CHC	Canadian Helicopters Corporation (Australia)
CHP	Community Helicopter Provider
CQ RESQ	Central Queensland Helicopter Rescue Service Ltd.
DME	Distance Measuring Equipment
E	East
ENR	Enroute
EST	Eastern Standard Time
FAA	Federal Aviation Administration (US)
FAR	Federal Aviation Regulation (US)
ft	Feet
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
HEMS	Helicopter Emergency Medical Service
JAR	European Joint Aviation Regulation
km	Kilometre
kts	Knots
LSALT	Lowest Safe Altitude
m	Metre
MBZ	Mandatory Broadcast Zone
NM	Nautical Mile (1 NM = 1.85 kilometres)
NPRM	Notice of Proposed Rule Making
NOTAM	Notice to Airmen
NTSB	National Transportation Safety Board
OPS	Operations
PIC	Pilot in Command
PSI	Pounds per Square Inch
QNH	Airfield Barometric Pressure
SARTIME	Search and Rescue Time
SB	Service Bulletin
S	South
SOP	Standard Operating Procedures
US	United States
UTC	Coordinated Universal Time
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions

EXECUTIVE SUMMARY

On the evening of 17 October 2003, an air ambulance Bell 407 helicopter, registered VH-HTD (HTD), being operated under the 'Aerial Work' category, was tasked with a patient transfer from Hamilton Island to Mackay, Queensland. The crew consisted of a pilot, a paramedic and a crewman. Approximately 35 minutes after the departure of the helicopter from Mackay, the personnel waiting for the helicopter on the island contacted the Ambulance Coordination Centre (ACC) to ask about its status. ACC personnel then made repeated unsuccessful attempts to contact the helicopter before notifying Australian Search and Rescue (AusSAR), who initiated a search for the helicopter. AusSAR dispatched a BK117 helicopter from Hamilton Island to investigate. The crew of the BK117 located floating wreckage, that was later confirmed to be from HTD, at a location approximately 3.2 nautical miles (NM) east of Cape Hillsborough, Queensland. There were no survivors.

Following 12 days of side scan array sonar searches, underwater diving and trawling, the main impact point and location of heavy items of wreckage were located. The wreckage was recovered and examined at a secure on-shore location.

Although the forecast weather conditions did not necessarily preclude flight under the night Visual Flight Rules (VFR), the circumstances of the accident were consistent with pilot disorientation and loss of control during flight in dark night conditions. The effect of cloud on any available celestial lighting, lack of a visible horizon and surface/ground-based lighting, and the pilot's limited instrument flying experience, may have contributed to this accident. Although not able to determine with certainty what factors led to the helicopter departing controlled flight, the investigation determined that mechanical failure was unlikely.

The circumstances of the accident combined most of the risk factors known for many years to be associated with helicopter Emergency Medical Services (EMS) accidents, such as:

Pilot factors

- the pilot was inexperienced with regards to long distance over water night operations out of sight of land and in the helicopter type
- the pilot did not hold an instrument rating and had limited instrument flying experience
- the pilot was new to the organisation and EMS operations.

Operating environment factors

- the accident occurred on a dark night with no celestial or surface/ground-based lighting
- the flight path was over water with no fixed surface lit features
- forecast weather in the area of the helicopter flight path included the possibility of cloud at the altitude flown.

Organisational factors

- a number of different organisations were involved in providing the service
- the operation was from a base remote from the operator's main base
- actual or perceived pressures may have existed to not reject missions due to weather or other reasons
- an apparent lack of awareness of helicopter EMS safety issues and helicopter night VFR limitations

- divided and diminished oversight for ensuring safety
- no single organisation with expertise in aviation having overall oversight for operational safety.

As a result of the investigation, safety recommendations were issued to the Civil Aviation Safety Authority recommending: a review of the night VFR requirements, an assessment of the benefits of additional flight equipment for helicopters operating under night VFR and a review of the operator classification and/or minimum safety standards for helicopter EMS operations.

Following the accident, the Queensland Department of Emergency Services took initiatives to implement:

- increased safety standards in the Generic Service Agreements to Community Helicopter Providers (CHP) to include increased pilot recency and training requirements, a pilot requirement for a Command Instrument Rating, crew resource management training, a Safety Management System and a Safety Officer
- the recommendations of the reviews associated with the aeromedical system/network
- the establishment of a centralised clinical coordination and tasking of aeromedical aircraft and helicopters for Southern Queensland[1], including all CHP state-wide through a centre in Brisbane, with a parallel system planned for all Northern Queensland by July 2005
- the establishment of a requirement for a safe arrival broadcast for flights of less than 30 minutes duration and the nomination of a SARTIME for all flights
- the revision of the standard operating procedures for helicopter emergencies to attempt to establish communication with an aircraft when lost for a maximum 5 minute period, then immediately contacting AusSAR
- the establishment of a requirement for CHP to provide updated contact/aircraft details on a bi-annual basis and amend the standard operating procedures containing this information accordingly
- a requirement for CHP operations to ensure sufficient celestial lighting exists for night VFR flights to maintain reference to the horizon.

1 Which commenced on 1 August 2004.

1. FACTUAL INFORMATION

1.1 History of the flight

On the evening of 17 October 2003, at 2103 Eastern Standard Time, personnel located at the medical clinic on Hamilton Island, Queensland contacted the clinical coordinator on duty at Mackay Base Hospital to report that they had a patient who required transfer to the mainland for medical attention. The patient had sustained a fractured leg and possible neck injuries from a vehicle accident on the island. The clinical coordinator requested the use of a helicopter through the Queensland Department of Emergency Services Queensland Ambulance Service Communications Centre (ACC), for the transfer of the patient to the Mackay Base Hospital on the mainland. ACC personnel telephoned the standby duty pilot and asked about the feasibility of a flight to Hamilton Island. The pilot responded that the flight to the island and return was possible. ACC personnel then contacted the standby duty in-flight paramedic, and requested that he proceed to the airport.

At about 2132, a Bell 407 helicopter, registered VH-HTD (HTD) departed Mackay Airport enroute to Hamilton Island with the pilot, a crewman[2] and the paramedic[3] on board. The flight to Hamilton Island was conducted under the night Visual Flight Rules (VFR) rules. At 2137, the pilot contacted the ACC by radio and informed them that he was 'on case'. ACC personnel acknowledged this report. Shortly thereafter, the pilot again contacted the ACC and announced that they had departed Mackay enroute for Hamilton Island with three persons on board, with an estimated time of arrival of 2207. ACC personnel acknowledged his report. No other communication was received from the helicopter crew for the remainder of the flight. Figure 1 represents the projected helicopter track in blue and the actual track in red.

FIGURE 1: Track to Hamilton Island

2 The crewman's role was to assisting with loading and unloading the patient and to operate the rescue hoist if required.

3 The paramedic's role was to stabilise and attend to the patient during transfer.

At approximately 2217, the personnel waiting for the helicopter on the island contacted the ACC by phone to query the status of the helicopter. ACC personnel then made repeated unsuccessful attempts to contact the helicopter both by radio and by telephone to the on-board mobile phone. At 2239, ACC personnel contacted Australian Search and Rescue (AusSAR) and notified them that the helicopter was overdue.

AusSAR then initiated a search for the overdue helicopter. At 2330, VH-BKE (BKE), an instrument flight rules (IFR), autopilot equipped, BK117 helicopter with two pilots and two crewmembers on board, departed Hamilton Island enroute to the last reported radar position for HTD. At 0010 on 18 October 2003, the crew of BKE reported sighting a possible strobe light in the water. At 0040, the crew of BKE confirmed sighting a large piece of wreckage floating in the water approximately 3.2 NM south-east of Cape Hillsborough at co-ordinates 20°56′931 S, 149°06′338 E. At 0133, a rescue boat reported being at the site of the floating wreckage and beginning a search for survivors. Following the arrival of the rescue boat, BKE returned to Hamilton Island due to fuel limitations. The rescue boat's crew was unable to locate any survivors.

1.1.2 Wreckage location and recovery

The ATSB supervised search for the wreckage over 12 days eventually located the main impact point (and heavy wreckage items) at co-ordinates 20°56′478 S, 149°06′319 E. The wreckage was localised and contained within an approximate 20 m diameter area on the ocean floor. Floating wreckage, the tail rotor and tail boom section, that had been moved by ocean currents, were recovered at co-ordinates 20°56′460 S, 149°06′325 E. The main rotor transmission, main rotor head, and sections of the main rotor transmission deck were initially caught in a trawler recovery net, but during the lift from the seabed floor, damaged the nets (as a result of rough sea states) and fell back into the water. These items were not able to be located again despite several additional days of searching. The wreckage was removed to a secure location on land for examination by the ATSB. Figure 2 represents the expanded track of the helicopter along with the locations of the wreckage and the last recorded radar position (final radar return).

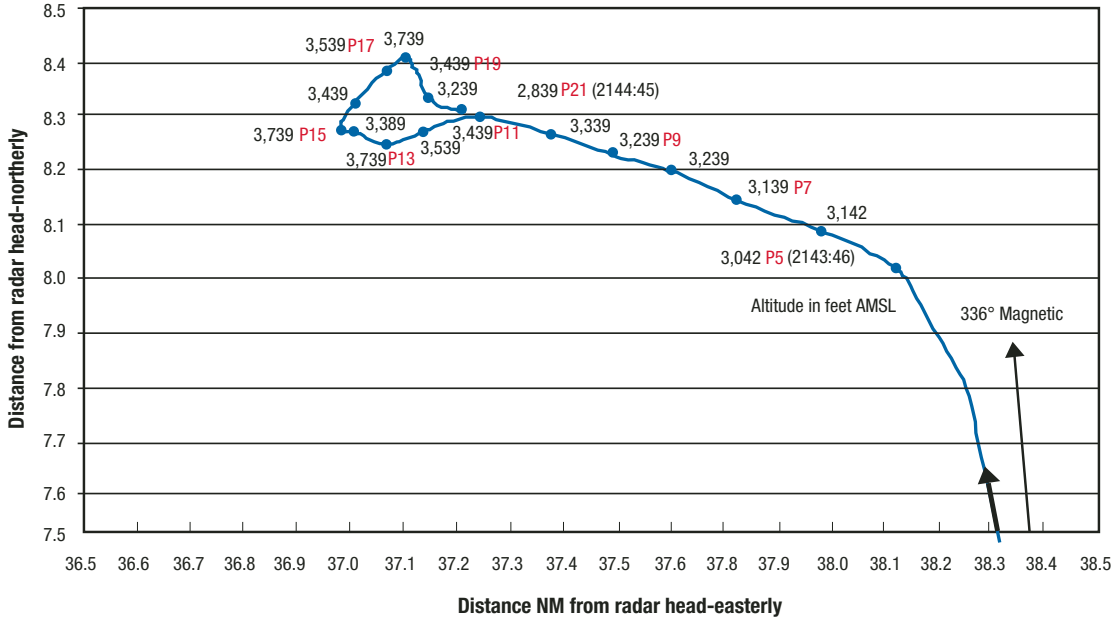
FIGURE 2: Map of projected and actual flight path and impact location

1.1.3 Radar information

Radar data for the Mackay area at the time of the accident was examined. The Swampy Ridge radar site[4] provided radar coverage in the Mackay area and was located approximately 40 NM west of the Mackay Airport. The radar site was at an elevation of 1,141 m (3,743 ft) above mean sea level (AMSL) and had a nominal range of 250 NM. Data from this radar site was recorded at the Airservices Australia Brisbane Centre Operations.

HTD was equipped with a transponder[5]. An observed radar image of HTD was recorded from 2134:54 to 2144:45, a duration of 9 minutes and 51 seconds. The first image of HTD was recorded at an altitude of 100 ft as HTD departed the vicinity of Mackay Airport. The pilot of HTD then initiated a right climbing turn to approximately 3,000 ft, on a track of 336 degrees magnetic in the direction of Hamilton Island. An expanded version of the recorded radar track data for the last 75 seconds of the flight is included in Figure 3.

FIGURE 3: HTD radar track last 75 seconds[6]



HTD then remained on track, varying in altitude from 2,800 to 3,100 ft until at 2143:46 (refer to Figure 3), position P5, it commenced a left turn at a rate of approximately 5 degrees magnetic per second until the heading had changed through approximately 60 degrees magnetic. A track of approximately 299 degrees magnetic was then maintained for 25 seconds, with the altitude varying from 3,000 ft to 3,400 ft. At 2144:08, position P11, HTD climbed to approximately 3,439 ft and banked left towards the mainland, on to a heading of about 260 degrees magnetic. HTD then continued to climb through 3,500 ft until 2144:16, position P13, when it turned right to a heading of about 290 degrees magnetic. Following a climb to 3,839 ft, HTD turned right to

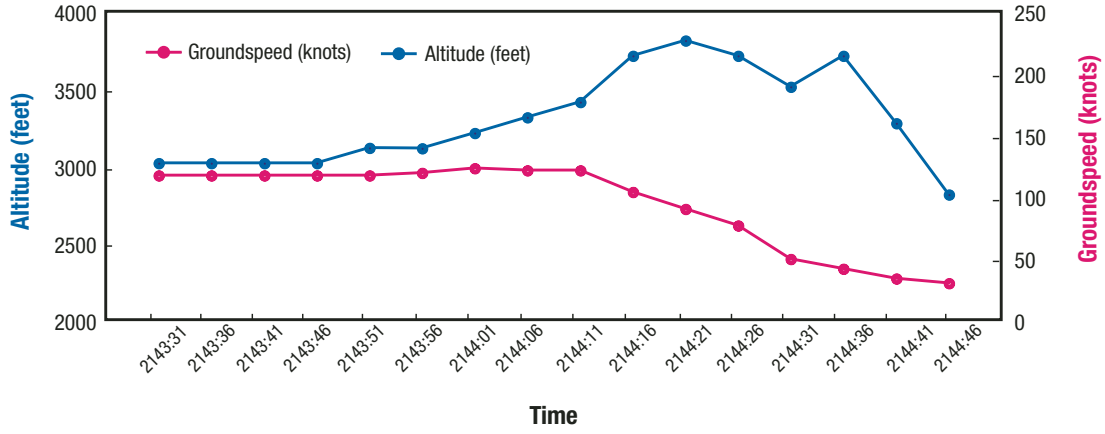
4 The Swampy Ridge site was a secondary surveillance radar unit. Secondary surveillance radar returns are dependent on the transponder in the aircraft replying to an interrogation from the ground.

5 A transponder is an electronic sending and receiving unit in helicopters or aircraft that transmits an encoded pulse train containing the secondary surveillance radar code, and other data. Pressure altitude was also encoded with these pulses with an accuracy of plus or minus 100 ft.

6 The radar rotated at 16.2 RPM, meaning the helicopter's position was updated every 3.7 seconds. The radar returns were subject to the accuracy limitations of the radar systems. During normal helicopter operation, it is reasonable to assume that the helicopter tracks smoothly from one return to the next. Under dynamic conditions such as uncontrolled flight, this assumption may not be valid.

040 degrees magnetic, position P15, and flew a heading of about 040 degrees magnetic for 12 seconds. At 2144:34, position P18, HTD turned right to a heading of 164 degrees magnetic and, over the next 16 seconds descended to 2,800 ft. At 2144:45, position P21, radar contact with HTD was lost. HTD was descending at the time radar contact was lost. The location of the last radar contact was at co-ordinates 20°56′556 S, 149°06′183 E (refer to Figure 4). Appendix A contains further details on the helicopter's radar track. Figure 4 displays the helicopter's altitude and groundspeed for the same timeframe.

FIGURE 4: HTD altitude and groundspeed profile



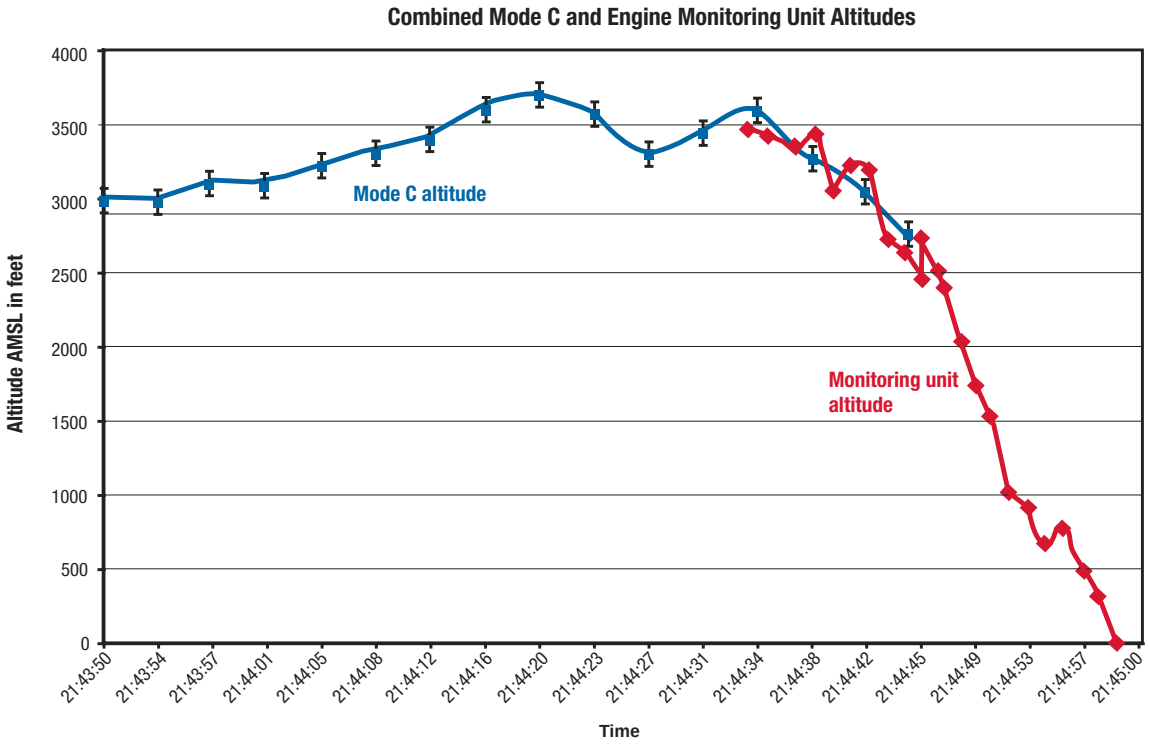
1.1.4 Other altitude information

The helicopter was equipped with a digital electronic engine monitoring unit. This unit logged pressure altitude as well as other parameters, to assist in engine starting at varying elevations. The unit was recovered and information was retrieved from a non-volatile memory chip within the unit. The recorded ambient pressure was sourced from an open port on the unit. The port was not connected to a helicopter instrumentation static pressure line. Given its location, it was susceptible to the pressure fluctuations due to airflow from the main rotor. The final pressure altitude value obtained from the unit was about 850 ft. This value was interpreted as the approximate sea level value, allowing for the sampling interval of 1.2 seconds.

Radar altitude data received from the Mode C altimeter[7] on the helicopter was time-stamped with coordinated universal time (UTC), which was synchronized with a satellite global positioning system (GPS). Unit data was time-stamped with elapsed time relative to the unit events. As these two time sources were not synchronized, an overlap of the two data sets was developed. Overlaying the Mode C altimeter data (from radar) and unit pressure altitude data, showed that a good match was obtained when the unit altitude was offset by –850 ft and the end of the Mode C radar data was overlapped by the start of the engine monitor data. The duration of the overlap was approximately 11 seconds. The tolerance of the duration of the overlap was considered to be ± 2 seconds. Figure 5 displays the helicopter's Mode C altimeter data overlayed onto the pressure altitude data from the engine monitoring system.

7 Mode C replies used by radar indicate aircraft altitude and are taken automatically from the aircraft's barometric altimeter and transmitted by the transponder.

FIGURE 5: Chart of mode C altimeter and engine monitoring unit data overlay



Once recorded radar confirmation ceased at time stamp 2144:46, using the interpreted data from the engine monitoring unit and the radar overlay, it was determined that the helicopter initiated an extreme rate of decent culminating in impact with the water. For further information on the engine monitoring unit refer to section 1.19.

1.2 Injuries to persons

Injuries	*Crew*	*Passengers*	*Others*	*Totals*
Fatal	3	-	-	3
Serious	-	-	-	-
Minor	-	-	-	-
None	-	-	-	-

1.3 Damage to helicopter

High speed impact damage destroyed the helicopter's cockpit and cabin structure. The tail boom, main rotor assembly and main transmission assembly separated during the impact sequence. Figure 6 displays portions of the wreckage recovered to the salvage vessel.

FIGURE 6: Recovery of wreckage

1.4 Other damage

Nil.

1.5 Pilot in command information

Type of licenses	Air transport pilot licence (ATPL) (helicopter), commercial pilot licence (CPL) (helicopter)
Medical certificate	Class 1 and 2 (no restrictions)
Flying experience (total hours)	2,570.3
Hours on type	46.1
Hours flown in the last 24 hours	0.9
Hours flown night VFR	149.4
Hours flown instruments	12.0
Hours flown in the last 7 days	4.1
Hours flown in the last 90 days	61.9

1.5.1 Pilot qualifications and ratings

The pilot held a night VFR rating[8] with Non-directional Beacon (NDB), VOR[9], GPS endorsements, and a Grade 1 and 2 Instructor (helicopter) single-engine rating.

The pilot was endorsed in accordance with Section 40.3.0 of the Civil Aviation Orders (CAO) to fly Bell 206 and Bell 407 model helicopters. He held further endorsements on the Robinson R22 and R44, Hughes 269B/C, Hughes 500, MD520 and AS350 model helicopters.

1.5.2 Pilot night VFR experience and training

The pilot had received his initial night VFR rating on 18 February 2000. He had completed a night VFR rating and a Biennial Flight Review on 11 August 2003. His last night VFR flight, of 0.2 hours duration, was completed on 15 October 2003. In the previous year, he had logged 75.5 hours night VFR flying. The last record of any instrument flying by the pilot was during a night base check on 3 April 2003, nearly 6 months prior to the accident flight.

Marine pilot transfer experience

The pilot had previously worked for an operator engaged in marine pilot transfer operations. Most of the pilot's marine pilot transfer flights were scheduled and were completed within sight of the coastline and of 0.6 hours duration on average. It was reported that when the weather in the marine transfer area was unsuitable for flight, a small boat would be used instead of the helicopter. The operator had taught the pilot, that in the event of inadvertent flight into instrument meteorological conditions (IMC) to turn 180 degrees and exit the conditions.

1.5.3 Pilot selection and company training

Pilot selection process

The operator kept on file, any expressions of interest in employment by prospective pilots. As positions became vacant, the operator's selection committee selected a suitable candidate for an interview. The committee was comprised of three members; one from the Flight Standards Department, the Resources Manager and the General Manager. On 18 June 2003, the pilot was given psychological testing, followed by an interview by the committee members. The operator's Resources Manager had known the pilot from previous mutual flight training.

The operator's committee members indicated that they normally preferred a candidate to have 1,500 hours as pilot in command (PIC), and an ATPL (helicopter) licence. If the candidate did not have an ATPL (helicopter) licence then they looked for a CPL (helicopter) licence and for the candidate to have completed the CASA instrument rating examination. The pilot's information sheet completed upon recruitment and dated 31 July 2003, listed his total aeronautical experience as 2,557.0 hours, with 2,318 hours as pilot in command, 12.0 hours instrument flight, 136.5 hours night flying and 300 hours offshore.

The committee members were aware of the pilot's previous experience in marine pilot transfer flying, and that he did not hold an instrument rating or completed the instrument rating examination. On 31 July 2003, the pilot was selected for the position and placed on a probationary period, which was still in force at the time of the accident.

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8 The pilot is required to demonstrated safe operation of the helicopter at night to the standard specified in CASA CAO 40.2.2 Appendix 1, which included recovery from unusual attitudes by reference to instruments only.

9 Very High Frequency omni-directional radio range navigational aid.

Company pilot training

The pilot's flight training at the Mackay base was conducted by the operator's check and training pilot from 1 to 11 August 2003. This training included area familiarisation, winch training, Nite Sun[10] training, night VFR[11] and type endorsements on the Bell 407 and 206L helicopters. The training pilot did not note any concerns with the pilot's skills.

Pilot instrument flight training and experience

The pilot had not recorded any instrument flight time since being employed by the current operator. Similarly, there was no specific entry in the operator's training records to indicate that dedicated instrument training had taken place with that operator. However, recorded training that may have included some degree of instrument training included:

- 9 August 2003- Nite Sun operations in the Bell 206L. The company training record indicated visual manoeuvres in the proximity of Mackay Airport
- 10 August 2003- Nite Sun operations in the Bell 407. The company training record listed visual training, although the pilot logged the trip as including VOR exercises. There was no mention of VOR work in the company training record
- 11 August 2003- Nite Sun operations in the Bell 407. The company training record did not report the completion of any instrument flying or VOR exercises during that training flight. The corresponding entry in the pilot's logbook noted the trip as including his VOR endorsement.

Following the flight of 11 August 2003, the instructor filed a night VFR rating application form certifying that the night VFR rating test was conducted as per CAO 40.2.2 Appendix 1 and that the pilot had passed the test in all respects[12]. The form noted that the following items were performed by the pilot to a satisfactory standard:

- nominated cruise altitudes maintained ±200 ft, and heading maintained ±10 degrees
- level turn through 180 degrees, with altitude maintained ±200 ft
- safe execution of climbing and descending turns to a specified altitude
- safe technique and smooth recovery from unusual attitudes.

The night VFR rating application form did not include the requirements for practicing limited panel[13] instrument flying, nor was there a requirement to do so. There was no annotation in any of the company training notes, or in the pilot's logbook, to the effect that any instrument flying had been conducted during the night VFR rating assessment[14].

10 A high candle power searchlight.

11 Including 3.8 hours of night VFR flight.

12 The instructor's recommendations noted on the application form were for CASA to add GPS and VOR to the pilot's existing night VFR rating.

13 Often referred to as partial panel, limited or partial panel flying is defined as flight with key instruments obliterated or inoperative and external cues absent.

14 The requirements of the Night VFR rating required the pilot to demonstrate some competencies to be preformed solely by reference to flight instruments.

1.5.4 Pilot recency

Completion by the pilot of his night VFR rating flight test on 11 August 2003 satisfied the night VFR recency requirements of CAO 40.2.2. In addition, the pilot satisfied the operator's night VFR recency requirement[15]. During the three months of his employment with this operator, the pilot averaged 4.8 hours night VFR flight per month. This included flight in both the Bell 407 and Bell 206L-3 model helicopters.

1.5.5 Pilot flight and duty times

The Mackay base was situated at the Mackay Airport and staffed by three full-time pilots. The pilots duty cycles were scheduled to ensure that crew fatigue was not an issue. The pilots were provided with sleeping and eating facilities at the base, and were rostered on a 9 day rotating shift cycle of 6 days 'on', followed by 3 days 'off'. The roster consisted of a normal sequence of 24 hours on reserve at home[16], followed by 24 hours on standby duty at the airport base for 6 consecutive days[17], and followed by 3 days free from duty or standby of any type. Roster details were recorded in a computer database.

The pilot had been on reserve standby duty for 14.5 hours prior to the commencement of the accident flight, which was his first flight for the day. His last day off (not on the roster) was on 11 October 2003. Table 1 details the pilot's recent duty cycle.

Table 1: Pilot reserve and duty times

Hours and date	*Duty type*	*Hours flown*	*Notes*
0700[18] 14 October to 0800 15 October	Rescue reserve (home)	0.0	-
1100 to 1930 15 October	Rescue standby (base)	1.2	A flight of 86 NM 0.2 hrs night VFR
0700 16 October to 0800 17 October	Rescue reserve	0.0	-
0700 17 October to accident	Rescue standby	0.2[19]	14.5 hrs on standby duty

1.5.6 Pilot fitness for duty

The pilot's last medical examination was completed on 6 December 2002, with an electro-cardiogram completed on 28 January 2002. The results of these examinations did not indicate any anomalies.

The pilot was reported to have slept and eaten normally. There was no indication that he was affected by fatigue at the time of the accident. He was a non-smoker.

15 One hour night VFR flying per 30 days (normal tasking can typically satisfy this requirement).

16 Not regarded as duty by the operator or the Civil Aviation Safety Authority.

17 On reserve at home was termed 'Rescue Reserve' by the operator and duty at the airport base was termed 'Rescue Standby'.

18 Pilots were required to report at the base for standby duty at 0700 to allow a one hour 'handover' with the pilot coming off duty.

19 Flight time from commencement to the accident.

One witness reported that he believed that the pilot had a slight cough and possible head cold on the night of the flight. However, the investigation found no evidence to indicate that the pilot had any illness on the night of the flight.

There were no indications of any significant personal, physiological or medical issues that may have adversely influenced the pilot's performance.

1.6 Helicopter information

Table 2: Information related to Bell 407 helicopter VH-HTD

Manufacturer	Bell Helicopter Textron
Model	407
Serial number	53105
Registration	VH-HTD
Year of manufacture	1997
Certificate of Airworthiness	Issue date 14 September 2000 (number HT/01/2000)
Certificate of Registration	Issue date 3 August 2000 (number AF/10813/01)
Maintenance release	Valid to 22 August 2004 or 2,442.4 hours (number 15454)
Total time airframe	2,210.9 hours
Maximum allowable take-off weight	2,381 kg [20]
Actual take-off weight	2,246 kg
Weight at occurrence	2,218 kg (estimated)
Allowable centre of gravity limits	302.30 to 326.80 cm [21]
Centre of gravity at occurrence	324.40 cm (estimated)

1.6.1 Helicopter background

The helicopter was manufactured in Canada in 1997 and imported to Australia from Papua New Guinea in 2000, receiving an Australian Certificate of Airworthiness on 14 September 2000. It had been maintained in accordance with manufacturer and CASA approved documents and schedules. The Rolls-Royce Allison 250-C47B engine had accumulated 1,253 hours time since overhaul. The helicopter had operated 17.8 hours since the last 300-hourly phase inspection.

On 11 April 1999, while on Papua New Guinea register, the helicopter sustained substantial damage during an emergency landing[22] accident. This resulted in the requirement for an airframe and engine manufacturer's sudden stoppage[23] inspection. Subsequently, the main rotor blades, main rotor driveshaft, horizontal stabilizer, finlets, and tail rotor driveshaft were replaced. The tail boom also required repair and the engine was removed, inspected, repaired and reinstalled. All work was completed in Australia by a repair facility approved by CASA and the helicopter manufacturer.

A comparison of the maintenance records with a listing of CASA mandatory Airworthiness Directives (AD) and airframe and engine manufacturers' Service Bulletins (SB) applicable to the helicopter indicated that the operator had complied with all relevant ADs and SBs.

20 Equipped with airframe manufacturer's kit part number 407-706-020, which increased take-off weight.

21 Equipped with airframe manufacturer's kit part number 407-706-020, which changed limits.

22 Landing made without the benefit of the full authority digital electronic control of the engine.

23 Requires inspection and replacement of several drive components and engine components.

Helicopter EMS configuration

During the repairs following the emergency landing accident, the helicopter was modified to an Emergency Medical Service (EMS) configuration. The EMS configuration included the installation of a 30 million-candle power[24] Nite Sun searchlight.

The EMS crew configuration for the flight was the pilot located in the front right seat, the helicopter crewman located in the left rear seat and the paramedic located in the right rear seat. Dual controls were not installed and normally, once a patient was boarded, the patient litter in the helicopter was extended so that it lay front to back on the left side of the helicopter's cabin. This configuration did not allow the paramedic and crewman, located in the rear cabin area, access to the flight controls. The investigation determined that the litter was not extended for the flight.

1.6.2 Helicopter flight instrumentation

The helicopter was fitted with an attitude indicator, directional gyro, and turn and balance indicator, along with other flight instruments. The attitude indicator received electrical power from the DC essential bus. A display of the flight instrument layout of HTD is included at Figure 7 below.

FIGURE 7: HTD console[25]

24 A measurement of the rate of emission of light by a source, usually in a given direction.

25 Photo sourced from CQRESQ.

Helicopter autopilot information

The helicopter was not fitted with an autopilot or stability augmentation system, nor was there a requirement to do so. However, during reconfiguration work to the EMS role, a quote was provided for the installation of a basic two-axis autopilot system, with pitch and roll stability augmentation and attitude retention for the helicopter.

1.6.3 Significant maintenance issues

Tail rotor blade

On 2 September 2003, a crack emanating from the water drain hole of the tail rotor blade was discovered during a pre-flight inspection. A replacement blade was installed.

Instrument lighting

The base maintenance engineer at Mackay had been troubleshooting an on-going intermittent problem with the 28 volt direct current instrument lighting circuitry. On 20 August 2003 at 2,141.0 hours total time airframe, a transistor was replaced behind the instrument panel that resolved the problem. No anomalies of the lighting system had been documented following that maintenance action.

Transmission oil pressure indicator

The base maintenance engineer reported that on the night of the accident, the pilot had called him at home at about 2100 to report an anomaly with the helicopter's main transmission oil pressure indicator. The main transmission oil pressure indicator was an electrically driven liquid crystal display (LCD) indicator, that graphically indicated oil pressure in LCD numerals as well as illuminated segments. During initial start up of the indicator, the system verified the integrity of the indicator by illuminating all 'trend arc' segments of the indicator for 6 to 8 seconds. If the indicator failed the 'power up self-test', the trend arc segments would not illuminate and the numerical digits would not be displayed, indicating a failure with the unit. Indicators that successfully completed the power up self-test would illuminate only the first LCD of the indicator segment until an increase of that particular instrument value.

According to the engineer, the pilot told him that the LCD display segments on the oil pressure indicator segment lights were only indicating one segment illuminated. The engineer was unsure if this was discovered during helicopter engine run up or during the initial start up self check of the unit. The engineer believed that the problem was related to the LCD segment light only, as the pilot reported to him that the oil pressure caution light was not illuminated. Had it been illuminated, it would have indicated a loss of oil pressure and not merely an indication problem. Suspecting corrosion on the connector, the engineer recommended that the pilot remove and reseat the connector to the sending unit of the indicator and call him back after that action, to confirm that it had resolved the problem. The pilot did not telephone the engineer back before the flight departed, or during the flight. A review of the on-board mobile telephone call summary did not indicate a telephone call logged as outgoing from the helicopter on the night of the accident.

1.7 Meteorological information

Weather information accessible to the pilot

Aeronautical Information Publication (AIP) ENR 76.5 required the pilot to obtain a meteorological forecast for the flight, specifically as the flight was over water. AIP ENR 1.10 Flight Planning paragraph 1.2.8 stated that, when the pre-flight briefing is obtained more than one hour prior to the estimated time of departure, pilots should obtain an update before departure to ensure that the latest information available can be used for the flight. The pilot held an account with the National Aeronautical Information Processing System (NAIPS), but this was not accessed in the days prior to, or on the day of the accident. On 17 October 2003, the operator's Mackay base Airservices Australia database account was accessed for code 9440[26] meteorological and Notice to Airmen information at 1114, 1218, 1748 and 1752 hours.

Area weather

Weather briefing information for the area was obtained by the pilot at 1752 (3 hours 40 minutes before the flight). That information was valid from 1630 on 17 October 2003 to 0300 on 18 October 2003, and forecast:

- isolated[27] thunderstorms and scattered showers[28], mainly land[29] until 2400 with isolated areas of smoke below 7,000 ft
- wind at 2,000 ft was 15 kts from the east-south-east, and at 5,000 ft was 15 kts from the south-east
- cloud was isolated cumulo-nimbus 5,000 to 30,000 ft, broken[30] stratus at 2,000 to 3,000 ft with precipitation (mainly land) and scattered cumulus at 2,000 to 8,000 ft over the sea and coast, 5,000 to 20,000 ft inland, broken alto cumulus/alto stratus above 12,000 ft with cumulo-nimbus
- visibility was 2,000 m in thunderstorms/rain, 4,000 m in showers/rain and otherwise 7 km in smoke reducing to 2,000 m in thick smoke[31].

An additional area forecast was issued at 1853 and was valid from 2100 on 17 October 2003 to 0900 on 18 October 2003. That report did not revise any forecast details. An amendment to this forecast was issued at 2125 removing all mention of possible thunderstorms and cumulo-nimbus cloud.

26 Code 9440 information included area 44 forecast & barometric pressure, Hamilton Island (YBHM), Mackay (YBMK), Proserpine (YBPN) and Rockhampton (YBRK).

27 Well separated in space during a given period.

28 Irregularly distributed over an area. Showers which, while not widespread, can occur anywhere in an area. Implies a slightly greater incidence than isolated.

29 Refers also to coastal land areas.

30 Forecast cloud was explained as 'few'-1 to 2 OKTAS (a unit of visible sky area representing 1/8 of the total area visible to the celestial horizon), 'scattered'- 3 to 4 OKTAS, 'broken'- 5 to 7 OKTAS and 'overcast'- 8 OKTAS.

31 If not experiencing thunderstorms, showers or smoke, the visibility would have been greater than 10 km.

Actual weather observations at Mackay Airport for 2130 were:

- wind from the east-south-east at 13 kts gusting to 17 kts
- temperature 22.6 degrees
- dewpoint 17.3 degrees
- airfield barometric pressure (QNH) 1018.4 Hectopascal (hPa)
- unlimited visibility with scattered cloud reported at 2,900 and 7,300 ft with broken cloud at 9,800 ft[32].

The terminal area forecast for Hamilton Island Airport for 1737 hours was:

- wind was from the east-south-east at 15 kts
- temperature 23 degrees
- QNH 1015 hPa
- unlimited visibility with scattered cloud at 2,500 ft

The forecast for Hamilton Island for 2256 hours was essentially the same except for an increase in wind from 15 to 18 kts and an increase in QNH from 1015 to 1018.

The Bureau of Meteorology (BoM) further advised that their analysis of the situation showed a trough of low pressure located over inland Queensland, which produced afternoon showers and isolated thunderstorms over most of the land areas, with a few showers making it onto coastal parts in the late afternoon/evening. The east coast was under the influence of a surface ridge, and this maintained a moderate east to south-easterly flow along much of the coast. The wind in the Mackay area was such that showers were moving from the south-east to the north-west at a rate of about 10 to 15 kts.

1.7.1 Weather radar available to the pilot

The weather radar located at Mackay was a dual purpose system, with both 'weather watch' and 'wind find' capability. Weather watch was the function that displayed precipitation, and the imagery was available on the BoM website. In weather watch mode, the radar pulses reflect off the raindrops in the beam and some of the pulses return to the radar. The location of the rain was determined from the orientation of the radar antenna and the time taken for the pulse to return to the radar receiver. The intensity of the rain was calculated from the power of the returned pulse, which depended on the size of the raindrops and their concentration.

Radar does not locate clouds, because cloud droplets are too small, but it does locate the rainfall which those clouds produce. However, radar will not necessarily detect light rain and drizzle from a shallow cloud weather system or at great distances[33].

The wind find mode referred to the use of the radar to track high-level meteorological balloons in order to measure the winds aloft in the upper atmosphere.

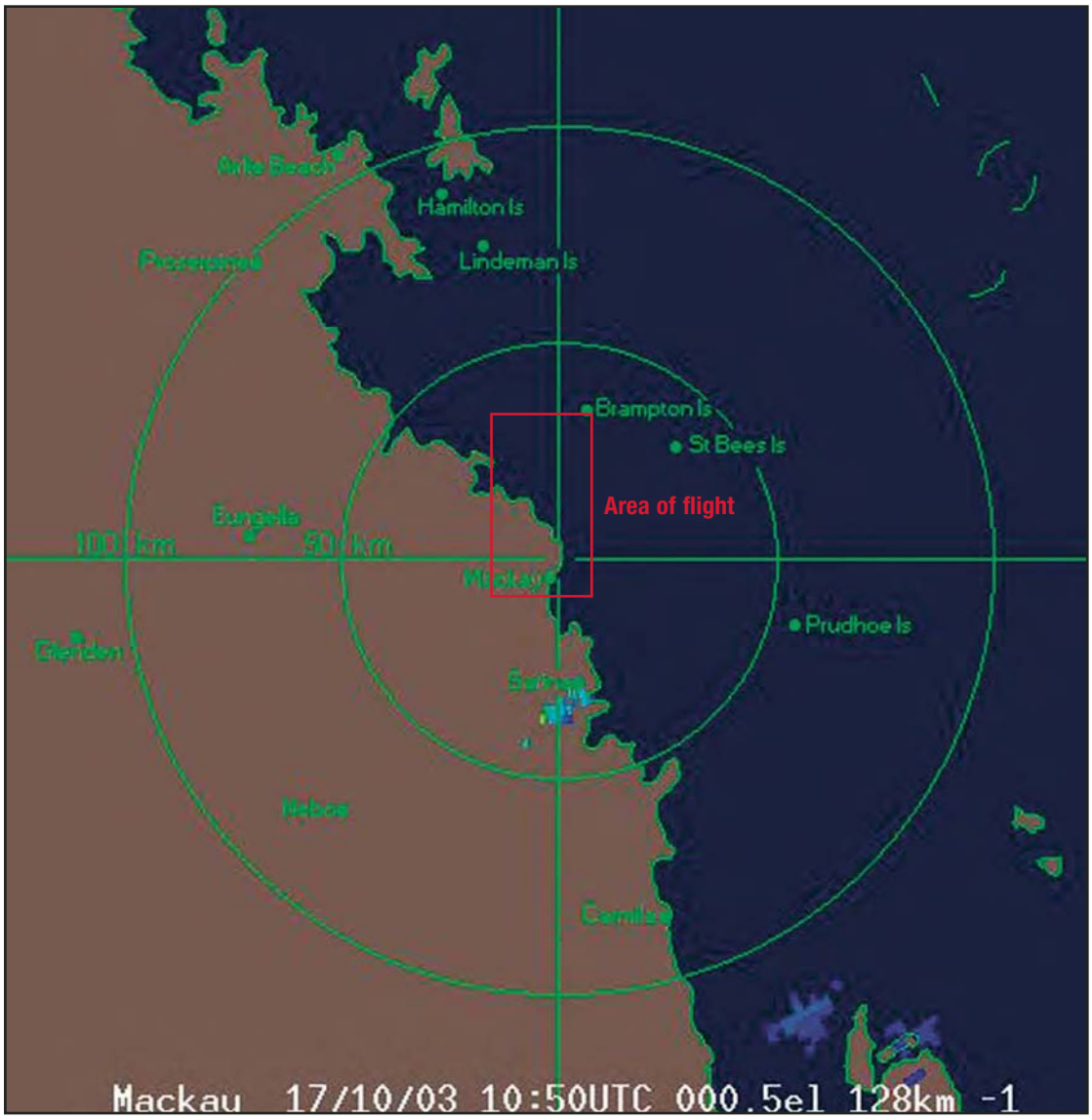
Weather watch radar images are normally updated every ten minutes; however there are full and part-time radar sites. The Mackay site was a 'part-time' radar site. Part-time radar sites had scheduled daily outages related to the use of the wind find mode during which up to date

32 These observations were provided by a visibility meter and a ceilometer and subject to limitations. Further information on this equipment may be found on the BoM website at http://www.bom.gov.au/general/reg/aviation_ehelp/cv.shtml.

33 Due to the Earth's curvature, the radar beam is higher above the ground the further it travels from the radar source. Therefore, the beam may be above showers or drizzle and therefore not detect the presence of any such precipitation in lower atmospheric levels.

weather imaging was not available. That normally occurred up to four times per day for approximately 1.5 hours for each interval. During these periods, the imagery displayed on the BoM website was the last radar image taken before shifting to wind find mode. The date and time of the image was included on the web page screen display. The BoM reported that on the 17 October 2003, the Mackay radar was taken out of weather find mode for the period 2050 to 2250 to allow the Bureau observer the use of the radar for a balloon flight and collection of the 2100 upper wind data. The last valid weather radar image display for this period indicated possible rain shower activity at Sarina to the south of Mackay. Figure 8 displays the Mackay radar image at 2050 hours.

FIGURE 8: Radar from Mackay at 2050 hours[34]



Following the accident, the radar data from the nearest available operational weather watch radar site was analysed. That site was located at Mount Stuart near Townsville, approximately 172 NM from Mackay[35]. The Mount Stuart weather radar image for 2140 indicated no shower activity in the area at the time of the accident. Figure 9 displays the Mount Stuart radar image for 2140 hours.

34 Image provided by the BoM.

35 The distance from the Mount Stuart radar site to the area of the occurrence would have negatively affected the accuracy.

FIGURE 9: Radar from Mount Stuart at 2140 hours[36]

The pilots at the Mackay base reported that they accessed the BoM website periodically to validate weather forecasts. The investigation could not confirm that the pilot had accessed this information prior to the flight. The base pilots also noted that, at the time of the accident, they were unaware of the part-time functioning of the Mackay radar site, nor of the table of projected outages on the BoM website.

1.7.2 Sunset, moonrise and moonset information

Sunset, moonrise and moonset information[37] for the Mackay area was sourced for the night of the accident. On 17 October 2003, official sunset was at 1807, end of civil twilight[38] occurred at 1829 and the moon set at 1005 and did not rise again until 0006 on 18 October 2003. These conditions signified that the moon could not have provided celestial illumination of the horizon for the duration of the flight.

36 Image provided by the BoM.

37 This information was available on the internet at http://www.ga.gov.au/nmd/geodesy/astro/.

38 Civil twilight is defined to begin in the morning, and to end in the evening when the centre of the Sun is geometrically

1.8 Aids to navigation

The Mackay and Hamilton Island Airports were both served by NDB and VOR navigation aids. On the night of the accident, there were no NOTAM listings relating to the operation of those aids.

The helicopter was equipped with a Garmin GNS 430 GPS[39] Navigational Moving Map display unit, which was certified to TSO C129a, Class A1, and the pilot was qualified for its use. The GNS 430 was a 12-channel unit which was Instrument Flight Rules (IFR), GPS, Instrument landing System, VOR, Localizer and glideslope capable.

A review of the available satellites for the time frame of the accident was completed. That review indicated that there would have been 10 to 11 satellites in view throughout the one hour window of the flight, indicating an excellent level of performance and availability from the GPS constellation in the area of the flight.

1.9 Communications

Helicopter communications

At the time of the accident, Mandatory Broadcast Zone (MBZ) procedures were in place. All pilot broadcasts on the MBZ frequency were recorded by ground-based recording equipment. Analysis of the recorded departure broadcast from the pilot of HTD did not indicate any anomalies with the helicopter at the time of the broadcast. The pilot reported that he was tracking parallel to runway 14, tracking 336 degrees magnetic to Hamilton Island and on climb to 3,000 ft. No other broadcast from the pilot was recorded on the Mackay MBZ frequency.

A review of the Airservices Australia Brisbane Centre Operations recordings for frequency 135.5 MHz (for the area north of Mackay) indicated that the pilot did not contact the Centre on the night of the flight, nor was there a requirement for him to do so.

Hamilton Island MBZ broadcasts were transmitted on the Whitsunday MBZ frequency of 126.7 MHz. The Whitsunday MBZ frequency was not recorded.

Ambulance Communication Centre communications

The ACC radio operated on a frequency of 136.4 MHz. All communications between HTD and the ACC, and communication within the ACC, were recorded by ground-based recording equipment for the duration of the flight and the subsequent rescue efforts. Those recordings were replayed in order to examine helicopter communications, survivability issues and flight-following procedures. The two brief broadcasts recorded from the pilot of HTD on that frequency did not indicate any anomalies with the helicopter at the time of the broadcasts.

1.10 Airport/aerodrome information

1.10.1 Mackay Airport

The Mackay Airport was operated by the Mackay Port Authority. The elevation of the airport was 19 ft (5.8 m), and the MBZ frequency was 124.5 MHz, which was also the Mackay Tower frequency. Airservices Australia Brisbane Centre Operations was predicted to be available from on the ground at Mackay on frequency 135.5 MHz. Mackay Air Traffic Control operating hours were from 0830 to 2040. Outside those hours, the airspace became the Mackay MBZ. The two

39 When used in this installation (VFR - equipped helicopter) the GPS unit was placarded as 'not an approved aid to navigation'.

runways at Mackay were runways 14/32 and runways 05/23. Right circuits were required off runways 05 and 14 outside the air traffic control operating hours. Skid-mounted helicopters were requested to use the helicopter landing site adjacent to taxiway 'C'.

1.11 Flight recorders

The helicopter was not fitted with a flight data or a cockpit voice recorder, nor was either required by the relevant aviation regulations.

1.12 Wreckage information

Damage to the helicopter's fuselage and structure was substantial. The wreckage examination indicated a high-speed impact with the water. The helicopter impacted the water nose down and left skid low. The hydraulic forces of the impact with the water separated the cabin roof, main rotor transmission deck, engine, main transmission and resulted in cabin and cockpit destruction. The engine was severed from the mounts and the engine deck area separated from the upper fuselage. The engine mount 'A' frames exhibited structural failure[40] fractures and the engine deck was compressed. The landing gear skid tubes, cross tubes and flotation bags were extensively damaged and partially separated from the fuselage. The left skid tube front section displayed a structural failure fracture and had separated. The pilot's seat structure exhibited deformation in a downward direction indicating positive g-force[41] applied at the time of impact[42].

Examination of the tail boom structure indicated that a section of the tail boom containing the intact tail rotor, tail rotor blades, tail rotor gearbox, horizontal and vertical stabilisers had displaced forward and upward and separated from the remaining fuselage/tail boom[43]. Figure 10 displays the separation point of the tail section.

FIGURE 10: Tail rotor and separated tail section

40 Breakage under load.

41 Inertial force, needed to accelerate mass, usually expressed in multiples of gravitational acceleration (Gs).

42 The helicopter's seat structure was designed in accordance with FAR 27.561. The airframe manufacturer indicated that an applied load beyond design expectations would be required to deform the seat pan.

43 The weight and arm of the tail rotor gearbox would have acted to separate the assembly with any forward motion when the fuselage was stopped suddenly.

The main rotor transmission deck, with the transmission and main rotor attached, separated from the wreckage. These items were video-recorded while temporarily in the trawler recovery nets before the nets were damaged and released the main rotor and transmission back into the water. An examination of the recording of the components concluded that the main rotor blades impacted the water at substantial rotational speed. The Nite Sun searchlight was extensively damaged and the investigation could not determine if the light was illuminated at the time of impact.

Continuity of the flight controls from the main rotor transmission deck to the cockpit controls was confirmed. However, the flight controls were separated, along with the section of the main rotor transmission deck, at a location slightly rearward of the main rotor hydraulic actuators.

Additionally, continuity of the tail rotor controls was confirmed from the tail rotor assembly forward to the tail rotor hydraulic actuator, but disruption of the structure prohibited further validation of the cockpit controls. Continuity of the tail rotor drive shaft was also confirmed. Because of structural damage, continuity of the engine controls could not be confirmed. Figure 11 displays the reconstruction of the available helicopter wreckage.

FIGURE 11: Reconstruction of the wreckage

1.13 Medical information

1.13.1 Post-mortem and toxicology

Pilot

The body of the pilot was not recovered.

Crew

Post-mortem medical examinations were completed on the crewman and paramedic. The examinations confirmed that they suffered fatal injuries as a result of impact forces.

Based on available evidence, there was no indication of any pre-existing medical conditions of the pilot or crew that may have contributed to the circumstances of the accident.

1.14 Fire

There was no evidence of an in-flight fire or fire after the impact.

1.15 Survival aspects

1.15.1 Impact forces

The helicopter's impact with the water was not survivable. All three crewmembers' seats, seat belts and attachment points were extensively damaged, indicating impact forces in excess of design limitations. This damage was consistent with the occupants having been restrained at the time of impact. Water hydraulic force and impact loads in excess of the design criteria substantially damaged the cockpit and cabin areas.

1.15.2 Emergency flotation equipment

The helicopter was equipped with emergency flotation equipment attached to the skid-type landing gear. The flotation equipment provided for occupant emergency egress from the helicopter, in the event of a water landing. The system comprised six individual flotation bags. Impact forces damaged several float bags and partially deflated several float compartments.

The helicopter was also equipped with an inflatable life raft stored internally in the cabin area. The life raft had a strobe light attached, which aid in locating the raft. The strobe light attached to the raft was believed to have activated, as it was reported seen by the crew of the search and rescue helicopter.

1.15.3 Personal buoyancy devices

All members of the crew were equipped with personal buoyancy devices. One crewmember's device was recovered and examined. It had not been inflated and was extensively damaged and punctured. The CO2 bottle used to inflate the device had not been activated.

1.16 Tests and research

1.16.1 Engine disassembly and inspection

Engine details

Manufacturer	Rolls-Royce Allison
Model	250-C47B
Serial number	CAE-847120
Date of last overhaul	12 September 2000
Hours since last overhaul	1,253.0 hours
Date of last maintenance	26 September 2003
Last maintenance type	Periodic (oil change)

The engine was recovered and sent to an approved facility for disassembly and inspection under the supervision of the ATSB, with the assistance of the engine manufacturer's representative. Examination of the engine found indications of normal operation at impact. There was no evidence of pre-impact failure of any kind. The engine compressor displayed evidence of high speed rotation at the time of impact. The fuel control unit was severely damaged from impact forces and could not be tested. Further evidence of normal engine operation prior to impact with the water, is documented in section 1.19. Figure 12 displays the engine compressor section with indications of rotation at impact.

FIGURE 12: Engine compressor during disassembly

Attitude indicator

The attitude indicator assembly contained an electrically driven gyro rotor. The rotor acted like a small electric motor with the spinning gyro acting as the motor armature. The gyro speed in this instrument was approximately 15,000 RPM.

The attitude indicator was recovered and examined in the ATSB laboratories. Because of hydraulic shock force damage at the time of water impact, the examination of the unit was inconclusive in establishing the angle of impact. However, the examination did conclude that the gyro rotor was rotating during impact.

Radio magnetic indicator light globe

The radio magnetic indicator light globe was recovered and examined in the ATSB laboratories. The examination concluded that the globe filament was illuminated (incandescent) at the time of impact, confirming electrical power to the helicopter's instrument lighting panel at the time of impact.

Underwater acoustic pinger

The helicopter was fitted with a Dukane DK120 Underwater Acoustic Pinger, which was water activated. The unit was recovered and examined in the ATSB laboratories. The examination indicated that the unit was capable of operating as specified.

Vertical speed indicator

The vertical speed indicator was recovered and examined at the ATSB laboratories. The face of the instrument included a witness mark indicating a vertical descent rate of approximately 3,600 ft per minute downward. Figure 13 displays the indicator position as found.

FIGURE 13: Vertical speed indicator

Directional gyro

The directional gyro contained an electrically driven gyro rotor. The rotor acted like a small electric motor with the spinning gyro acting as the motor armature. The gyro speed in this instrument was approximately 10,000 RPM.

The directional gyro was recovered and examined at the ATSB laboratories. The examination concluded that the instrument gyro element was rotating during the impact with the water, which induced collapse and break-up of the instrument.

Main rotor hydraulic actuators

The main rotor hydraulic actuators were recovered and bench tested for travel and freedom of movement. All four servos indicated sufficient movement during the examination, with no anomalies found.

1.17 Organisational information

1.17.1 Organisational framework

The organised use of helicopters for emergency retrieval work for Emergency Medical Services (EMS) in Queensland commenced in the mid 1980s with the Queensland Surf Life Saving Association and the Queensland Department of Emergency Services.

At the time of the accident, the organisational framework that supported the provision of a helicopter EMS service in the Mackay region involved three main organisations:

- The Queensland Department of Emergency Services
- Central Queensland Helicopter Rescue Service Ltd (CQRESQ)
- Canadian Helicopters Corporation (CHC) Australia (CHC Australia).

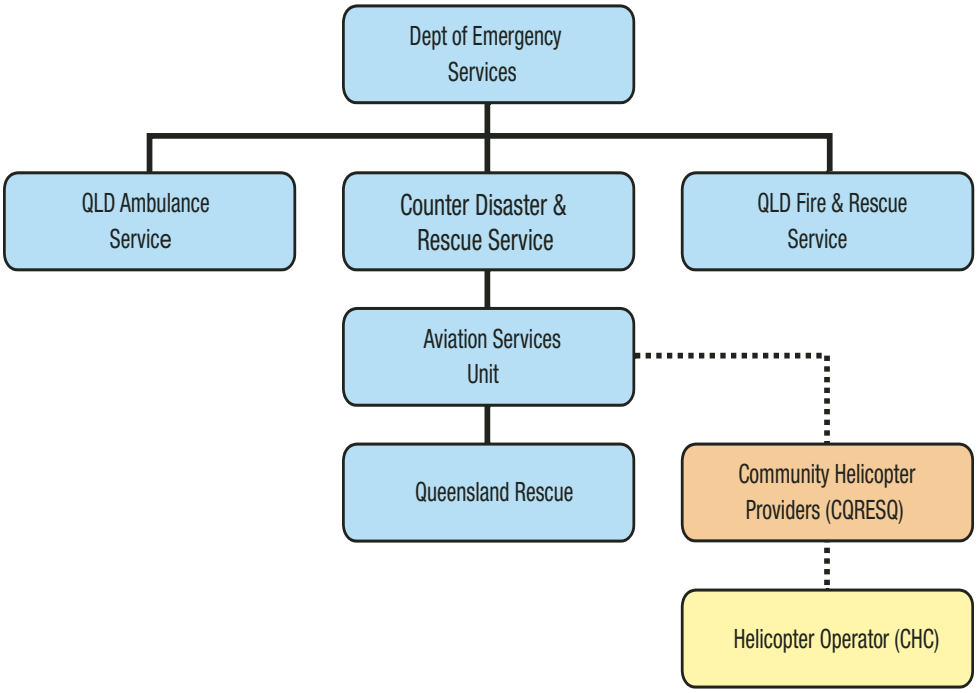
In 1997, an interdepartmental coordination framework known as the Queensland Emergency Medical System (QEMS) was established. QEMS contained a committee which acted as an inter-departmental advisory committee between Queensland Health, and the Queensland Department of Emergency Services.

1.17.2 Queensland Department of Emergency Services

The provision of emergency helicopter services in Queensland was overseen by the Department of Emergency Services and, in particular, the Aviation Services Unit of the Counter Disaster and Rescue Services Division of the Department.

The Aviation Services Unit operated the Queensland Government Helicopter Rescue Service (Queensland Rescue), with four helicopters located at bases in Brisbane, Townsville and Cairns. In addition, the Aviation Services Unit supported four Community Helicopter Providers (CHP) operating on the Gold Coast, the Sunshine Coast, Bundaberg, Rockhampton and Mackay (CQRESQ). The unit also had oversight of a contract service at Thursday Island in the Torres Strait. Figure 14 displays the relationships both within the Department of Emergency Services and the other external organisations. The dotted line in the figure indicates an indirect relationship.

FIGURE 14: Organisational chart of the operation



The Department of Emergency Services provided support to the CHP through partial funding, and other support, for the services that they provided. These arrangements were formalised in five-year service agreements between the Department and the service providers.

The Queensland Rescue Bell 412 helicopter based at Townsville, which was IFR equipped, occasionally completed tasks in the Mackay area that could not be completed by CQRESQ[44].

Service agreement

The Service Agreement in effect at the time of the accident between the Department of Emergency Services and CQRESQ was signed on 30 January 2002, and took effect on 1 February 2002, with an expiry date of 31 January 2007. It included aspects such as:

- the agreed services to be provided
- determining task priorities
- operational issues and strategies
- corporate and financial matters
- independent audit requirements.

The Service Agreement specified the minimum qualifications and experience of pilots and other crew operating the service, including aspects related to flying duties, emergency and rescue tasks, and physical fitness. Following the fatal EMS helicopter accident near Marlborough, Queensland in July 2000, the Generic Service Agreement between the Department of

44 This was due to the VFR only flight limitations of the Mackay helicopter.

Emergency Services and the CHP had been modified by the Department to strengthen safety and training issues. It included the following requirements for pilot standards:

- 2500 hours piloting or between 2000 and 2500 hours (provided that the pilot has substantial aeromedical experience and more than 200 hours night flying experience or other equivalent experience as agreed between parties);
- 1500 hours pilot in command (helicopter);
- 500 hours turbine engine experience (helicopter);
- 100 hours night flying experience; and
- Possession of commercial pilot's licence (helicopter).

The previous Service Agreement made on 12 June 1996[45] listed pilot standards as:

- 3000 hours piloting, with 1500 hours helicopter experience, including appropriate night flying experience;
- 1500 hours PIC;
- 500 hours turbine engine experience;
- Possession of commercial pilot's licence.

Pilots with less that 3000 hours (but more that 2000 hours) experience, may be used provided they have substantial aeromedical and night/instrument flying experience.

A requirement of the current Service Agreement was that CQRESQ notified the Department of Emergency Services of the full names, qualifications and experience of pilots working for the rescue organisation. CQRESQ had been notified by the operator (as per contract requirements) of the pilot's qualifications and experience and the investigation established that they had forwarded that information on 30 June 2003 to the Department, noting that the pilot's experience had included 'a considerable background in both instructing and offshore marine pilot transfers'. That information indicated that the pilot had 2,456 total hours experience (all in helicopters), with 2,269 hours time in command, 1,293 hours turbine engine experience, 168 hours night flying experience. No instrument flight hours or aeromedical experience were noted.

The Service Agreement also included a requirement for the pilot acting on behalf of the rescue organisation to assess all relevant operational issues, including the weather conditions and the time of day, to decide if it was safe to undertake the task.

The Service Agreement did not include detailed directions or guidance of a technical or operational nature, but did state that the term 'aircraft' as used throughout the agreement meant a single-engine turbine-powered helicopter such as 'Bell 206L, AS 350 Squirrel or a helicopter determined by the Department of Emergency Services to be equivalent'. The Service Agreement made provision for the Department to carry out audits or inspections of any aspect of the CQRESQ operations, excluding medical audits and aviation audits. The Department had not completed any audits of the Mackay operation at the time of the accident.

The Service Agreement did not include a standard response time for call out of the helicopter. Under the Agreement, CQRESQ was required to perform services in accordance with the *Queensland Aeromedical & Air Rescue Network Helicopter Tasking Guidelines*.

45 The requirements of this Agreement were in effect at the time of contract implementation between CQRESQ and the operator. See Section 1.17.5.

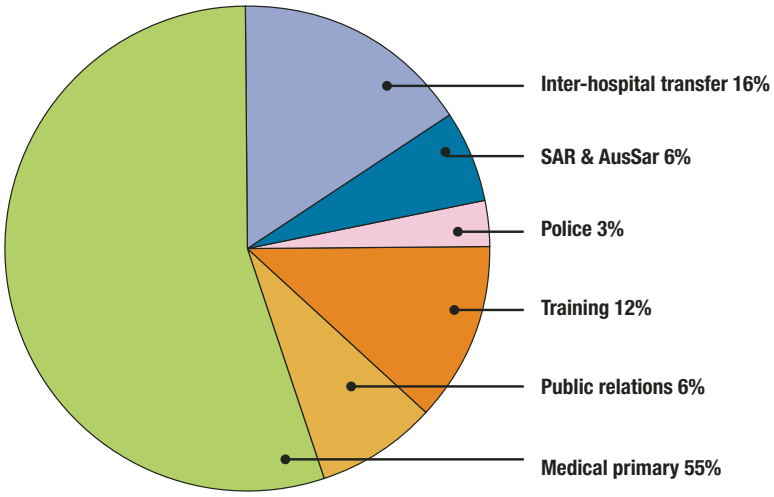
1.17.3 The rescue organisation

CQRESQ was formed in 1994 by local citizens and commenced flight operations from 1 September 1996. Funding for the organisation was by public donations, Queensland State Government assistance, and commercial sponsorship. The Queensland Government contribution towards the annual operating costs of CQRESQ was $A852,000 per annum.

The CQRESQ base was located at Mackay Airport and provided a primary service to an area consisting of a 162 NM radius overland and 145 NM radius area over water from Mackay. Operations were conducted 24 hours a day, 7 days a week. Individual flights were often flown over return distances of 215 NM from Mackay.

In the period from its inception to July 2002, CQRESQ flew 1,250 emergency missions. During the calendar year ending 2001, inter-hospital patient transfers accounted for 49 of the 313 missions flown, or 16 per cent of missions flown and 25 per cent of hours flown. The rescue organisation team consisted of three full-time pilots and two full-time and two part-time rescue crew members. represents the distribution of the missions. Figure 15 represents the distribution of the missions.

FIGURE 15: CQRESQ operation types (September 1996 to July 2002)



1.17.4 The operator

HTD was operated by CHC (Australia) under contract to CQRESQ. CHC (Australia) was part of the Canadian Helicopters Corporation, a large provider of helicopter services operating in 30 countries. CHC (Australia) had its Head Office in Adelaide and a number of operational bases throughout Australia and in East Timor. CHC (Australia) operations, including those from the Mackay base, were carried out under a CASA Air Operators Certificate enabling the company to carry out helicopter charter services and a wide range of Aerial Work operations, including EMS services, throughout Australia. The provisions of emergency medical services at the Mackay Base were as follows:

- CHC (Australia) was contracted to CQRESQ to provide the helicopter pilot and crewman[46] for rescue tasking
- the Queensland Department of Emergency Services, Queensland Ambulance Service provided the paramedics and/or clinical crewing necessary for a tasking
- Queensland Health performed clinical coordination and provided doctors or nurses for clinical staffing.

A backup Bell 206L3 helicopter owned by CHC (Australia), registered VH-LHP, was also available at the Mackay base.

Voyage reports

The operator's Flight Operations Manual paragraph 2.14 'Flight Voyage Report' stated:

> Any event or happening not involving aircraft safety, or any comments involving the commercial considerations of a flight should be submitted to the Resource Cell on a Flight Voyage Report (Form CHCO-611).

On 10 October 2003, the Mackay Base Manager issued an internal memo for all Mackay Base staff concerning the completion of Voyage Reports. It stated:

> Reminding all pilots at Mackay Base that if any task is rejected either due weather or otherwise a voyage report is to be completed. In the case where weather was the reason for rejection attach a copy of the weather to the report. Thank you all for the completed reports thus far.

Voyage Reports were completed and then sent to the operator's main base and were used by the operator at other locations. The investigation was advised that the additional purpose of the Voyage Report at the Mackay base was to document the occasions when a night VFR task could not be completed due to weather, and also if the prevailing conditions would have allowed an IFR capable helicopter to complete the task. The signature block on the report included a 'tick the box' format (to witness having seen the document) for the Chief Pilot, Resources Manager, Executive Director and Sales and Marketing Manager. Information included on the report consisted of crew names, aircraft registration, client, date, route, air crew report of circumstances and base manager remarks and action.

During the period 25 December 2002 to 7 October 2003, four Voyage Reports from the Mackay base were submitted, including one by the pilot of HTD dated 16 August 2003. All four reports noted cancelled flights due to weather. One report noted that the IFR equipped Bell 412 from Townsville had completed the mission following cancellation of the task by the Mackay base.

1.17.5 Rescue organisation/operator contract issues

In 2000, CQRESQ issued a 5 year contract tender request to potential helicopter aviation services providers for the Mackay operation. The tender included specifications for an aeromedical configured single or twin-engine helicopter that was capable of a minimum cruise speed of 120 kts, 30 minutes on-task (with a four-person crew) and that could be configured with medical and search and rescue equipment. It also stated that the helicopter may be IFR capable, either single or dual pilot, and must be able to:

46 The Mackay base engineer acted on rare occasions as an in-flight rescue winch operator.

> Fly in all weather day and night at very short notice to emergency situations, within weather minimums specified by Civil Aviation Safety Authority and/or Air Services Australia.

The tender also stated that replacement of any personnel shall be done with the permission of the rescue organisation and that such personnel shall be competent and have the necessary skills. It also included a requirement for pilot experience as noted in the Service Agreement made on 12 June 1996 in Section 1.17.2.

The tender respondent's submissions, along with economical factors were considered and evaluated by an independent organisation. There were various helicopters and configurations offered by the applicants. The evaluation indicated that in a comparison between the Bell 407 (night VFR equipped) and the Bell 412 (fully IFR equipped) helicopters, there was a monthly fixed cost difference of about $A33,000 dollars. The evaluation also noted:

> Consideration must be given to the limited operational capacity of a single engine aircraft that does not provide the role flexibility of an IFR capable aircraft or provide the safety of a twin engine aircraft.

Eventually, CHC (Australia) was chosen as the preferred contract provider with the Bell 407 nominated as the preferred helicopter.

The contract between CHC (Australia) and CQRESQ noted that the minimum standard response time for an emergency flight[47] call out of the helicopter (being airborne) was 15 minutes. However, for flights offshore in excess of a 81 NM radius from Mackay, the response time was extended to 30 minutes. The contract did not differentiate between emergency flights and inter-hospital transfer flights.

The CHC Mackay Base Operating Procedures manual stated that the contractual response time (being from notification to engine start) for each flight was 15 minutes. However, for flights offshore in excess of a 81 NM radius from Mackay, the response time could be extended to 30 minutes[48]. The flight to Hamilton Island was 49 NM. The Mackay Base Operating Procedures manual did not differentiate between emergency flights and inter-hospital transfer flights.

1.17.6 Independent audits of the operation

In August 2000, an independent organisation was tasked by CQRESQ to review the Mackay base draft operations manual, conduct an independent audit of the proposed operation and report to the Board of Directors before the specifications for the contract were distributed to those who had expressed an interest to submit tenders.

The audit addressed the suitability of the Mackay Base Hospital helipad for a Bell 206L3[49] size helicopter. It noted a requirement to extend the helipad if a larger helicopter (such as the Bell 412) was chosen. The audit also noted that because the helicopter currently in use (a Bell 206L3) was limited to VFR flight, it was unavailable for tasking on 76 per cent of the nights in 1997, 80 per cent in 1998 and 67 per cent in 1999. The audit concluded by stating that a twin-engine helicopter was a more viable option considering the scope of operation. The audit specifically mentioned that there would be little to be gained over the existing helicopter by acquiring a Bell 407, as the performance characteristics and operational limitations of the two helicopters were similar.

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47 An emergency flight was not defined.

48 On 8 September 2003, CHC Mackay base personnel were advised to not use the contract response times pending a Mackay Base Operating Procedures Manual revision.

49 The Bell 206L3 was the same general size as the Bell 407, with similar instrumentation, a slightly lower cruise speed and lower gross weight.

Following the contract awarding, an independent audit of CQRESQ was also completed by another organisation in September 2003 using ISO 9001:2000 criteria. The audit noted only very minor issues with the operation and did not address actual helicopter operational issues. Additionally, internal audits of the organisation were conducted in March 2003 and October 2004.

1.17.7 Helicopter tasking guidelines

The *Queensland Aeromedical & Air Rescue Network Helicopter Tasking Guidelines*[50] current at the time of the accident were developed as a practical aid to assist tasking agencies when allocating aeromedical and air rescue helicopter services throughout Queensland. They were designed to facilitate availability, co-ordination and monitoring of aeromedical and air rescue helicopters. According to the guidelines, there were essentially two types of aeromedical operations; inter-hospital transfers and aeromedical primary response.

Inter-hospital transfers were defined as providing transportation of patients from one Queensland Health facility to another. The tasking guidelines flow chart for an inter-hospital transfer included a statement which read:

> When a patient could be managed within the local health service every attempt should be made to do so. Advice and support can be sought from nominated senior rural practitioners, the flying specialist services and from clinical coordination centres.

The inter-hospital transfer tasking guidelines also stated:

1. All urgent (less that 24 Hours) inter-hospital aeromedical transfers must be referred to a Queensland Health approved Clinical Coordinator [a medical practitioner] in general this should be the Clinical Coordinator from the patient's destination.
2. The Clinical Coordinator will provide advice on patient management both prior to and during transport and decide on the most appropriate vehicle and crew for the transport.
3. The aircraft and crew will be tasked by the regional ACC [Ambulance Communication Centre].
4. The ACC will monitor the location and availability of aeromedical aircraft to ensure rapid tasking when required. The Aeromedical Desk located in the ACC in Brisbane monitors all aeromedical aircraft in the State.
5. When prioritisation of multiple patients is required the Clinical Coordinator of the tertiary centre and the appropriate ACC will ensure optimum use of aviation resources.
6. All decision making within this system must be clearly documented in accordance with the *Aeromedical Services Queensland Minimum Data Set*, as approved by the Queensland Emergency Medical System Advisory Committee (QEMSAC).

The investigation could not confirm that the categorisation of the patient as either an inter-hospital transfer or an aeromedical primary response was completed in accordance with the tasking guidelines. However, a Clinical Coordination Data Form Assessment listed the patient as suffering a trauma injury 'not danger body area', semi-urgent (6-24 hours) in priority, with a 'low dependency' predicted level of care.

50 Version 2, Issued December 2001

1.17.8 Helicopter flight-following

Operations manual flight-following[51] requirements

The CHC Mackay Base Operating Procedures manual required that 'Ops normal' broadcasts to the ACC were completed every 30 minutes for all flights. Information in the broadcasts included:

- Track
- Destination
- Estimated time of arrival (ETA)
- Persons on board
- Next 'Ops normal' call.

Responsibility for flight-following rested with the ACC located at Mackay. It was one of several communications centres within the state. Emergency calls for assistance were routed firstly to the ACC for prioritising, analysing and tasking a suitable response of emergency personnel and equipment.

Following the helicopter's overdue status, ACC personnel made numerous unsuccessful attempts to contact the helicopter's crew by both radio and mobile telephone, which was mounted in the helicopter. A review of the mobile telephone records for the telephone installed in the helicopter indicated several calls, which diverted to voice mail, from 2217 to 2253.

The Mackay ACC Standard Operating Procedure (SOP) Number 39 entitled 'Flight Following Procedures/CQ Rescue helicopter' stated:

> The CO [Central Office] will monitor the progress of CQRESQ by receiving 'OPS NORMAL' calls, which will be given at intervals of not more that 30 min apart, for flights greater than 40 min duration.

The pilot of CQRESQ will contact the comms room by radio giving the following departure details:

> Position, Destination, ETA and, or time of next call (OPS NORMAL call).

According to the aircraft flight manual route information, the flight from Mackay to Hamilton Island was 26 minutes, signifying that no 30 minute 'OPS NORMAL' call was required.

The SOP further stated that the pilot will nominate a SARTIME[52] when he considers that communications with the ACC may be unreliable or cannot be maintained. The pilot of HTD did not nominate a SARTIME.

The SOP did not note a requirement for pilots to notify the ACC upon arrival at the helicopter destination. Therefore, if the flight duration was less than 30 minutes, no communication with the ACC was required following an initial departure call.

ACC SOP number 40 entitled 'Helicopter Emergency' included a note that stated that it was extremely important that AusSAR was to be contacted without delay. The SOP included telephone numbers for contacts with the rescue organisation and the operators and names for the individuals. The SOP had not been revised to include the operator's current personnel or

51 Maintaining contact with specified aircraft to determine en route progress.

52 A time nominated by the pilot that when he/she fails to report, search action is required.

telephone numbers. The aircraft type listed was also incorrect[53]. Neither the registration of the Bell 407, nor the B206L3, were included in SOP number 40 (Refer to refer to appendix B for further details of the SOP).

Taped communications between HTD and the ACC were reviewed following the accident. The ACC operator did not strictly follow SOP number 40 when advising AusSAR of the loss of communication with the helicopter. When the ACC initially notified AusSAR of the overdue helicopter, the operator taking the call at AusSAR requested the registration of the helicopter. The ACC operator replied with 'CQ Rescue' which was the helicopter's call sign. There was initial confusion at the ACC as to the registration of the helicopter and the AusSAR operator was eventually erroneously given the registration of the backup Bell 206L3 helicopter, VH-LHP. AusSAR later corrected this error. The ACC notification to AusSAR came 32 minutes after the estimated time of arrival of the helicopter at Hamilton Island and 22 minutes after the initial phone call from Hamilton Island personnel asking about the status of HTD.

The ACC's SOPs included a Flight Safety Instruction titled 'Night Operations Rockhampton' issued by another operator and dated 29 November 2002, which stated that over water flights must be only undertaken when there is adequate celestial lighting and a visual horizon.

1.17.9 Night VFR operational requirements

CASA Aeronautical Information Publication (AIP) ENR (en route)

The AIP ENR 1. 'General Rules and Procedures' paragraph 19.2 'Flight under the VFR' defined the requirements for both day and night visual flight rules. Paragraph b. of this section stated:

> b. When navigating by visual reference to the ground or water, the PIC must positively fix the aircraft's position by visual reference to features shown on topographical charts at intervals not exceeding 30 minutes. When flying over the sea, visual reference features may include rocks and reefs and fixed man-made objects which are marked on suitable charts and are readily identifiable from the air.
>
> **Note:** Flight above more than SCT [scattered] cloud, or over featureless land areas, or over the sea, may preclude visual position fixing at the required intervals and may therefore make visual navigation impracticable.

The AIP ENR 1.2 'Visual Flight Rules' paragraph 1.1.1. stated:

> VFR flight may only be conducted:
>
> a. in VMC;
>
> b. provided that when operating at or below 2,000 FT above the ground or water, the pilot is able to navigate by visual reference to the ground or water;
>
> c. at sub-sonic speeds; and
>
> d. in accordance with the speed restrictions identified in ENR 1.1.79.

The AIP ENR 1.2 'Visual Flight Rules' Section 2 table 2.6 stated that for aeroplanes (and helicopters) at or below 3,000 ft AMSL (or 1,000 ft AGL whichever is higher) flight visibility must be 5,000m with the aeroplane or helicopter clear of cloud and within sight of the ground or water.

53 Information included in the SOP was dated 10 June 1998, and included flight duration's calculated on the cruise speeds of the B206L3 (maximum cruise speed 115 kts), not the Bell 407 (maximum cruise speed 133 kts).

CASA VFR Flight Guide

The CASA VFR Flight Guide publication included a flow chart under the night VFR Operations section to assist in quickly determining suitable conditions and requirements for night VFR operations. Appendix C displays the CASA VFR Flight Guide flow chart requirements. Item number 7 of that chart included a question concerning cloud. If the cloud was greater than 4/8 OKTAS (scattered or more cloud) below the Lowest Safe Altitude (LSALT), plus 1,000 ft on the area forecast, flight was not advisable due to inability to remain in VMC. The CASA VFR Guide Section 3 Operations Take-off, En-route and Landing also displayed graphically, the requirements for clearance from cloud for VFR flights. Appendix D displays the CASA VFR Flight Guide clearance from cloud requirements.

The LSALT for the flight from Mackay to Hamilton Island was estimated by the investigation team as follows:

- AIP GEN 3, paragraph 3.8 a.- 2,951 ft[54], applying the 10.3 degrees either side of track, plus 5 NM LSALT methodology
- AIP GEN 3, paragraph 3.8 b.- 3,154 ft[55], applying the 10 NM either side of track methodology
- AIP GEN 3, paragraph 3.8 a.- 3,181 ft, applying the 15 degrees either side of track, plus 5 NM methodology.

The helicopter flight manual included company-published route information for the Bell 407, including the route data for the flight from Mackay to Hamilton Island. The manual listed the LSALT as 3,000 ft[56],

Averaging the LSALT calculations, and adding the LSALT plus 1,000 ft as per the CASA VFR Flight Guide, would result in a required cruising altitude of 3,951 to 4,181 ft. The forecast cloud[57] would therefore have been below that altitude and have exceeded the CASA VFR Flight Guide 4/8 OKTAS limitation, indicating that flight at that altitude was not advisable. However, the pilot could have chosen to transit at a higher altitude as the forecast for Hamilton Island was acceptable.

Helicopter flight manual night VFR requirements

The Bell 407 helicopter had been type certificated by CASA on 24 February 1999. The helicopter's aircraft flight manual (AFM), BHT-407-FM-1, had received CASA approval on 28 September 1999. The AFM had no mention of night VFR or night flight restrictions in Section 1 LIMITATIONS, or elsewhere in the AFM.

At the time of the accident, under NIGHT FLIGHT LIMITATIONS, the Bell 206 BHT-206B-FM-1 AFM, previously approved by CASA for Australian registered Bell 206 helicopters, stated:

> Night flight operation is limited to visual contact flight conditions. Orientation shall be maintained through visual reference to ground objects solely as a result of lights on the ground or adequate celestial illumination.

54 Based on the 1,591 ft spot height at Cape Conway.

55 Based on Mount Jukes, elevation 1,794 ft, situated about 4.5 NM west of the approximate position of the occurrence.

56 Published on L4 ERC for the route Mackay to Hamilton Island.

57 Refer to Section 1.7.

The helicopter manufacturer advised that it considered the requirements for night VFR flight to fall into the domain of the local regulatory authority, and as such, was not eligible for inclusion in the Bell 407 BHT-407-FM-1 AFM. They further advised that their current revision planning would be to, in future, delete the night VFR reference from the Bell 206 BHT-206B-FM-1 AFM.

Operator night VFR requirements

The operator's Flight Operations manual titled 'Flight Operations-EMS Operations', included a paragraph titled 9.1 'Operations Under the VFR at night' that stated:

> The responsibility for terrain clearance at night rests with the PIC [pilot in command] and pertains to that period of time between the end of evening civil twilight and the beginning of morning civil twilight. Except as outlined below, aircraft must not be operated during this period below 1000' above obstacles within 10NM from any point along the aircraft's track of the published LSALT [lowest safe altitude]. Means for determining the LSALT can be found in AIP GEN 3.3-14. Note that consideration must be given to the height of terrain as well as obstacles.
>
> Aircraft may only be operated under the VFR at night below the LSALT when being radar vectored, conducting an instrument approach, during take off, conducting a visual approach within the prescribed circling area or when conducting nightsun operations IAW [in accordance with] the Operations Manual.
>
> Flight under the VFR at night may be conducted during SAR and EMS operations (or training for these operations) if the aircraft is equipped with a serviceable nightsun. Approach and departure procedures in the Operations Manual are to be adhered to where specified.
>
> The aircraft may be operated in the cruise not below 500' AGL [above ground level] and not below 300' AGL during a search, with the nightsun on with the following conditions:
>
> - only when conducting SAR [search and rescue] or MED [medical] 1 category flights
> - a thorough pre-flight preparation and briefing is conducted identifying potential obstacles enroute, if possible
> - an occurrence report is to be submitted to the base manager on return.

Operator VFR requirements

The operator's Flight Operations Manual included a requirement that pilots assess meteorological conditions prior to takeoff or landing to ensure the ability to comply with an ATC clearance or operate in accordance with the ceiling and visibility criteria for VMC or Helicopter VMC, as appropriate.

Aviation Services Unit, Operations Manual night VFR requirements

The Operations manual used by personnel operating the Queensland Rescue AS350 helicopter based at Brisbane included a notation which stated:

> The pilot must hold a current night VFR and Command Instrument Rating[58] and night sorties should only be conducted with fully qualified Aircrew Officers to support the pilot.

It also noted:

> Night over water transit operations should only be considered when favourable celestial lighting and visual horizon exist.

58 The rating allows a pilot to fly in cloud, day or night, in non-visual meteorological conditions.

1.17.10 Regulatory issues

Prior to the accident, CASA last completed an audit of the operator's Mackay base on 2 May 2002. The audit found no deficiencies within the organisation affecting the immediate safety of operations at the base. There was no record of any other audits of the base having been completed. CASA last completed an audit of the operator's home base on 26 July 2002. The audit found that the operator was conducting the majority of its operations to a high standard, in a safe and efficient manner.

Proposed changes to Australian Civil Aviation Regulations

Under Australian Civil Aviation Regulations (CAR) 206, helicopter EMS operations are classified as Aerial Work. This is in contrast to the typical classification of similar operations in New Zealand, UK, USA and Canada (see section 1.18.5 below).

In 1996, CASA began a major programme of reform of the Australian Civil Aviation Safety Regulations (CASR). However, difficulties with stakeholder consultation and communications processes have at times delayed progress[59]. The classification of EMS operations was one of many aspects under review as part of the regulatory change program. For further details concerning these proposed changes refer to appendix E.

1.17.11 Risk management issues

Risk management principles

Risk is the chance of something happening that could impact upon objectives. It is measured in terms of likelihood and consequences.

The concept of risk has three elements:

- the perception that something could happen
- the likelihood of something happening
- the consequences if it happens.

The level of risk is the combination of the likelihood of a risk occurring, and the consequences if it does occur. Action taken to manage or treat the risk, and therefore change the level of risk, will need to address the likelihood of any event occurring, or the consequence if it does occur, or both[60].

Operator risk management

The operator had no formal operational risk management program in place at the time of the accident at the Mackay base, nor was there a requirement to do so. The risk management policy applied by the operator, called a Quality Risk Assessment, was done during the vetting of the contract and related to the assessment of risk concerning the contractual requirements, the helicopter type to be used to support the requirements and the overall risk to the operation. The Quality Risk Assessment also evaluated the emergency response plans and flight following when managed by the clients. The Quality Risk Assessment did not assess day to day operational risk, or potentially hazardous issues relating to flight regimes and equipment required.

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59 CASA Annual Report 2000–01.

60 *A basic introduction to managing risk using the Australian and New Zealand Risk Management Standard AS/NZ 4360:1999*, Standards Association of Australia, 1999, Strathfield, NSW, Australia.

1.18 Additional information

1.18.1 Risks associated with night VFR helicopter EMS operations

Flight operations at night

Night VFR operations present a number of distinct hazards and piloting challenges that are not encountered during day operations. At night the pilot has a greatly reduced amount of visual information to rely on and, in addition, some of that information may be misleading due to the effects of night visual illusions[61].

In reduced lighting conditions, the ability to distinguish small or distant objects is greatly diminished and colour vision is markedly degraded. Distance determination can be particularly difficult in the dark. The human eye takes approximately 30 minutes to completely adapt to darkness and reach its maximum sensitivity to low levels of light[62]. Under low light conditions, the greatest visual sensitivity is no longer in the central area of focus, but occurs in the periphery of the visual field. Therefore, when conducting night VFR flights, it is particularly important for a pilot to scan outside the cockpit frequently and to avoid straight-ahead fixations.

A pilot flying under night VFR can potentially be mislead by a range of night visual illusions such as 'false horizon' effects. For example, in dark night conditions, a steady prominent light (such as used on ocean going vessels) can produce a strong sensation that the light is positioned above the horizon, rather than below the horizon as is actually the case. This can result in a very strong sensation that the aircraft is climbing, leading to the possibility that the pilot will pitch down the nose of the aircraft to compensate. Autokinesis is another potential dark night illusion. A single stationary ground light, or star against a black background, may appear to wander due to the pilot's own involuntary eye movements[63].

The lack of visual information available to a pilot flying under the VFR on a dark night, coupled with the potentially misleading effects of night visual illusions, has the potential to result in the pilot being susceptible to spatial disorientation. The danger of spatial disorientation can be further increased if the night flight is conducted in marginal weather conditions.

Spatial disorientation

Spatial disorientation refers to a situation in flight in which the pilot fails to sense correctly the position, motion or attitude of the aircraft and has been described as follows:

> Spatial disorientation to a pilot means simply the inability to tell which way is 'up'.[64]

The risks of non-instrument rated pilots flying in conditions in which they are not able to orientate the aircraft by visual means has been well known for over 50 years. During testing conducted on a group of non-instrument rated pilots, the average time before the loss of control of the aircraft was lost, after visual reference was lost, was just 178 seconds[65].

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61 Benson, A J. (1999). *Spatial disorientation - General aspects, and Spatial disorientation - Common illusions*. In J Ernsting, A N Nicholson, and D J Rainford, Aviation Medicine. Butterworth-Heinemann: Oxford, UK.

62 O'Hare D and Roscoe S (1990). *Flightdeck performance: The human factor*. Iowa State University Press: Ames, IA.

63 Previc, F H, & Ercoline, W R (2004). *Spatial disorientation in aviation*. American Institute of Aeronautics and Astronautics: Reston, VA.

64 *Pilot's spatial disorientation*. FAA Advisory Circular AC 60-4A, 1983. FAA: Washington, DC.

65 Bryan, LA, Stonecipher, JW, & Aron, K. (1954). *180-degree turn experiment*. University of Illinois Bulletin, 54(11), 1-52.

Advice provided to United States of America (US) pilots by the US Department of Transportation Federal Aviation Administration (FAA) indicates that basic adherence to flight regulations concerning the minimum requirements for VMC may not be sufficient alone to protect a pilot from the dangers of spatial disorientation caused by loss of visual reference with the ground or water. A part of that advice stated:

> Surface references and the natural horizon may at times become obscured, although visibility may be above visual flight rule minimums. Lack of natural horizon or surface reference is common on over water flights, at night, and especially at night in extremely sparsely populated areas, or in low visibility conditions. [64]

Spatial disorientation can be a particular problem in helicopter operations[66]. Unless a helicopter is fitted with some form of autopilot or stability augmentation system, it will require constant control input from the pilot in order to maintain heading and altitude. A helicopter typically cannot be trimmed for straight and level flight in the same way that most fixed-wing aircraft can. As a result, pilots must divide their attention between basic control of the helicopter and the requirements of other essential operations, such as navigation and communication activities.

In a report into the safety aspects of helicopter EMS operations, the US National Transportation Safety Board (NTSB) summarised the risks of spatial disorientation after loss of visual reference as follows[67]:

> If the pilot is not trained (and current) to fly the aircraft by reference to instruments, there is a great risk of losing control of the aircraft. Even if the pilot is instrument rated, current, and proficient in helicopters, success in coping with inadvertent instrument flight is not guaranteed. The FAA has reported that in tests with qualified instrument pilots, it took as long as 35 seconds for some of the pilots to establish full control of the aircraft by instruments after the loss of visual contact with the surface (and these tests were conducted with fixed-wing aircraft, which are inherently more stable than helicopters).

VFR flight into IMC conditions is a major factor in many spatial disorientation accidents[68]. In such situations, pilots who do not hold an instrument rating, or who are flying at night, are at particular risk. For example, during the period 1994 to 2003 there were at least 83 fixed and rotary wing VFR flight into IMC spatial disorientation accidents in the US[69]. Non-instrument rated pilots were involved in the majority (83%) of the accidents recorded. The data also clearly indicated that darkness increases the risk of spatial disorientation occurrences. Though the vast majority of hours flown are in daylight, almost half of the accidents (47%) occurred during night flight. Figure 16 displays the number of US fixed and rotary wing aircraft VFR into IMC spatial disorientation accidents, with related conditions and ratings of the pilots, for the period from 1994 to 2003.

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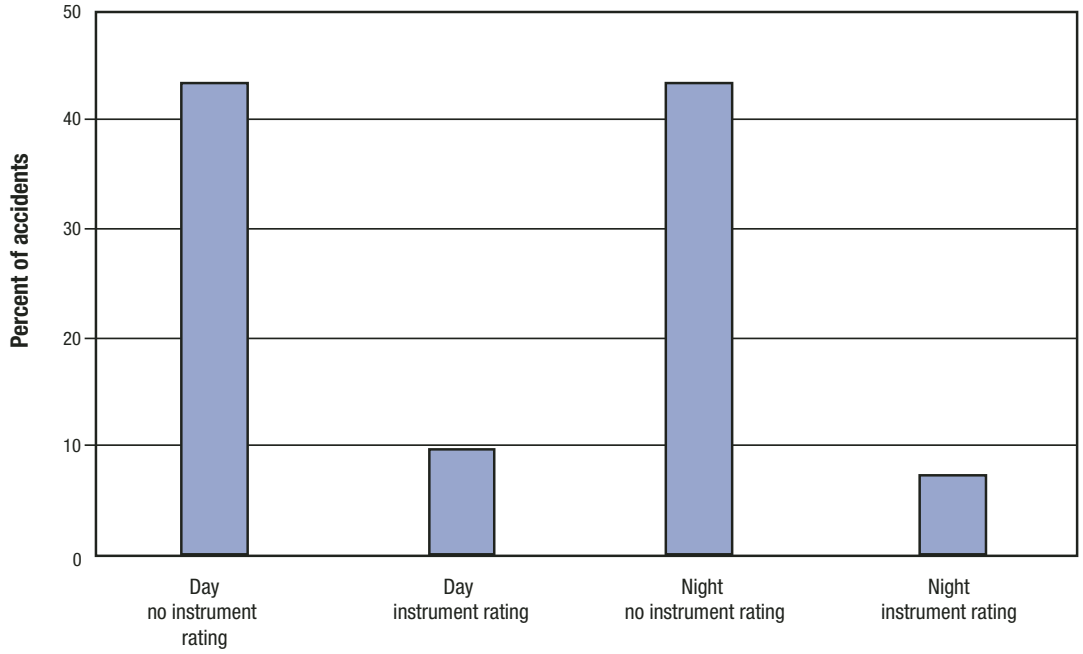
66 Hart, S A, (1988). *Helicopter Human Factors.* In E L Wiener and D C Nagel, *Human Factors in Aviation*. Academic Press: San Diego, CA.

67 *Safety study - Commercial emergency medical service helicopter operations*. US National Transportation Safety Board Report No. NTSB/SS-88/01, 1988. NTSB: Washington, DC.

68 For the period 1991 to 2003, the NTSB recorded ten helicopter EMS accidents in which 'VFR into IMC' was considered to be a factor.

69 *Spatial Disorientation Confusion that Kills*, AOPA Air Safety Foundation, Safety Advisory Physiology No. 1: 2004, AOPA: Frederick, MD.

FIGURE 16: US VFR into IMC spatial disorientation accidents 1994 to 2003



Limited panel flying

One particular aspect related to spatial disorientation is that of limited panel flying. Limited panel flying is very demanding and previous occurrence investigations have indicated that even highly experienced IFR-rated pilots are challenged to fly safely in such a configuration. Limited panel flying by a pilot inexperienced in IFR flight and operating in low celestial or artificial lighting conditions, during flight under the night VFR, may impose a significant safety risk.

Loss of the functionality of a normally electrically operated primary attitude indicator, on a helicopter not equipped with a standby attitude indicator during flight under the VFR at night, would result in limited or partial panel flying by the pilot.

1.18.2 Helicopter EMS safety issues

The first commercial EMS helicopter service to offer advanced life support began in Colorado, USA, in 1972. The number of US helicopter EMS operations grew rapidly during the late 1970s and early 1980s. In the early years of helicopter EMS operations the accident rate was more than three times higher than the accident rate for other helicopter operations[70]. In 1986, the US helicopter EMS accident rate rose to 17.08 accidents per 100,000 flight hours. As a result, both the FAA and the NTSB carried out studies to determine the reasons for the high EMS helicopter accident rate[71].

70 Veillette, P R. (2001). *Human error cited as major cause of US commercial EMS helicopter accidents*. Flight Safety Digest, April-May 2001. Flight Safety Foundation: Alexandria, VA.

71 *Investigation of hazards of helicopter operations and root causes of helicopter accidents*. FAA Report No. DOT/FAA/PM-86/28, 1986. FAA: Washington, DC.
Safety study - Commercial emergency medical service helicopter operations. NTSB Report No. NTSB/SS-88/01, 1988. NTSB: Washington, DC.

The FAA and NTSB studies highlighted the importance of the following two aspects in relation to EMS helicopter accidents:

- pilot decision making
- helicopter EMS program risk management.

As a consequence, the FAA developed a series of training manuals to address these issues. Specific manuals were developed for pilots, operators, and helicopter EMS administrators[72]. By 1997, the accident rate for helicopter EMS operations had been reduced to 1.97 accidents per 100,000 flight hours.

The training material produced for pilots emphasised the importance of sound aeronautical decision making in flight operations. A series of awareness exercises covered examples from the four accident types most frequently associated with EMS operations; night flying, weather, obstacle strikes, and mechanical failures.

Guidance material aimed at administrators outlined the limitations of helicopter EMS operations, including the increased risks of operating in marginal VMC, reduced visibility, and/or at night. Material prepared for operators described techniques and tools that could be used to balance the demands of running a business with the need to maintain safety. Emphasis was given to the importance of applying sound risk management principles to helicopter EMS operations right from the beginning when a service contract was being developed.

The FAA training and guidance material emphasised that, while sound pilot decision making was crucial to safe operations, of equal importance was the management of risk by operators and EMS program administrators (FAA *Risk management for air ambulance helicopter operators*). The FAA material noted that:

> Independently (duty pilot) controlled risk is a delicate situation that depends upon consistent flawless performance by the pilot even when under adverse and changing circumstances. Any mistakes, oversights, or underestimation of risks can result in an occurrence or incident. However the managerial control of risk through the systems approach provides an optimal set of checks and balances that assures risk reduction.

The NTSB study also addressed the management structure of helicopter EMS operations, describing the typical hybrid combination of separate hospital/emergency service management and helicopter operator management as providing few advantages and many potential problems. As the report (NTSB *Safety study: Commercial emergency medical service helicopter operations*) stated:

> The two separate management structures occasionally have objectives that conflict and thus adversely impact safety.

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72 *Aeronautical decision-making for air ambulance helicopter pilots: Learning from past mistakes*. FAA Report No. DOT/FAA/DS-88/5, 1988. FAA: Washington, DC.
Aeronautical decision-making for air ambulance helicopter pilots: Situational awareness exercises. FAA Report No. DOT/FAA/DS-88/6, 1988. FAA: Washington, DC.
Aeronautical decision-making for air ambulance administrators. FAA Report No. DOT/FAA/DS-88/8, 1990. FAA: Washington, DC.
Risk management for air ambulance helicopter operators. FAA Report No. DOT/FAA/DS-88/7, 1989. FAA: Washington, DC.

The NTSB study outlined the potential conflict that can exist when the pilot is employed by the helicopter operator, but works at a remote base and has greater day-to-day contact with the EMS program management as follows:

> Conflict in this situation can occur because pilots are required to make judgements that directly influence the safety of every EMS flight, yet, if they make a judgement that displeases the hospital administrator (such as cancelling a flight due to weather, especially a flight which a competing program subsequently completes), it could be used against their employer when the contract is renewed. This problem is further complicated by the fact that pilots usually have no on-site management from whom they can seek guidance. Pilots may even receive criticism of their judgement from the operator management when the hospital program administrator calls the EMS helicopter management and complains. If the operator management does not back up the pilots' decision, pilots may feel compelled to complete a flight trip in spite of their discomfort with a proposed mission.

The NTSB report also outlined the way in which the particular mission imperatives of EMS operations can potentially influence a pilot's decision making as below:

> Hospital management, the EMS medical personnel, and the dispatchers can all intentionally or unintentionally put pressure on the pilots to take a flight in marginal weather conditions.

In this situation, strong support of the pilot by operator management is important to reduce the chance that mission imperatives will influence pilot decision making. This support may be more difficult to achieve when the operation is remote from the operator's main base.

As outlined above, the US helicopter EMS accident rate was reduced significantly in the period from 1987 to 1997. However, in 1998, there was again a marked increased in US helicopter EMS accidents. Between 1987 and 1997, there were on average four helicopter EMS accidents per year. In 1998, the number of accidents rose to eight, then to ten in 1999, and to twelve in 2000[73].

As a result of this increase in accidents, an industry summit was convened and an Air Medical Service Occurrence Analysis Team was created. In its report, the team recommended that the US Air Medical Safety Advisory Council focus efforts on developing implementation strategies for the six interventions that were deemed to be both highly effective and highly feasible. Four of the six recommended interventions related to aircraft equipment such as radar altimeters and terrain avoidance warning systems, and to pilot training for mountain flying operations. The other two interventions in this category were to:

- enhance training for night flying operations
- improve the content of weather briefings.

These findings emphasise that the combination of marginal weather and night operations remain a dangerous combination in helicopter EMS operations. It corroborates the FAA finding of the 1980s that 67 per cent of all fatal helicopter EMS accidents were weather related, and that 71 per cent of those occurred during the hours of darkness (FAA *Aeronautical decision making for air ambulance helicopter pilots: Situational awareness exercises*) as follows:

> Even on the clearest night with VFR conditions, a pilot can come close to IFR operations if there is no moon and/or no ground lights to establish a horizon reference.... However, the real 'killer' lurking in the night sky is unseen cloud. Clouds disappear easily in the dark and you can fly into one without seeing it coming. *Accordingly, the prudent aeromedical pilot must be proficient in keeping the helicopter upright by reference to instruments, even if he's not instrument rated.* [emphasis in the original]

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73 *A safety review and risk assessment in air medical transport*, Air Medical Physician Association, 2002. AMPA: Salt Lake City, UT.

Flight Safety Foundation EMS helicopter study

In 1996, the Flight Safety Foundation conducted a study[74] of EMS helicopter pilots to determine the influence of experience on pilot performance during inadvertent flight into IMC at night. The simulator based study was based on a group of 28 pilots of which all but three were IFR-rated. The pilots were told that the autopilot was inoperative and could not be used during the mission to ensure pilots who regularly used the system would not have an added advantage. The results of the study concluded that pilots with a higher average of flight hours and instrument flight hours scored better than their counterparts. It also noted that bank angle was a frequent source of comment of the instructors, who specifically noted excessive bank angles on 8 of the 28 pilots' flight performances. This study also noted that for the period 1987–1993, although only 37 per cent of EMS flights were conducted at night, 72 per cent of the accidents occurred at night.

1.18.3 Australian helicopter EMS accident rates

A recent study of Australian helicopter EMS accidents rates for the period 1992 to 2002[75] indicated that the overall Australian helicopter EMS accident rate was similar to that reported in other countries. However, there were significant differences in accident rates between the Australian States. New South Wales, with the highest level of helicopter EMS activity, recorded no helicopter EMS accidents during the period 1992 to 2002, while Queensland recorded three accidents within the same period (see Table 3). No other Australian State or Territory recorded a helicopter EMS accident during the period 1992 to 2002[76].

TABLE 3: Australian helicopter EMS activity and accidents by State – 1992 to 2002[77]

State	*Missions*	*Patients*	*Flying hours*	*Accidents*
NSW	21,336	21,336	32,421	0
QLD	16,899	16,795	23,199	3
VIC	9,524	7,829	8,720	0
SA	1,982	2,080	3,164	0
TAS	423	423	931	0
Total [78]	50,164	48,463	68,435	3

As outlined in section 1.17, helicopter EMS operations in Queensland were conducted either directly by the Queensland Government Helicopter Rescue Service (Queensland Rescue) or by local organisations called Community Helicopter Providers (CHP). During the period from 1992 to 2002 a similar number of helicopter EMS missions were flown by the Queensland government service (8,532 missions and 11,212 flying hours) and by CHP operations (a total of 8,367 missions and 11,987 flying hours).

74 *EMS Helicopter LOFT [line orientated flight training] Study Shows Experience Influences Pilot Performance during Inadvertent Flight into IMC*, Flight Safety Foundation Helicopter Safety, Volume 22, No. 1, January-February 1996, Flight Safety Foundation, Alexandria, Virginia.

75 Holland J and Cooksley DG (2005). *Safety of helicopter aeromedical transport in Australia: A retrospective study*. Medical Journal of Australia, 182, 17-19.

76 To allow a valid comparison with helicopter EMS accident data from other countries, the accident data reported by Holland and Cooksley (2005) did not include ad-hoc patient transports by commercial (non-HEMS) helicopter operators, or EMS operations such as winch (hoist) operations or 'search and rescue' missions.

77 Data from Holland and Cooksley (2005).

78 Ad-hoc patient transports by commercial non- helicopter EMS services operators, as occurred in the Australian Capital Territory, Western Australia and the Northern Territory during the study period were excluded.

All three Queensland helicopter EMS accidents that occurred during the period 1992 to 2002 involved services operated by CHP. For more information regarding past Australian helicopter EMS accidents refer to appendix F.

Table 4 compares the total accident rate and the fatal accident rate (expressed per 100,000 flying hours) for different helicopter EMS services both in Australia and internationally. The data indicated that the overall accident rate for Queensland CHP helicopter EMS services were more than five times higher than the Australian national average and that the fatal accident rate was nearly eight times higher than the national average.

TABLE 4: Helicopter EMS services accident rates comparisons

Helicopter EMS service	*Period*	*Fatal accident rate †*	*Total accident rate †*
Australia (total)	1992 to 2002	1.46	4.38
Australia (excluding QLD)	1992 to 2002	0.00	0.00
QLD government	1992 to 2002	0.00	0.00
QLD Community Helicopter Providers	1992 to 2002	8.34	25.03
Germany	1982 to 1987	4.1	10.9
United States	1982 to 1987	4.7	11.7
United States	1992 to 2001	1.69	4.83

† Accident rate per 100,000 flying hours. Adapted from Holland and Cooksley (2005).

1.18.4 Recent overseas Bell 407 helicopter EMS accidents

On 21 March 2004, at 0220 local time, a Bell 407 EMS helicopter was destroyed when it impacted trees while manoeuvring in reduced visibility conditions near Pyote, Texas, USA. Four occupants were fatally injured, and one seriously injured. Night IMC conditions prevailed at the time of the accident. An investigation into the accident is being conducted by the NTSB.

On 13 July 2004, at 0535, a Bell 407 EMS helicopter collided with trees shortly after takeoff near Newberry, South Carolina, USA. The four occupants were fatally injured. Night VMC with mist and light fog and a no moon condition prevailed at the time of the accident. An investigation into the accident is being conducted by the NTSB.

On 21 August 2004, at 2358, a Bell 407 EMS helicopter impacted mountainous terrain near Battle Mountain, Nevada, USA. The five occupants were fatally injured. Dark night VMC and a no moon condition prevailed in the area at the time of the accident. An investigation into the accident is being conducted by the NTSB.

1.18.5 Overseas helicopter EMS operations

As part of the investigation, a comparison was made between the Australian requirements for EMS helicopter night VFR flights and similar operations in New Zealand, Canada, the US and the UK.

Australia

Air operations in Australia were classified as belonging to one of four categories:

- Regular public transport (RPT)
- Charter
- Aerial Work
- Private

RPT operations attract the highest level of regulation and CASA safety oversight, and private operations the least. Helicopter EMS flights in Australia, are categorised as Aerial Work[79].

New Zealand

EMS helicopter flights in New Zealand are conducted as Air Transport[80] operations. In a recent investigation into a helicopter EMS night VFR flight, controlled flight into terrain (CFIT) accident, the New Zealand Transport Accident Investigation Commission (TAIC) report[81] identified a number of safety issues including;

- the need for air operators to include in their operations manuals practical guidance material for night VFR flights
- the need for guidance material for all night VFR flying.

Following the investigation into the accident, TAIC issued a report which stated:

> The major practical differences between night and day VFR operations arise because, while in each case the pilot is required to maintain visual contact with the ground, at night in undeveloped areas there may be insufficient surface definition for continuous visual navigation or for terrain avoidance, even though visibility is clear. A further difference is that at night it may often not be possible to see cloud ahead until the aircraft has entered it. One outcome of these considerations is that at night a minimum safe altitude for the route must be determined beforehand, rather than just knowing the height of the route. Another need is for instrument flying ability, so that inadvertent flight into cloud can be managed without difficulty or danger.

As a result of the TAIC recommendations, the NZ Civil Aviation Authority agreed to publish a Good Aviation Practice booklet containing guidance material for night VFR flying.

Canada

EMS helicopter flights in Canada are classified as Air Transport[82] operations. As a result, all night VFR EMS flights in Canada are conducted with twin-engine, IFR-equipped helicopters, with two IFR-rated crewmembers as required for that category.

There have not been any night VFR accidents involving Canadian helicopter EMS operations since the inception of dedicated night VFR helicopter EMS operations. The Canadian approach to helicopter EMS operations at night recognises the inherent limitations of defining VFR conditions simply in terms of cloud base and visibility. In essence, it may be possible to see for miles, but there may not be anything to see. That is, there may not be any visually identifiable reference that the pilot can use for orientation or navigation.

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79 CAR 1988 206(1)(a)).

80 This is a higher level of classification of operation than Australian Aerial Work.

81 NZ Transport Accident Investigation Commission (TAIC) Report 03-001, *Kawasaki BK-117 helicopter ZK-III collision with tree tops at night Tararua Range* 14 January 2003.

82 This is a higher level of classification of operation than Australian Aerial Work.

> In certain circumstances, the meteorological conditions may meet the criteria to permit VFR flight but the visual references may not be adequate for safe flight. Examples of such circumstances are: 'whiteout' conditions where a cloudy sky over snow covered terrain with no man-made landmarks causes a situation where sky and land blend together, no landmarks are available and a horizon cannot be distinguished; during operations at night over sparsely settled areas where the absence of lighted man-made landmarks leaves little or nothing visible on the surface; or during 'dark night' conditions with neither moon, stars nor ground lights illuminating the surface over which the flight is being made[83].

United States of America

EMS helicopter flights in the US are classified as commercial flights[84] and are conducted under FAR Part 135[85].

Part 135 Section 135.207 specifies the horizon reference requirements necessary for VFR helicopter operations by day or night.

> No person may operate a helicopter under VFR unless that person has visual surface reference or, at night, visual surface light reference, sufficient to safely control the helicopter.

United Kingdom

EMS helicopter flights in the United Kingdom are classified as Public Transport[86] and carried out in compliance with the European Joint Aviation Authority (JAA) JAR-OPS 3 'Commercial Air Transportation (Helicopters)'.

JAR-OPS 3 details specific requirements for helicopter EMS operations in Appendix 1 to JAR-OPS 3.005(d). 'Helicopter Emergency Medical Service (HEMS)'. This document details a range of requirements relating to helicopter EMS operations including aspects such as:

- helicopter performance requirements
- operating minima
- crew selection and experience
- crew composition for day and night operations
- crew checking and training.

In particular Appendix 1 section (c)(3)(iv)(B) stipulates a minimum crew of two pilots for night operations unless a range of other requirements are met:

> (B) *Night flight.* The minimum crew by night shall be two pilots. However, one pilot and one HEMS crew member may be employed in specific geographical areas defined by the operator in the Operations Manual to the satisfaction of the Authority taking into account the following:
>
> (B1) Adequate ground reference;
>
> (B2) Flight following system for the duration of the HEMS mission (see AMC to Appendix 1 to JAR-OPS 3.005(d), sub-paragraph (c)(3)(iv)(B)(B2));

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83 Regulatory Impact Analysis Statement for Canadian CAR 705.46. This statement was made in support of a night VFR aeroplane regulation and not helicopter operations. However, its philosophy is consistent with that of Canadian helicopter EMS operations.

84 This is a higher level of classification of operation than Australian Aerial Work.

85 Part 135 relates to the operating requirements for commuter aircraft flights and 'on demand' air taxi type operations.

86 This is a higher level of classification of operation than Australian Aerial Work.

(B3) Reliability of weather reporting facilities;

(B4) HEMS minimum equipment list;

(B5) Continuity of a crew concept;

(B6) Minimum crew qualification, initial and recurrent training;

(B7) Operating procedures, including crew co-ordination;

(B8) Weather minima;

(B9) Additional considerations due to specific local conditions

The JAA has also issued an 'Advisory Circular – Joint' (ACJ) that provides 'Acceptable Means of Compliance' and 'Interpretative Material' (AMC & IM) in relation to Appendix 1 of JAR-OPS 3.005(d). This additional guidance material outlines the JAA helicopter EMS philosophy, based on acceptable risk standards. The underlying principle is that the aviation risk should be proportional to the task (for further details relating to JAR-OPS 3.005 refer to appendix G).

1.18.6 Previous Australian helicopter occurrences involving night VFR flight

For details on previous Australian helicopter occurrences for the period 1994 to 2003 involving flight under the night VFR refer to appendix H.

1.18.7 Previous night VFR flight to Hamilton Island

On 3 September 2003 at 0141, the pilot of HTD conducted a patient transfer under conditions similar to the accident flight, flying from Mackay to Hamilton Island and return. The moon had set at 2328 on 2 September 2003, signifying a flight completed with no celestial illumination.

Available runway lighting at Hamilton Island included portable runway lighting and low intensity runway lighting[87]. Prior notification was required in order to activate that lighting. The lights were deactivated manually by the airport duty member. CASA requirements for aerodrome lighting stated that the lights should be operated for a departing aircraft at least 10 minutes before the estimated time of departure to at least 30 minutes after takeoff.

Personnel on board the helicopter that night reported that during the departure from Hamilton Island, and as the helicopter was climbing through 500 to 1,000 ft above the airfield, the runway lighting was extinguished by the airport duty member. They further reported that within an estimated 1 minute of the runway lights being extinguished, the pilot asked whether the crew could 'see the [runway] lights'[88]. The crewman replied that he could not. The pilot continued the climb and commenced a left turn. The pilot was flying from the right seat, and the runway 14 circuit direction was to the right. During that turn, the pilot again asked whether the crewman could see the island surface/ground-based lights. It was reported that the pilot's voice was at a noticeably heightened level of anxiety during the event. Once the pilot had reacquired the island surface/ground-based lights, he was reported to 'settle down' somewhat, and the flight continued on track to Mackay uneventfully. The crew conducted an informal de-brief after the flight, during which the pilot was reported to have related that he, '…had lost reference [during the departure from Hamilton Island], and had to get comfortable again'.

87 Back-up power was available via a manual switch by the airfield operator.

88 During takeoff from Runway 14, the island's built up area lights would initially be obscured by the high ground to the centre of the island. Therefore, the only concentrated ground lighting on the island once the airfield lights were extinguished would be on the NE side and would initially not be in sight.

The left turn completed by the pilot during this event:

- was contrary to the published circuit direction
- was towards the high ground on the island
- required him to look through/across the cockpit to reacquire the surface/ground-based lights of the island built-up area.

1.18.8 Night VFR simulation flight

On 28 October 2003, at approximately 2117, ATSB personnel, along with a qualified commercial IFR-rated pilot, conducted a night VFR flight in an IFR equipped aircraft that simulated the flight path of HTD to the extent possible[89]. The forecast weather for the simulated flight was similar to that on the night of the accident:

- isolated thunderstorms and scattered showers
- wind at 2,000 ft was 20 kts from the north-west, and at 5,000 ft was 25 kts from the north west
- cloud was broken stratus at 1,000 to 3,000 ft with precipitation, and scattered cumulus at 1,800 to 7,000 ft over the sea/coast
- visibility was 2,000 m in thunderstorms, 4,000 m in showers and 7 km in smoke reducing to 2,000 m in thick smoke[90].

The flight was conducted in dark night conditions. There was no surface/ground-based lighting either left or right of the track and only intermittent surface vessel lights were visible for reference. There was no celestial lighting and the horizon was not visible when flying over the water to the north-east. Although the forecast weather conditions met the regulatory requirements for flight under the night VFR, and the flight was conducted clear of cloud, maintaining a visual reference to the horizon was not possible.

1.18.9 Witness reports

Witness reports by members of the public

Several witnesses were interviewed who reported seeing or hearing the helicopter on the night of the accident. Of those interviewed, one witness reported seeing a 'red glow' in the area of the flight path of the helicopter. Another reported a 'blue glow' in the estimated area of the flight path. Another witness reported seeing flares in the estimated impact area off of Cape Hillsborough. Several witnesses on land reported rain showers on the coast that night in the area of the flight.

Pilot of BK117 witness report of weather

The flight crew of BKE reported that while en route to the last known position of HTD, they were required to fly under cloud at about 2,500 to 2,600 ft AMSL and that it was a black featureless night. They reported that they did not fly through rain on the flight from Hamilton Island to the search area. They also reported that they had dropped a flare when they had spotted a flashing strobe light in the water (see section 1.15.2).

89 The simulation aircraft was unable to exactly duplicate some turning manoeuvres made by the pilot of HTD because of the limitations of the aircraft's manoeuvring envelope.

90 If not in these conditions, the forecast visibility would be greater than 10 km.

1.18.10 Independent post-accident review of the Queensland aeromedical and air rescue helicopter network

Following the accident, the Queensland Department of Emergency Services commissioned an independent review by an aviation safety consultant, of aeromedical and air rescue helicopters services in Queensland, including the CHP and Queensland Rescue. In addition, the Queensland Department of Emergency Services also reviewed:

- the Queensland Aeromedical Retrieval System
- the clinical coordination arrangements across Queensland
- the safety provisions in current Service Agreements with the CHP
- the aeromedical services of the Torres Strait and Northern Peninsula Area.

Minimum helicopter standards

The report addressed the suitability of the current minimum standard helicopter for aeromedical and air rescue services stating that the minimum standard of helicopter for aeromedical and air rescue remained a single-engine turbine powered VFR helicopter. However, the report also recommended an upgrade of the Torres Strait CHP to a twin-engine IFR helicopter citing:

- all flights were over water with no towns or cities in sight
- no visual horizon on moonless nights
- an operating environment similar to an offshore oil platform
- the need for a helicopter with greater capacity.

One of the short-term solutions proposed by the report was imposing restrictions or limitations on CHP night VFR operations, such as those currently in use by the Queensland Rescue single-engine VFR helicopters[91]. Another short-term solution suggested was to restrict CHP utilising single-engine VFR helicopters to daylight operations only. However, it was stated that this option could result in increased flying of missions by Queensland Rescue twin-engine IFR helicopters and the resulting increases in cost to the government and backlash of the local communities from the resultant lower response times and service levels.

Regarding equipment fit out of the CHP helicopters, the report noted that the attitude indicator on VFR helicopters was not prominent and consideration should be given to fitting a larger instrument. The report mentioned that one CHP had installed standby attitude indicator in their helicopter fleet.

Helicopter tasking

Addressing the importance of clinical coordination and it's vital role in the process of providing the most appropriate use of air assets, the report stated that the training of personnel to effectively undertake the coordination of tasking may not have occurred to the standard required. It also reported that there was a need to ensure full coordination of each tasking to minimise risk, especially during night VFR flights, and that in the past some unnecessary patient transfers were accomplished that could have waited until conditions were more favourable.

The report also advocated a centralised clinical coordination process to ensure that the right asset was used in the right circumstance to warrant the risk involved.

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91 The pilot must hold a current night VFR rating and a Command Instrument Rating and night VFR flights should only be considered when celestial lighting is favourable and a visual horizon exists.

Pilot experience and operational matters

The report noted that aeromedical and air rescue operations could be demanding and therefore heavily reliant on the skills and experience of the operating crew. The report observed that lack of experience in a demanding role may have been a contributory factor in two separate fatal accidents involving CHP, including the Mackay accident. It was suggested that experience levels in relatively new operations may have been further affected by changing operator personnel.

It further noted that given the nature of helicopter EMS night VFR flights, the possibility existed that pilots might encounter weather conditions that were below night VFR minima. Therefore, training pilots to the higher standard of a full instrument rating would have a marked improvement on safety. The report recommended that all pilots involved in aeromedical and air rescue operations have a current instrument rating or have held a Command Instrument Rating and maintain competency only.

The report noted that the level of exposure of CHP pilots to night VFR flying, would not constitute recency in this very difficult flying environment, and suggested that the CHP adopt specific and extensive night VFR training programs to ensure recency.

The report also addressed pilot decision making, mentioning that it was important that decisions made by the pilot on duty to accept or reject a flight were fully supported by the organisation, including by the backing of operating procedures to allow tasks to be refused without fear or retribution or job loss. The report also commented on the possibly of a conflict of interest arising between management and operations in the CHP related to sponsorship and said that it must be made clear that there was no pressure on a crew to accept a task against their better judgement.

Results of related audit

The report noted that the Independent Review of the Aeromedical Retrieval System in Queensland had raised a number of issues concerning clinical governance. The issues included the need for experienced staff, a centralised tasking process, and for training including that related to the use of helicopter and their operating constraints.

Report conclusions

The report summary also stated that implementing higher standards of aeromedical and air rescue operations (i.e. full IFR capability) would be onerous, costly and time consuming. It went on to say that once established, the cost of maintaining the new standard would be in the order of two to three times the current budgetary requirements.

1.18.11 Standards and accreditation of aeromedical services

Historically, Australia has been a pioneer in the development of aeromedical services from an operational perspective. However, there is not a comparable record for the development and implementation of uniform standards and recommended practices for those services.

Currently, Australian does not have a national standard or a system of accreditation for the provision of aeromedical services, including helicopter EMS services. There is no Australian equivalent of the US Commission on Accreditation of Medical Transport Systems (CAMTS) that provides a program of evaluation of compliance with accreditation standards for aeromedical service providers. This shortcoming has been recognised for some time. In 1993, the Australian Health Ministers' Advisory Council (AHMAC) published a report by the AHMAC Aeromedical Services Working Party into aeromedical services in all states of Australia.

Key findings of the report were that there was a need for a more strategic and synchronised approach to the provision of aeromedical services, and that there was a need for uniform standards and a national system of accreditation.

The AHMAC Aeromedical Services Working Party's recommendations for 'Required Action' indicated that:

- a composite set of standards should be developed covering all aspects of the aeromedical service
- a process of accreditation should be established under the auspices of a professionally acknowledged agency such as the Australian Council of Health Care Standards, drawing upon recognised peak agencies in aviation, communication and health expertise.

At the time of this report, no Australia-wide composite set of standards or process of accreditation has been implemented.

1.19 New investigation techniques

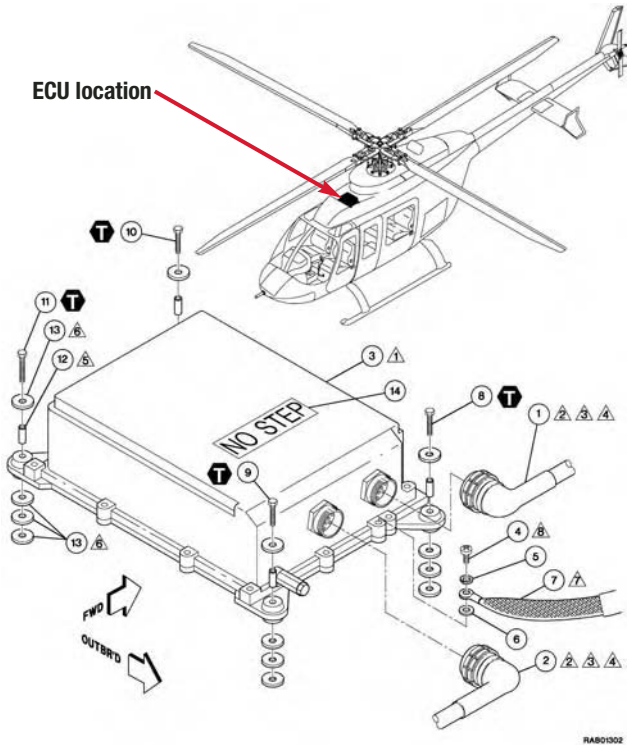
Engine electronic control unit

The helicopter was equipped with a single-channel, full authority, digital electronic control (FADEC). That system controlled all the engine aspects from the pilot inputs to the engine, and was also referred to as the Engine Control Unit (ECU). The ECU controlled, monitored and limited the engine[92] while maintaining helicopter main rotor speed (Nr). The engine input parameters recorded by the ECU included Nr, engine gas generator speed (Ng), engine turbine speed (Np), engine torque (Q), engine measured gas temperature (MGT), engine fuel flow in pounds per hours (Wf), collective transducer position (CP), power lever angle (PLA) and pressure altitude in pounds per square inch (PSIA). Nr, Ng, Np and Q were measured in percentages.

The ECU recorded engine information on a printed circuit memory board. The memory board contained an electronically erasable programmable read only memory (EEPROM) chip (printed circuit board) for use in the diagnosis of the engine health and serviceability. It also recorded excursions of any engine input parameters above defined levels and stored 15 seconds of data prior to any excursion event and 45 seconds after the event. Figure 17 displays the location of the ECU on the helicopter (located on the forward transmission deck).

92 The ECU included an automatic overspeed protection system for both Ng and Np.

FIGURE 17: ECU location [93]



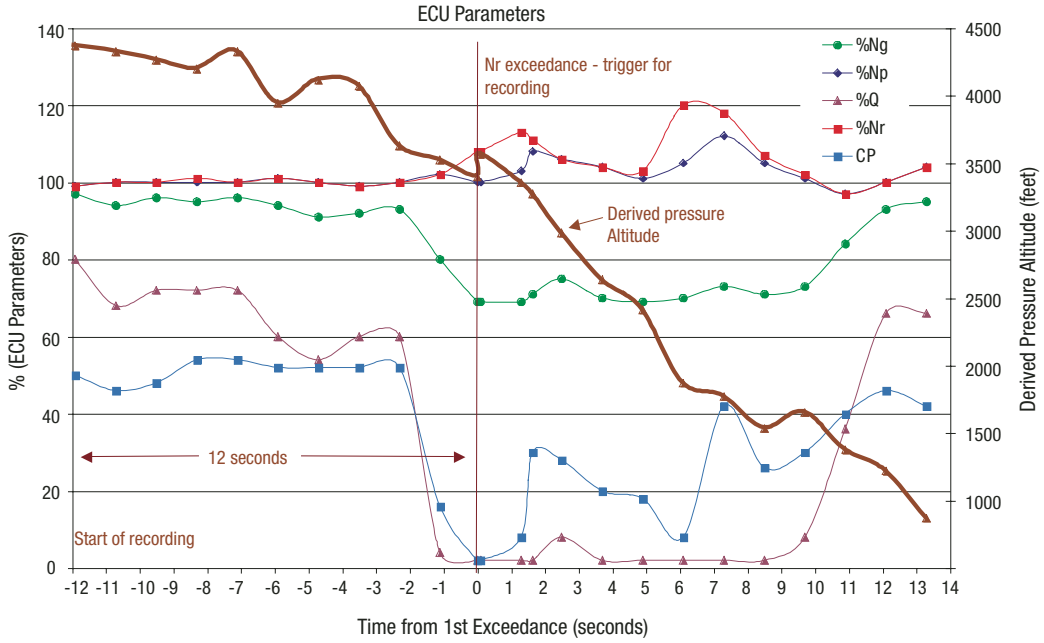
The ECU was successfully recovered, preserved and shipped to the engine manufacturer, where it was placed into quarantine. Data from the EEPROM was successfully downloaded under the supervision of the NTSB. Figure 18 displays the condition of the ECU after recovery.

FIGURE 18: Recovered ECU

93 Sourced from Bell Helicopter Textron Service Bulletin 407-99-31.

The recovered data included approximately 25 seconds of recorded parameters initiated by a main rotor (Nr) excursion event to 120 per cent[94]. The EEPROM captured approximately 12 seconds of data prior to the Nr excursion, and ended approximately 13 seconds later when electrical power to the unit was interrupted. The ECU did not have its own power source, and the interruption of the electrical power supply was most likely the result of impact forces. The chart shows that the collective transducer position sensor (CP) was varying during the duration of the recorded data, indicating that the collective control was being manipulated. The position of the cyclic control was not recorded by the ECU. Figure 19 displays the information recovered from the ECU.

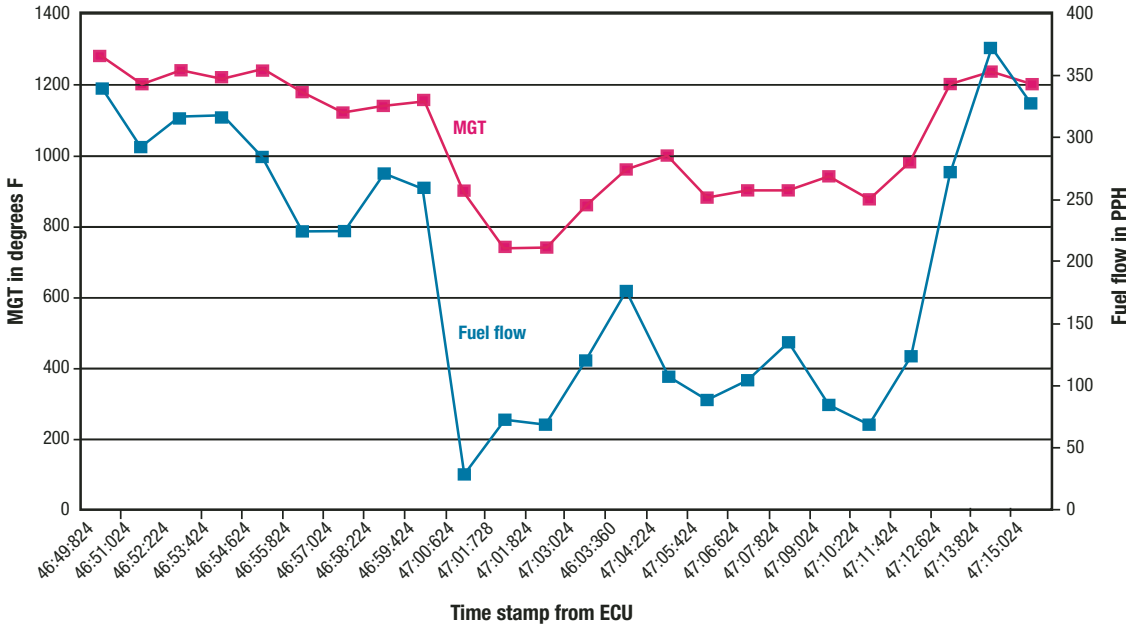
FIGURE 19: ECU parameters



94 The engine overspeed protection system included a upper limitation of 118.5 per cent Np. When the Np exceeded this amount, the overspeed system would limit fuel flow to allow the engine to remain operating.

A review of the data indicated no recorded anomalies of the engine, and that the engine was preforming as designed. Figure 20 shows normal engine response to power requirements, including decreases and increases in both fuel flow and MGT during the 25 seconds recorded.

FIGURE 20: Chart of fuel flow and MGT from ECU data



2. ANALYSIS

2.1 Technical analysis

Analysis of the helicopter's structure and components indicated that it had impacted the water at high speed, in a left skid low, nose down attitude, at high rate of descent.

Analysis of engine control unit and radar data

Analysis of the data indicated that:

- the main rotor RPM (Nr) over speed was the result of a rapid lowering of the collective lever
- the collective lever was modulating during the last 25 seconds of the flight and the pilot may have been attempting to arrest the increase in main rotor RPM by applying collective pitch
- the engine control unit (ECU) operated as designed when it sensed a main transmission overspeed condition[95]
- once engine turbine speed (Np) returned to a normal value of about 100 per cent[96], fuel flow increased and the engine responded as would be expected.

The recorded data also indicated that the collective lever had lowered to the bottom stop approximately 12 seconds after the data recording initiated, and 6 seconds prior to the high Nr event. The collective lever rose to mid-range, 4.5 seconds prior to the high Nr event and to three-quarters range directly following the event. The initiator of the collective movement during this time could not be confirmed[97].

Engine power at impact

The engine was developing a significant amount of power at the time of impact. The data from the ECU, along with the results of the engine disassembly and inspection, confirmed that there were no apparent anomalies of the engine during the flight.

Other observations

The tail rotor was rotating and being driven at the time of impact. Both blades were intact, as were their associated control systems. Although the main rotor system and main rotor blades were not recovered for examination, analysis of main rotor blade fragments, along with video evidence of the main rotor in the trawler nets, indicated that the blades were turning at high RPM upon impact with the water. Analysis of the Nr from the ECU recording confirmed no over speed of the main rotor transmission as would be seen with a main rotor blade separation and departure. This evidence would also appear to preclude any internal anomaly, over speed or stoppage of the transmission.

95 The increase in Np to 112 per cent would have been the result of the friction of the over-running clutch of the free-wheeling unit, which would have slightly increased the Np.

96 At about 4 seconds before electrical power loss to the ECU.

97 The position of the engine power lever did not change during this time period.

The examination of the attitude indicator revealed that the unit's gyro motor was turning at the time of impact with the water. As a gyro unit requires several minutes to 'wind down' and cease rotation, operation of the unit at the time of impact could not be confirmed. The globe analysis from the radio magnetic indicator light indicated that the light was illuminated at the time of impact. This indicated that the helicopter instrumentation lighting and electrical system were operating at the time of impact.

The investigation considered that mechanical failure was unlikely because:

- electronic evidence from the ECU and physical examination of the wreckage and components indicated that there was no evidence of a catastrophic failure of any system or structure of the helicopter prior to impact with the water
- evidence (both physical and electronic) indicated that the engine and main rotor transmission were operating at the time of impact
- examination of the radar track data, electronic information and the helicopter flight control servos indicated that the helicopter had not incurred any uncontrollable 'jamming' of the flight controls
- the tail rotor and driveshaft assemblies were being driven that the time of impact
- the engine and main rotor system were responding as designed to inputs provided by the pilot from the collective system
- no Mayday[98] or Pan-Pan[99] radio distress broadcast was received from the pilot.

2.2 Operational considerations

The investigation was unable to determine, with certainty, what factors lead to the loss of control of the helicopter. Although the forecast weather conditions appeared to have met the regulatory requirements for flight under the night Visual Flight Rules (VFR), the circumstances of the accident were consistent with pilot disorientation and loss of control during flight in dark night conditions. The pilot had reportedly experienced disorientation in the helicopter on previous occasions. He may have become disoriented during the accident flight due to a number of factors such as:

- lack of a visible horizon due to the absence of celestial and surface/ground-based lighting
- flight through cloud
- flight through cloud with the Nite Sun illuminated
- loss of a primary flight instrument, such as the attitude indicator, requiring limited or partial panel flying.

Lack of a visible horizon due to the absence of celestial and surface/ground-based lighting

The helicopter was not equipped for flight in instrument meteorological conditions (IMC), and the pilot was not qualified for instrument flight. He had previously experienced disorientation on a recent similar flight under dark night conditions with no celestial lighting, but had reorientated himself following a turn back to land and acquisition of surface/ground-based lighting. The dark night conditions present at the time of the accident due to the effect of cloud

98 International broadcast for urgent assistance.

99 Radio broadcast indicating uncertainty or alert, general broadcast to widest area but not yet the level of a Mayday.

on available celestial lighting, the lack of a visible horizon and ground-based lighting, and the pilot's limited instrument flying experience, increased the risk of the pilot experiencing spatial disorientation.

Flight through cloud

The left turn from track may have been the result of the pilot becoming aware of cloud in the proposed flight path, or having flown through cloud and consequently altered course towards the mainland. The forecast cloud, which was predicted at and below his planned flight level, would have been difficult, if not impossible, to detect in the limited celestial or surface/ground-based lighting conditions present. If he had entered cloud, he may have experienced spatial disorientation, resulting in the loss of control of the helicopter.

Flight through cloud with the Nite Sun illuminated

The investigation could not confirm activation or serviceability of the Nite Sun. Witnesses reported seeing a 'glow' in the sky in the area of the flight path. Although it could not be verified, it is possible that the reported glow may have been from the Nite Sun searchlight fitted to the helicopter.

Limited panel flying

The helicopter was not equipped with an autopilot or stability augmentation system, which may have assisted the pilot in maintaining straight and level flight in cruise and would have relieved pilot workload.

The investigation could not confirm the serviceability of the attitude indicator. The helicopter was not equipped with a standby attitude indicator that would have allowed reference to the helicopter's actual orientation in the event of the failure of the primary instrument. If the primary attitude indicator had failed during the flight and the helicopter had entered cloud, with no standby indicator, the pilot would have been required to fly the helicopter with a limited panel. This demanding task may have, in combination with his relative inexperience in instrument flying, resulted in spatial disorientation.

2.2.1 Pilot fitness for duty

The investigation considered the possibility that the pilot may have experienced some degree of incapacitation during the flight. While unable to be conclusively determined, pilot incapacitation was considered unlikely on the basis of:

- the pilot's age and results of the most recent medical examination and electro-cardiogram indicating no anomalies
- the majority of witness reports indicating that the pilot was fit and well rested
- technical analysis of the recorded data.

2.3 Reduced EMS helicopter operational safety margins

The investigation found that two underlying factors may have lead to the safety margins of the Mackay base helicopter emergency medical service (EMS) being reduced:

- limited awareness of helicopter EMS safety issues
- divided and diminished responsibility for ensuring safety.

2.3.1 Awareness of EMS helicopter safety issues

The circumstances of this accident combined most of the classic risk factors known for many years to be associated with EMS helicopter accidents. In the 1980s, in response to a high rate of EMS helicopter accidents in the US, the Federal Aviation Administration (FAA) and the National Transportation Safety Board (NTSB) carried out major studies to identify the most significant threats to safety for this type of operation. The results of these studies have been widely available to EMS helicopter operators and program administrators for many years. However, this investigation found little evidence to indicate that key organisations in this accident had fully incorporated, or in some cases were even aware of, this significant work. Some of the risk factors identified in the FAA and NTSB studies that are relevant to this investigation included:

Pilot factors

- the pilot was relatively inexperienced, particularly with regards to long distance over water night operations out of sight of land
- the pilot did not hold an instrument rating
- the pilot was new to the organisation and helicopter EMS operations
- the pilot was relatively inexperienced in the helicopter type
- the pilot was subject to an employment probationary period.

Operating environment factors

- the accident occurred on a dark night with no celestial or surface/ground-based lighting
- the flight path was over water with few surface lit features
- forecast weather in the area of the helicopter flight path included the possibility of cloud at the altitude flown.

Organisational factors

- a number of different organisations were involved in providing the service
- the operation was at a base remote from the operator's main base
- actual or perceived pressures to not reject missions due to weather or other reasons.

The FAA and NTSB studies highlighted the importance of decision making and risk management in EMS helicopter operations. As a result, specific safety-related materials covering these topics were developed for pilots, operators, and program administrators. Some relevant aspects of this training and guidance material were:

- the decision making material developed for pilots emphasised the increased risks associated with operating in marginal visual meteorological conditions (VMC), reduced visibility, and/or at night. Situational awareness exercises were provided for pilots so that they could learn from the past mistakes of other pilots
- the training and guidance material stressed that sound risk management by the operator was vital to ensure system safety. Otherwise safety was reliant on the flawless performance of the pilot at all times, even in changing and difficult circumstances
- emphasis was given to the importance of applying sound risk management principles when the service contract for the EMS helicopter operation was initially developed

- the material highlighted the potential problems that could develop when a pilot was operating at a remote base with no onsite management to provide support and guidance. For example, the increased likelihood that mission imperatives could influence pilot decision making.

The investigation found little evidence that sufficient consideration had been given to these matters by the organisations involved with the provision of the Mackay EMS helicopter service.

One final aspect of the FAA and NTSB safety studies that has relevance to the current investigation relates to the organisational framework underpinning the Mackay operation. The NTSB described the typical hybrid combination of separate emergency service management and helicopter operator management as providing few advantages and many potential problems. This aspect is addressed in more detail in the following section.

2.3.2 Safety oversight

The organisational framework that supported the provision of an EMS helicopter operation in the Mackay area was relatively complex in nature. As a result, overall organisational safety oversight of the service was diffused.

The provision of the Mackay EMS helicopter service involved three organisations that were linked by both formal and informal inter-relationships. At a formal level the division of responsibilities between the organisations was laid out in service level agreements and contract documents. However, these documents primarily covered issues related to finance and governance and contained relatively little detail related to operational issues or safety matters. At an informal level, the interaction between the three organisations was largely influenced by the close proximity and close working relationship between the Central Queensland Helicopter Rescue Ltd (CQRESQ) and CHC (Australia) personnel at the Mackay base.

One significant weakness of this organisational framework was the distribution of high-level expertise and decision making in matters related to EMS helicopter operational safety. Paradoxically, the organisation with the greatest knowledge and experience had relatively little input, while the organisation with the least knowledge and had relatively large input. This was not an ideal situation and had the potential for the 'big picture', in relation to safety, to be lost.

The organisation within the framework with the greatest knowledge and experience in EMS helicopter operations in Queensland was the state government Department of Emergency Services Aviation Services Unit. However, while the Department was in a position to provide a significant degree of guidance and oversight to Community Helicopter Providers (CHP), it viewed its role in a comparatively limited way and provided relatively little practical guidance to CQRESQ either during the establishment of the Mackay service or during day to day operations. Hence a valuable source of operational and safety information was not used to best effect.

In contrast to the Aviation Services Unit of the Department of Emergency Services, the body at the centre of the organisational framework, CQRESQ, was not an 'aviation organisation', but a community advocacy group. The Board of CQRESQ was comprised of public minded local citizens and the work of the Board involved aspects such as fundraising and community liaison. However, CQRESQ was responsible for important decisions both in establishing the type of helicopter EMS service to be provided in Mackay and in formulating and letting the contract for that service. In meeting its responsibilities in relation to operational and safety matters, CQRESQ took advice from outside bodies such as aviation auditors and helicopter operators, including the eventually successful tenderer, CHC (Australia).

Ultimately, the operational safety of an EMS helicopter mission rests with the helicopter operator and the PIC of the flight. However, the broader context in which operational decisions are made can have a very real influence on safety. It is recognised throughout the aviation industry that the type of safety culture that permeates an organisation can contribute significantly to safety outcomes[100]. From this point of view, having overall safety assurance for the Mackay EMS helicopter operation divided between a number of disparate organisations had the potential to diffuse safety oversight.

Greater safety assurance could have been obtained if one organisation with knowledge and expertise in aviation had overall responsibility for operational and safety oversight of the Mackay EMS helicopter operation. The Queensland Government Department of Emergency Services appeared to have been the body best placed to fulfil that role.

2.4 Helicopter procurement/contract issues

2.4.1 Contract tendering and evaluation

Following contact tendering, the Bell 407 helicopter type was authorised for use on the contract by the CQRESQ management. This decision was made following a third party independent evaluation which concluded that the Bell 407 was limited because of it's lack of equipment necessary to permit Instrument Flight Rules (IFR) flight and to mitigate the risk of night VFR flight. The decision was also apparently made with statistical evidence to indicate a high rate of mission cancellations because of the previous similarly equipped Bell 206 helicopter not being fully IFR capable. Cost may also have been a factor in this decision. Additionally, a fully IFR equipped helicopter, which most likely would have been larger than the Bell 206 or 407, may have required an update to the current hospital helipad with the associated costs.

All but one of the Aviation Services Unit Queensland Rescue helicopters utilised for the fully-funded EMS operations were twin-engine, fully IFR capable helicopters. For the remaining non-IFR equipped helicopter, with similar capabilities as HTD, strict guidelines were put in place requiring a visible horizon for night VFR flight. However, for the CHP, the Department did not make a recommendation either for a specific helicopter type or its provisions, or for a preferred helicopter type or required equipment.

2.4.2 Contractual response time

The response time as stated in the contract with CHC (Australia) and CQRESQ was 15 minutes for each emergency flight. The response time of 15 minutes (30 minutes offshore) for each flight, as stated in the Mackay Base Operating Procedures as the contractual response time, may not have allowed pilots enough time to sufficiently update weather forecasts, and assess actual conditions and celestial lighting prior to the flight.

In an amendment to the generic Service Agreements with the CHP, the Aviation Services Unit removed the requirement for a response time in the contracts between the operators and the CHP, as it may impose additional operational pressures on the flight crews. At the time of the contractual process between CQRESQ and CHC (Australia), this recommendation was not included. However, the revision to delete a response time had been passed to CHC (Australia) and they were in the process of revising their base manuals.

100 Reason J, 1997. *Managing the Risks of Organisational Accidents*, Ashgate: UK.

2.4.3 Pilot experience requirements per the contract

In order to mitigate risk to an operation, parties to a contract may insert specific requirements for personnel and equipment related to the operation. The contract between CQRESQ and CHC (Australia) listed specific contractual pilot requirements. The pilot met all of the requirements of the current Service Agreement and the contract, except for the requirement to have completed 2,500 hours total flying time as per the Service Agreement and 3,000 hours for the contract. At the time of employment, the pilot had a total flying time of 2,456 hours and not the 3,000 hours as required by the contract without a waiver. He had no previous recorded aeromedical experience before joining this operator. His recorded 149.4 hours total night, and 12.0 hours instrument flying experience, would not appear to constitute the 'substantial' night/instrument flying experience required as per the contract waiver clause. It would also not appear to satisfy the requirements of the Service Agreement which required substantial aeromedical experience or more than 200 hours night flying experience for a pilot with that level of experience.

CHC (Australia), CQRESQ and the Department of Emergency Services Aviation Services Unit were apparently aware of the pilot's lack of experience to meet the contract and Service Agreement requirements. However, it appears that a good deal of emphasis was placed on the pilot's previous marine pilot transfer experience as an acceptable alternative to the Service Agreement and contract wavier clause requirements for experience in aeromedical and night/instrument flying.

2.4.4 Pilot hiring issues

The CHC (Australia) pilot selection committee members that interviewed the pilot advised that they normally preferred a candidate that had more substantial instrument flying experience or knowledge. The pilot's experience in marine pilot transfer may have influenced the decision by the committee members to employ the pilot, even without the instrument experience or knowledge that they had normally preferred.

2.5 Patient transfer/flight decision making

2.5.1 Medical and operational factors

According to the Department of Emergency Services *Aeromedical & Air Rescue Network Helicopter Tasking Guideline*, the decision to request the helicopter to transfer the patient by air that evening, rather that wait until the following morning and use a ship transfer, rested with the Mackay Base Hospital Clinical Coordinator. Neither the Clinical Coordinator nor the Ambulance Communications Centre (ACC) personnel had operational aviation experience. Therefore, they were not in a position to judge the feasibility of a night VFR helicopter flight to Hamilton Island that night. The flight to Hamilton Island that night was not an emergency flight, but an inter-hospital transfer as defined in the tasking guidelines. The tasking guidelines were not applied to the case in order to evaluate the urgency of the transfer of the patient. The Clinical Coordination Data Form Assessment indicated that the patient's conditions was not life threatening and that alternate methods for transfer could have been used.

When asked by ACC personnel about the possibility of going to Hamilton Island, the pilot replied immediately and accepted the mission without any hesitation, indicating that no extensive check of the latest weather forecast was undertaken.

2.5.2 Operator personnel flight cancelling considerations

The operator's personnel were required to submit a Voyage Report noting any flights that were cancelled and the reasons for the cancellation, which was then passed on to management. However, the pilot had recently been employed and was under probation. This factor, along with the requirement to document all cancelled flights, which then received management review, may have placed unintentional additional pressure on the pilot to complete the flight.

2.5.3 Rescue organisation cancelling considerations

The rescue organisation was funded by the local community and the state government. When the community based Mackay helicopter service was not able to accept or complete a flight, because of non-VFR weather, or non-night VFR conditions, the Queensland Rescue Bell 412 helicopter based at Townsville, which was fully IFR equipped, would often complete the flight. It is possible that not being able to complete all tasks, even though for valid reasons, may have negatively impacted on the perception of the Mackay operation, the rescue organisation and their relationship with the local community. This may have had an influence on the willingness of the Mackay rescue organisation to accept demanding tasks.

2.6 Weather considerations

2.6.1 Celestial lighting considerations

Information on moonrise/ moonset and celestial lighting was available to pilots. The investigation could not determine whether the pilot accessed celestial lighting information prior to the flight. However, since there was no regulatory requirement to consider celestial lighting available and as he had recently completed a similar flight (with no celestial lighting available), there was the potential that he would have accepted the flight, regardless of the celestial illumination conditions.

2.6.2 Weather forecast considerations

Considering that the pilot applied the area meteorological forecast obtained at 1752 to the departure time for the flight, he had not satisfied the intent of the regulated pre-flight briefing requirements. However, although a new area forecast was issued at 1853, the absence of any change in the content of that forecast, effectively meant that the pilot had the most recent weather forecast applicable to the flight. The accuracy of the forecast cloud was supported by the report from the pilot of BKE after the accident, of cloud in the area at 2,500 to 2,600 ft AMSL.

The forecast terminal and en route weather conditions did not preclude the possibility for flight in night VMC, in accordance with flight under the night VFR. However, the altitude chosen by the pilot was deemed to be 'not advisable due to inability to remain in VMC' and clear of cloud as per the CASA VFR Flight Guide (appendix C). The dark night conditions and lack of ambient lighting over the water may have prevented the pilot from maintaining flight in VMC, as any cloud under those conditions would not have been visible until after it was entered. That would have been the case in terms of the pilot's inability to:

- maintain the required distance from the forecast scattered and potentially broken cloud at and below the cruising level

- ensure the prescribed visibility conditions
- maintain sight of surface/ground-based lighting or water.

2.6.3 Weather radar considerations

The pilot's decision to accept the flight to Hamilton Island was made without the benefit of the latest weather radar information for the Mackay site on the Bureau of Meteorology (BoM) website. The radar images available from the Mackay radar site would have been 42 minutes old when HTD departed. A review of the radar images current for the time of the flight at the nearest available location, Mount Stuart. did not indicate any substantial precipitation in the area of the flight. However, limitations on the Mount Stuart radar as a result of the distance away from the area of the accident, could mean that it was possible that rain or showers were in the area of the flight path and not detectable by radar.

Discussion with the other base pilots revealed that they were unaware of the part-time functioning of the local weather radar at the time of the accident. It is possible that the pilot was also unaware, and accessed the website to check for existing precipitation, not realising that the display shown was not accurate for the current time.

2.7 Flight-following issues

ACC Standard Operating Procedure (SOP) did not include a requirement for a call from the pilot to confirm 'destination in-sight' at the conclusion of a flight. Because the flight was less than 40 minutes, no 'operations normal' call was required. The helicopter had been overdue it's estimated time of arrival at the island by 10 minutes, with the ACC still unaware of its missing status. ACC personnel remained unaware of the status of the helicopter until nearly 26 minutes after it had impacted the water.

The SOP had not been updated to include current contact information for CHC (Australia) personnel, or the correct registration for the helicopter. This lack of current contact information led to delays in contacting CHC (Australia) personnel and ascertaining the status of the helicopter. The incorrect helicopter registration provided to Australian Search and Rescue (AusSAR) by ACC personnel meant that search and rescue personnel initially had incorrect information on the helicopter type, payload, cruise speed, range, equipment and endurance. ACC personnel were unaware that the helicopter was equipped with an underwater acoustic beacon and therefore did not advise AusSAR of this additional location assisting equipment.

Apparent initial confusion by ACC personnel resulted in approximately 26 minutes elapsing from the time of notification from the Hamilton Island clinic personnel of the overdue helicopter, until they notified AusSAR. If the accident had been survivable, this time delay could have been significant.

2.8 Night VFR rating

When flight under the night VFR was first approved in Australia in 1967, it was developed with the intent that pilots would still be conducting the main part of their flying in daylight hours. It appears that this has altered over time to include a much broader use of the rating. Flights are now routinely undertaken and completed between the hours of last light and first light by pilots with night VFR ratings alone. Night VFR flying is more demanding on the pilot and in some situations requires substantial instrument flying skills. Night VFR flying may also require more instrumentation (similar to IFR equipped helicopters) to give the pilot all the necessary tools and equipment required to safety complete a night VFR flight.

A night VFR rating does not require a pilot to have any substantial instrument flying experience. Although there is a requirement for flight under the night VFR to remain clear of cloud, cloud may be difficult or impossible to see during night flight and inadvertent flight into cloud may occur. When this does occur, if the pilot is not IFR-rated, or does not have substantial instrument flying experience, he/she may be susceptible to spatial disorientation and the subsequent loss of control of the helicopter. Studies have indicated that less instrument experienced and non-IFR rated pilots are more susceptible to spatial disorientation when inadvertently entering IMC than more experienced instrument rated pilots.

2.8.1 Night VFR requirements by the other organisations

Evidence indicates that individual organisations preforming helicopter EMS activities have identified the risks associated with night VFR flight and are implementing local safety actions to mitigate those risks. These requirements appear to be more stringent that the current Civil Aviation Safety Authority (CASA) requirements for night VFR flight. This is evidenced by a local operator's requirement for celestial lighting and a visual horizon to be included in the SOP for the ACC.

The Aviation Services Unit Operations manual also stated a requirement for celestial lighting and a visible horizon for night VFR flight in a single pilot, single-engine turbine, non-IFR equipped helicopter during over water transit. The manufacturer of the helicopter had also included a requirement for a visible horizon in a similar model (Bell 206) helicopter flight manual.

2.9 Pilot requirements

2.9.1 Pilot training and instrument flying proficiency

Prior to the accident, while the pilot had flown a substantial amount of night VFR flight hours, he had not recently documented any instrument flying. The pilot did not have a Command Instrument Rating, which precluded his flight in Instrument Meteorological Conditions (IMC) as pilot in command (PIC). Therefore, his previously completed instrument flying was most likely conducted with an instructor as PIC, and in VMC. If he had inadvertently entered IMC conditions during the flight, this lack of documented instrument flying proficiency may have affected his ability to recover the helicopter from any developing in-flight unusual attitude or other emergency.

2.9.2 Australian licence requirements for ATPL (helicopter) and night VFR

The lack of a requirement of instrument flying training for the award of an air transport pilot licence (ATPL) (helicopter) licence did not coincide with the regulatory requirements for the award of an ATPL (aeroplane) licence. Additionally, the existing Australian requirements do not meet the existing International Civil Aviation Organization (ICAO) requirements.

The only instrument flying experience required by CASA regulations for a helicopter pilot, prior to operating under the night VFR, was that necessary to achieve a night VFR rating and for any navigation aid endorsements. Examination of the pilot's logbook and training records indicated that, with his instrument flying experience, he would have met the CASA night VFR requirements, but he would not have met the ICAO requirement.

The lack of a requirement to renew a night VFR rating meant that a night VFR pilot did not require periodic confirmation of instrument flying competence. This was in contrast to the annual renewal requirements affecting an instrument flight rules (IFR) rating, and increased the likelihood for a pilot undertaking operations under the night VFR to have minimal instrument flying experience. That increased the risk that such a pilot might become disoriented during inadvertent flight into IMC or under dark night conditions.

Pilot confidence flying night VFR

During a recent night VFR flight under similar conditions as the accident flight, the pilot exhibited a degree of 'discomfort' in dealing with an in-flight situation in which contact with surface/ground-based lighting was lost during a dark night departure. The limited instrument flying experience of the pilot, together with his previous marine pilot training for unexpected entry into IMC, or becoming disoriented, may have contributed to his actions during the previous night VFR departure from Hamilton Island to turn:

- contrary to circuit direction
- towards the high ground
- such that he was required to look across the cockpit.

Department of Emergency Services pilot requirements for night VFR

The Department of Emergency Services Aviation Services Unit requirements for Queensland Rescue pilots flying night VFR in a single pilot, single engine turbine, non-IFR equipped helicopter included a requirement for a helicopter Command Instrument Rating. By including this requirement, it appeared that the Aviation Services Unit recognised that flight under the night VFR was a demanding task that required additional skills and ratings beyond a night VFR rating. At the time of the accident, no such recommended requirement was made by the Aviation Services Unit to the Community Helicopter Providers.

2.10 Regulatory issues

2.10.1 Proposed CASR Part 61

The draft CASR Part 61 proposes to remove differences between current Australian and ICAO flight crew licensing standards. CASR Part 61 as drafted, would include a requirement for limited instrument flying training for candidates for the award of a helicopter CPL/ATPL category rating. Instrument flight training, as in the ICAO requirements to include partial panel training, could help mitigate the conquences related to the risk of inadvertent flight into IMC and night VFR disorientation. It would also include the incorporation of a biennial flight review requirement for night VFR ratings. This requirement would have the potential to help mitigate the risk of pilots lacking instrument flying competency.

2.10.2 Proposed CASR Part 133

The draft CASR Part 133 proposes to review the categorisation of several rotorcraft air transport and air work operations. CASR Part 133 as drafted, would include a requirement for operators of EMS helicopters to include a serviceable standby attitude indicator and an autopilot or

stability augmentation system[101] in the helicopter for all over water flights in excess of 10 NM from land or over land areas where reference to the ground features cannot be maintained. This requirement has the potential to help mitigate the consequences related to the risk of spatial disorientation by a pilot flying over land or water during single-pilot operations, where reference to the ground or water cannot be maintained.

2.10.3 Classification of helicopter EMS operations

A review of aviation regulations in other countries indicated that they classified helicopter EMS operations as Air Transport, Public Transport or commercial flights and all receive increased regulatory scrutiny beyond what is currently required by CASA for helicopter EMS operators in Australia.

Current CASA policy includes a plan to harmonise aviation regulations in Australia with the US FAA Federal Aviation Regulations. Under current Australian regulations, helicopter EMS flights, including those in which a patient is carried aboard the helicopter, are classified as Aerial Work operations. As a result, EMS helicopter operations are subject to a lesser degree of regulatory control and oversight than, similar Charter operations.

If, for example, a person elected to hire a helicopter to travel from Hamilton Island to Mackay, the operation would be categorised as a Charter flight and regulated accordingly. In contrast, if a passenger makes the same flight in an EMS helicopter as a result of injury, ill health, or as required in their employment duties, then the operation is categorised as Aerial Work. However, there appears to be little justification for the different level of safety assurance that is afforded to the passenger in these two cases; for example refer to ASTB investigation report BO/200100348 on the ATSB website at **www.atsb.gov.au**

The reclassification of EMS helicopter operations into the Charter category would increase the level of regulation and CASA safety oversight of such flights. In addition, the adaptation of the requirements of JAR-OPS 3.005 into the proposed Part 133 would act to further mitigate the risks of helicopter EMS operations.

2.11 Risk management

2.11.1 Potential operational risk

The induction and other training provided to the pilot by the operator recognised the familiarity requirements of Civil Aviation Order 40.3.0, and appeared to take account of the pilot's experience in the day and night marine pilot transfer task. However, the apparent lack of any attempt during that induction training to introduce the pilot to, or confirm prior competence in limited panel instrument flight, while in accordance with extant regulations, did not recognise the potential risks associated with an in-flight failure of the single attitude indicator installation in the helicopter.

2.11.2 Risk management by EMS operators

The absence of a formal operational risk management program may have contributed to the pilot accepting a flight which could be interperted as being acceptable for flight under the night VFR as defined by the relevant regulations, but did not ensure clearance from cloud at the

101 Or two pilots minimum.

selected cruise level. The utilisation of an operational risk management assessment for all EMS flights, to include night VFR flights, may reduce the associated risks by applying an analytical assessment of the conditions required for the specific flights. A risk management assessment for night VFR may take into consideration celestial and surface/ground-based lighting availability, visible horizon and cloud clearance and flight over water. In order to reduce the decision making time related to the risk analysis, a checklist could be utilised by flight crews, with the requirements for each flight to ensure safe operation.

3. CONCLUSIONS

3.1 Departure from controlled flight

The investigation was unable to determine, with certainty, what factors lead to the departure from controlled flight of the helicopter. The possibility of pilot incapacitation was considered, but viewed as unlikely because of the pilot's age, recent medical examination results and available technical evidence. The forecast weather and ambient lighting conditions on the night of the flight represented several factors which are known to contribute to spatial disorientation. In the absence of any radio broadcasts from the pilot in command, and technical evidence of the helicopter's serviceability, the circumstances of the accident were consistent with loss of control due to spatial disorientation of the pilot in command.

3.2 Helicopter EMS operations in Australia

There are currently no requirements for emergency medical service (EMS) helicopter pilots to be Instrument Flight Rules (IFR) rated, or for the helicopter utilised to be fully IFR equipped. Helicopter EMS operations, which are day or night all weather, are very demanding and require highly trained, qualified and experienced pilots, along with appropriate helicopter operational and flight equipment for the task. EMS single-pilot night Visual Flight Rules (VFR) operations conducted by non-IFR qualified pilots in non-IFR equipped helicopters, without an autopilot or stability augmentation system, increases the pilot's workload and the risk of pilot spatial disorientation and loss of control. US Federal Aviation Administration (FAA), US National Transportation Safety Board (NTSB), and Flight Safety Foundation studies have indicated that IFR rated pilots cope better with inadvertent flight into Instrument Meteorological Conditions (IMC) than their peers who do not have an IFR rating.

Because of the current Australian classification of helicopter EMS operations as Aerial Work, a passenger flying in an EMS helicopter either as a patient or as a relative or a friend in support of a patient, is exposed to the same risk as the crew of the helicopter. This amount of risk exposure is higher than that of passengers flying on Charter or Regular Public Transport flights. In several countries, helicopter EMS patients or passengers are exposed to less risk than in Australia, as EMS operations in those counties are classified as comparable to Regular Public Transport operations.

Recent data, not including this accident involving HTD, has established that both the total accident and fatal accident rate of Community Helicopter Providers EMS helicopters in Queensland, which operate primarily single-pilot VFR helicopters, was substantially higher than that for the rest of the country.

3.3 Flight under night Visual Flight Rules

The absence of a regulatory requirement for non-IFR rated pilots to maintain visual reference to the horizon during flight at night under the VFR, contributed to the risk of pilot spatial disorientation and loss of control. Local organisations and operators have identified this risk and acted to implement such a requirement.

3.4 Findings

Operational

1. While the forecast weather conditions could be interperted to meet the regulatory requirements for flight under the night Visual Flight Rules (VFR), there was a possibility of encountering cloud at the cruise level chosen by the pilot.
2. The lack of celestial or surface/ground-based lighting precluded visual reference to the horizon during the over water portion of the flight.
3. Radar imaging from the nearest Bureau of Meteorology radar unit was not available to the pilot immediately prior to the flight.

Helicopter

1. Based on wreckage examination and assuming standard crew configurations, the helicopter was calculated to be within its approved centre of gravity and gross weight limits at the time of the accident.
2. The helicopter was appropriately equipped for flight under the night VFR rules.
3. The helicopter was not equipped for flight in instrument meteorological conditions.
4. No pre-existing defect was found with the helicopter or engine that may have contributed to the accident.
5. The maintenance records indicated that the helicopter was equipped and maintained in accordance with the manufacturer's requirements, existing regulations and approved procedures.
6. Damage to the helicopter's structure indicated a high speed, left skid low, nose down impact with the water.

Flight crew

1. The pilot held a valid air transport pilots licence (helicopter) and medical certifications as required.
2. The pilot held type endorsements relevant to the operation of the Bell 407 helicopter.
3. The pilot was qualified and endorsed to perform a night flight under the VFR rules.
4. The pilot did not hold an instrument rating. He had limited instrument flying experience.
5. There was insufficient evidence to determine if the pilot's pre-flight planning considered the available celestial lighting for the flight.
6. There was no evidence that any pre-existing medical conditions to any crewmembers contributed to the circumstances of the accident.

Organisational

1. There was an apparent organisational lack of awareness of EMS unique helicopter operational safety issues.
2. There was diffused responsibility for ensuring safe operation of the EMS helicopter.
3. The organisation that appeared to have been best positioned to provide safety oversight acted in a passive role with regard to safety input involving CHP EMS helicopter procurement and operations.

4. The operator's procedures at the Mackay base did not include considerations for celestial or surface/ground-based lighting availability for night VFR flights.

5. The regulatory requirements for flight under the night VFR did not include considerations for celestial or surface/ground-based lighting availability or visual reference to the horizon.

3.5 Significant factor

1. The helicopter departed controlled flight during flight under the night Visual Flight Rules, resulting in impact with the water.

4. SAFETY ACTION

4.1 Previous recommendations

4.1.1 Night VFR

On 5 November 1996, the ATSB (then known as the Bureau of Air Safety Investigation) identified a safety issue with night visual flight rules (VFR) training following a fatal fixed wing accident, which occurred at Warrnambool Airport, Victoria on 10 October 1995. During the course of the investigation, it was identified that Civil Aviation Order (CAO) 40.2.2, which referred to the night VFR rating, was initially brought into effect on 4 May 1967 as a Class 4 Instrument Rating[102]. The investigation noted that the original intention of the order was for pilots to be able to complete their journey after last light, or take off before first light (landing in daylight hours). The investigation also documented that from 1986 to 1995, 20 accidents, involving night VFR rated pilots, had occurred in Australia after last light.

No recommendation was issued as a result of this investigation.

ATSB investigation BO/200100348

On 23 October 2002, the ATSB identified a safety issue with the existing requirements for pilots to maintain currency, recency and proficiency for night VFR flight under dark night conditions. On 23 October 2002, the Bureau issued the following safety recommendation:

Recommendation R20010193

The Australian Transport Safety Bureau recommends that the Civil Aviation Safety Authority (CASA) review the general operational requirements, training requirements, flight planning requirements and guidance material provided to pilots conducting VFR operations in dark night conditions.

On 13 December 2002, CASA responded to the recommendation as follows:

> CASA acknowledges the intent of this Recommendation. As part of the proposed CASR Part 61, CASA is developing the requirements for night VFR ratings which will be based on the existing Civil Aviation Order CAO 40.2.2. In addition, a draft competency standard for night visual flight operations has been developed for inclusion in the proposed CASR Part 61 Manual of Standards. CASA plans to publish a Notice of Proposed Rule Making in relation to this matter in March 2003.

ATSB classification: Monitor

102 Air Navigation Order 60.1.3

4.1.2 Classification of operations

ATSB investigation BO/200100348

On 7 September 2001, the ASTB identified a safety issue with the classification of passenger carrying operations. The investigation noted that passengers were being carried on flights categorised as Aerial Work and were not being afforded the same level of safety as fare paying passengers on flights categorised as Charter or Regular Public Transport . Personnel flying in Aerial Work classification helicopters or aircraft were generally only personnel considered essential to the conduct of the flight. Helicopter EMS flights were categorised as Aerial Work and patients being flown on helicopters operating under Aerial Work categorisation were not essential crew. On 7 September 2001, the Bureau issued the following safety recommendation.

Recommendation R20010195

The Australian Transport Safety Bureau recommends that the Civil Aviation Safety Authority consider proposing an increase in the operations' classification, and/or the minimum safety standards required, for organisations that transport their own employees and similar personnel (for example contractors, personnel from related organisations, or prisoners, but not fare-paying passengers) on a regular basis. This recommendation applies to all such operations, regardless of the take-off weight of the aircraft involved.

CASA response

On 2 February 2002, CASA responded to Recommendation R20010195 as follows:

> As you are aware, CASA is presently reviewing the standards contained within the existing Civil Aviation Regulations (CARs) and Civil Aviation Orders (CAOs) with regard to the Classification of Aircraft Operations. The input and recommendations contained within Air Safety Recommendation R20010195 will be taken into consideration and addressed as part of this project. The outcome of the review will determine which category employees (and similar personnel such as contractors) are placed and the standards that will apply to their transportation in aircraft. I trust that this review will satisfactorily address the issues raised in this Air Safety Recommendation.

On 14 November 2002, CASA once again responded to the recommendation:

> ...the draft Classification of Operations policy document is with the Standards Consultative Committee for consultation and it is anticipated that it will go to the Aviation Safety Forum for consultation on the 6th of December 2002. As a result of this consultation, CASA proposes releasing an NPRM early next year to consult with the aviation industry with a view to amend CAR 206 to give effect to changes which would see recommendation R20010195 being adopted.

On 21 December 2004, CASA once more responded to the recommendation:

> A Notice of Proposed Rule Making (NPRM) proposing amendments to Civil Aviation Regulation (CAR) 206 was issued in March 2003. Responses to this NPRM and the associated review of the Classification of Operations confirmed that the proposed amendment to CAR 206, which would accommodate this recommendation would be problematic. Consequently, CASA has decided to proceed only with other amendments to CAR 206. The associated NFRM [Notice of Final Rule Making] is currently with the Department of Transport and Regional Services for clearance prior to Ministerial approval.

However, under the new Civil Aviation Safety Regulations, Corporate Operations will be classified as Aerial Work and will be regulated under CASR Part 132. The carriage of patients and other personnel (other than in air transport operations) will be regulated as Aerial Work under a subpart of Part 136 to be titled *Emergency and Medical Services Operations*. It is

proposed that 'Emergency Services Flights' will cover aerial fire-fighting, law enforcement, and search and rescue operations, while 'Medical Services Flights' will cover air ambulance flights, health services flights, and emergency medical services flights. The development of these regulations is proceeding in consultation with industry.

ATSB classification: Monitor

4.2 Recommendations as a result of this accident

4.2.1 Night VFR

As a result of this investigation, the following safety recommendation was issued by the Australian Transport Safety Bureau on 6 November 2003.

Recommendation 20030213

The Australian Transport Safety Bureau recommends that the Civil Aviation Safety Authority review the night visual flight requirements and promulgate information to pilots emphasising the importance, during flight planning, of considering whether:

- environmental conditions allow for aircraft orientation by visual reference alone,
- there is likely to be sufficient ground or natural lighting and flight visibility along the proposed route to provide visual reference to the ground and/or water during the flight, and
- they are capable of safely operating the aircraft should non-visual conditions be encountered.

CASA response

On 10 December 2003, the Civil Aviation Safety Authority (CASA) responded to Recommendation 20030213 and stated in part:

> CASA supports the issues raised in the Air Safety Recommendation and advises that the Authority is currently reviewing the night visual flight requirements with a view to emphasising to pilots, through its safety promotion activities, the importance of considering the above factors.

On 21 December 2004, CASA further responded to the recommendation:

> CASA does not agree that a review of night VFR requirements is necessary. Firstly, regulations specify that weather conditions of night VFR must be such that a planned flight can be conducted at a safe height clear of cloud. With respect to pilot competency, Civil Aviation Order (CAO) 40.2.2 specifies that the night VFR rating requires pilot be trained to control an aircraft solely by reference to instruments. Any notion that celestial lighting and/or an apparent visible horizon are appropriate references for the control of an aircraft by night is misleading and dangerous and increases the probability of pilot disorientation.

On 27 January 2005, when asked for clarification on the issue, CASA responded:

> Reliance on ambient lighting at night rather than instruments for attitude reference is potentially hazardous due to the high risk of pilot disorientation. CASA strongly believes that the requirements specified in Civil Aviation Order (CAO) 40.2.2 are adequate for night VFR operations. It is the responsibility of the operators to ensure that pilots meet the requirements specified for rating issue, especially those related to instrument flying. Therefore, CASA does not believe that a review of these requirements is necessary given that Australia already has the most comprehensive night VFR pilot qualification.

ASTB classification: Closed – not accepted

4.2.2 Helicopter equipment

As a result of this investigation, the following safety recommendations were issued by the Australian Transport Safety Bureau on 12 May 2004.

Recommendation 20040052

The Australian Transport Safety Bureau recommends that the Australian Civil Aviation Safety Authority assess the safety benefits of requiring a standby attitude indicator, with an independent power source, in all helicopters operating flights under the night VFR in the Charter and Aerial Work category, excluding dual pilot training.

CASA response

On 21 July 2004, CASA responded to Recommendation 20040052 and stated:

> As part of the consultation process associated with the development of Civil Aviation Safety Regulation (CASR) Part 133, CASA consulted with the Helicopter Association of Australia (HAA) and the general helicopter industry regarding the benefits of a standby attitude indicator.
>
> On the basis of these consultations, CASA has assessed the safety benefits of requiring a standby attitude indicator with an independent power source, and determined that greater emphasis should be placed on training pilots carrying out NVFR [night VFR] flight. CASA considers this to be a more effective approach than introducing a mandatory requirement for the fitment of a secondary attitude reference instrument. Therefore, CASA has taken steps in CASR Part 133 to strengthen recurrent training and checking and operator proficiency checks for pilots undertaking NVFR flights in helicopters engaged in air transport operations. It will also apply to those engaged in Emergency Medical Service (EMS), Search and Rescue (SAR) and Marine Pilot Transfer operations as well as any other aerial work operations that CASA deems appropriate.

ATSB classification: Monitor

Recommendation 20040053

The Australian Transport Safety Bureau recommends that the Australian Civil Aviation Safety Authority assess the safety benefits of requiring an autopilot or stability augmentation system in all single-pilot helicopter operating flight under the night VFR, in the Charter and Aerial Work category, excluding dual pilot training.

CASA response

On 21 July 2004, CASA responded to Recommendation 20040053 and stated:

> CASA has reviewed the recommendation and believes that it will be addressed with the introduction of CASR Part 133. Included in CASR Part 133 is a general statement that provides practical and effective approach to this aspect of the safety of NVFR flight in rotorcraft. An extract from that Part is provided below for your information.
>
> 133.360 Instruments and equipment- General
>
> Subparagraph (2)
>
> For a night VFR flight by a rotorcraft involving flight over water beyond a distance from land at which a coastline would be visible at night in VMC at 500ft amsl, or over land areas where rotorcraft attitude cannot be maintained by adequate illumination of surface features or by reference to ground illumination of surface features or by reference to ground lighting or a visible discernible horizon, the operator must ensure that the rotorcraft:

a) is equipped with an approved automatic pilot; or

b) is equipped with an approved automatic stabilisation system; or

c) carries a 2 pilot crew.

ATSB classification: Monitor

4.2.3 EMS helicopter operations

As a result of this investigation, the following safety recommendation is issued by the Australian Transport Safety Bureau.

ATSB Recommendation R20050002

The Australian Transport Safety Bureau recommends that the Civil Aviation Safety Authority review its operator's classification and/or its minimum safety standards required for helicopter Emergency Medical Services operations. This review should consider increasing; (1) the minimum pilot qualifications, experience and recency requirements, (2) operational procedures and (3) minimum equipment for conduct of such operations at night.

During consultation regarding issues related to this investigation, CASA indicated that it would act to review:

- the requirements for helicopter EMS operations to include consideration for two pilots, or a stability augmentation and/or autopilot system
- the special operational and environmental circumstances of helicopter EMS services, particularly with regard to pilot qualifications, training and recency including instrument flight competency
- pilot recency requirements for helicopter EMS operations to ensure that operator check and training processes are focused on the EMS environment.

ATSB classification: Monitor

4.3 Local safety action

Operator

Immediately following the accident, the operator acted to:

- issue a Flying Staff Instruction with the subject 'Night VFR Operations', including a change to existing night VFR operational requirements as outlined in appendix I
- give training for all Mackay base pilots to acquire and maintain a Command Instrument Rating
- include a requirement for all Mackay Base pilots to hold a Command Instrument Rating
- replace the accident helicopter with a fully Instrument Flight Rules (IFR), autopilot equipped, twin-engine helicopter.

Queensland Department of Emergency Services

The Queensland Department of Emergency Services advised that they have taken, or propose to take, the following actions:

- the strengthening of safety standards in the Generic Service Agreements to Community Helicopter Providers (CHP) to include increased pilot recency and training requirements, a pilot requirement for a Command Instrument Rating, crew resource management training, a Safety Management System and a Safety Officer
- ongoing operational guidance to CHP in general, including specific support to each CHP
- the implementation of the recommendations of other reviews associated with the aeromedical system/network
- the establishment of centralised clinical coordination and tasking of aeromedical aircraft and helicopters for Southern Queensland[103], including all CHP state wide through a centre in Brisbane, with a parallel system planned for all Northern Queensland by July 2005
- establishment of a requirement for a safe arrival broadcast for flights of less than 30 minutes duration and the nomination of a Search and Rescue Time (SARTIME) for all flights
- revision of the standard operating procedures for helicopter emergencies to include provisions relating to establishing communications with the crew of any helicopter that does not make an 'OPS normal' or 'Safe Arrival' call. If contact cannot be established within a maximum 5 minute period, then Australian Search and Rescue (AusSAR) will be immediately advised
- establishment of a requirement for CHP to provide updated contact/aircraft details on a bi-annual basis and amend the standard operating procedures containing this information accordingly.

Additionally, on 11 January 2005, the Department issued a letter advising all CHP to adopt and follow revised guidelines for night helicopter operations. Included in these guidelines were requirements for Night VFR flights, which stated:

> (e) In the case of NVFR operations, the Provider shall ensure that there is sufficient celestial lighting to enable the helicopter to be flown and navigated by continued visual reference to the ground or water. Moon rise, set and phase must be consulted and a copy must be kept with the helicopter maintenance release;
>
> (f) NVFR over water transit operations at night should only be considered when celestial lighting is favourable and there is a visual horizon[104];

Civil Aviation Safety Authority

Following consultation with the ATSB during the investigation, CASA advised that it would:

- Develop competency standards based on night VFR requirements for inclusion in Civil Aviation Safety Regulation (CASR) Part 61 Manual of Standards along with a new requirement for a biennial flight review of the night VFR rating in Part 61 itself
- Consider a requirement in Part 133 for night helicopter EMS operations to be conducted by two pilot crews
- Issue a Civil Aviation Advisory Publication (CAAP) to summarise safety guidelines for use by operators and pilots in command involved in helicopter EMS operations
- Issue a CAAP to clarify safety guidelines for night VFR operations.

103 Which commenced on 1 August 2004.

104 These requirements were also included in the amended Generic Service Agreement.

Other safety action

The Australian Transport Safety Bureau will distribute copies of this report to all Australian organisations involved in the provision of helicopter EMS services, including operators and medical and rescue organisations, and to all state government departments with responsibility for emergency services.

The Australian Transport Safety Bureau will bring this report to the attention of the Australian Health Ministers' Advisory Council (AHMAC), including reference to the Aeromedical Services Working Party's recommendations for the development of;

- standards and recommended practices for all aspects of aeromedical services
- a process of accreditation for aeromedical services drawing upon recognised peak agencies in aviation, communication and health.

5. APPENDICES

Appendix A: Significant radar track and radar data

Position (P)	*Time*	*Altitude in feet AGL*	*Groundspeed in knots*
1	2143:31	3,042	120.52
2	2143:35	3,042	120.52
3	2143:39	3,042	120.52
4	2143:42	3,042	120.52
5	2143:46	3,042	120.52
6	2143:50	3,142	120.52
7	2143:53	3,139	122.46
8	2143:57	3,239	124.41
9	2144:01	3,239	126.35
10	2144:05	3,339	124.41
11	2144:08	3,439	124.41
12	2144:12	3,539	116.63
13	2144:16	3,739	106.91
14	2144:19	3,839	93.30
15	2144:23	3,739	79.70
16	2144:26	3,439	54.43
17	2144:30	3,539	52.48
18	2144:34	3,739	44.71
19	2144:38	3,439	36.93
20	2144:42	3,239	31.10
21	2144:45	2,839	33.05

Radar data from HTD was lost at 2144:45. As a transponder directly transmits a reply, the signal received by the antenna is normally relatively strong. Consequently, a helicopter which has its transponder operating can be more easily and reliably detected by radar. A transponder-equipped helicopter is not always detected by secondary surveillance radar. This could be due to one of the following reasons:

- the helicopter was outside of the range of the radar
- the transponder was not activated
- the transponder was not serviceable
- loss of electrical power to the transponder
- terrain shielding[105]
- the helicopter's transponder aerial was shielded from the radar due to maneuvering.

The investigation concluded that the transponder on HTD was operational at the time of the accident and that radar contact was lost due to terrain shielding.

105 For aircraft flying at low altitudes, radar coverage to the North and South of Mackay was limited due to terrain shielding.

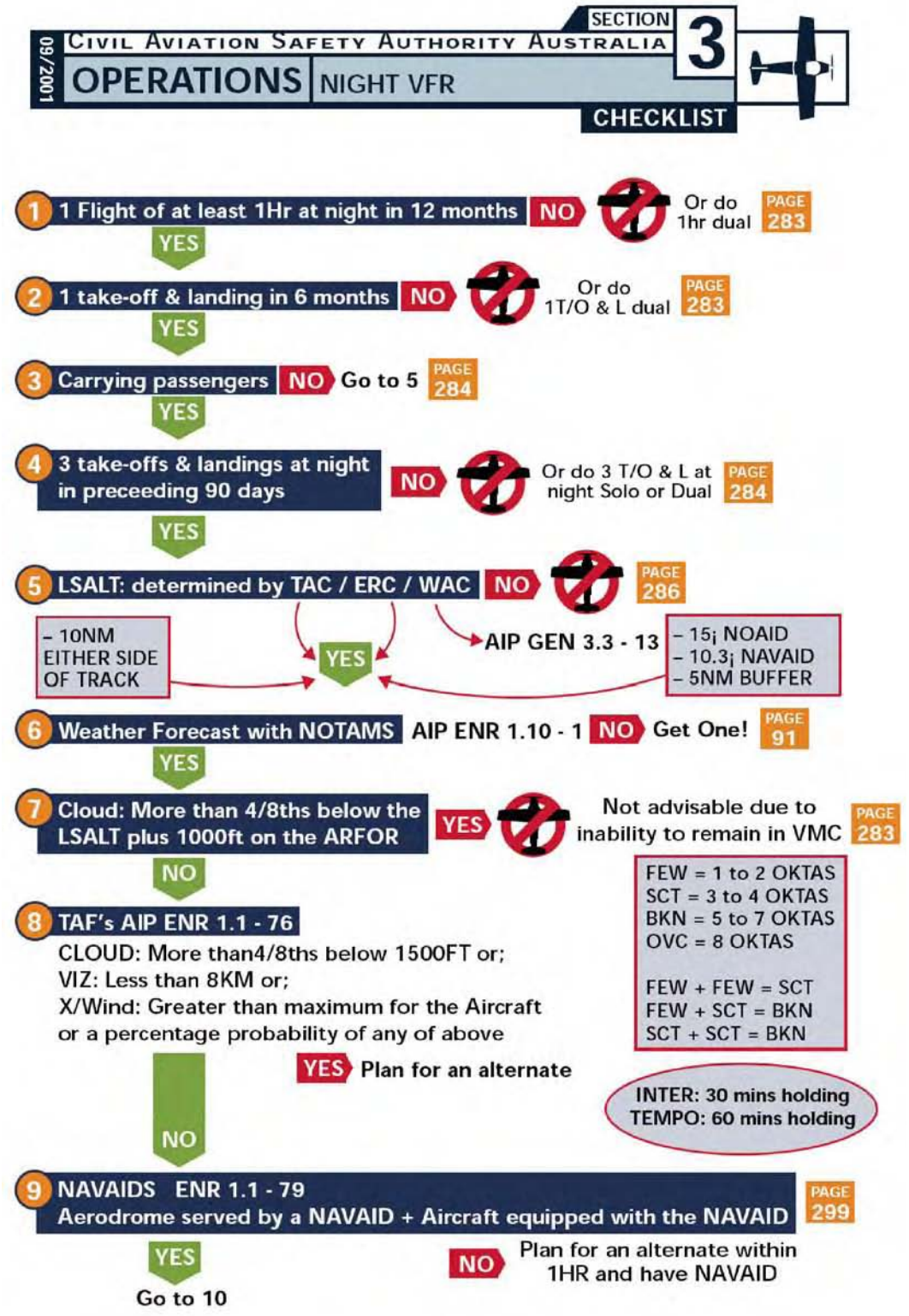
Appendix B: Ambulance Communication Centre (ACC) Helicopter emergency (overdue) procedures[106]

ACC SOP number 40 'Helicopter Emergency' stated:

> In the event that CQRESQ fails cancel SARWATCH, fails to make a position report or transmits a MAYDAY call, the following procedure is to be undertaken.
>
> Contact AUSSAR Rescue Coordination Centre, Telephone 1 800 815 257
>
> The information below is to be given in the following order;
>
> 1. Departure point
> 2. Destination
> 3. Number of persons on board (POB)
> 4. Details of last radio contact
> 5. Aircraft type- B206L
> 6. Endurance- normally approximately 155 minutes (from Mackay)
> 7. Aircraft fitted with crash activated Emergency Locator Beacon (ELT) operating on frequency 121.5 and 243 MHz.
> 8. Aircraft is fitted with emergency flotation device and carries life vests and life rafts for over water flights. The aircraft also carries a portable EPIRB [emergency position indication radio beacon].

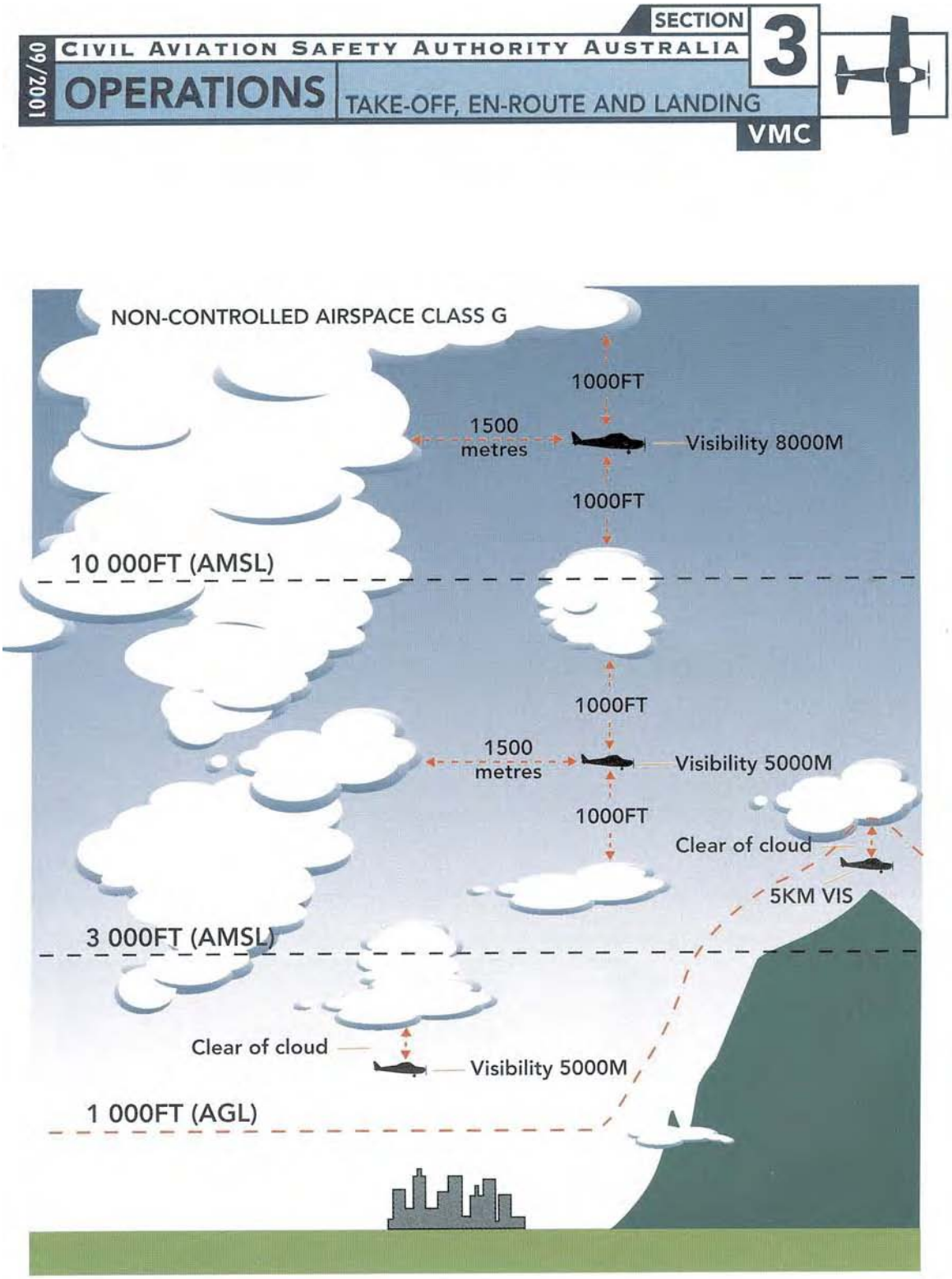
106 The issue of incorrect phone numbers for base personnel was raised at a meeting between CQRESQ and CHC (Australia) base personnel on 8 September 2003. Action coming out of the meeting was that the Ambulance Communication Centre was to be faxed updated contact details.

Appendix C: CASA night VFR requirements[107]



107 Sourced from the Civil Aviation Safety Authority publication 'VFR Flight Guide' issued September 2001.

Appendix D: CASA clearance from cloud requirements[108]



108 Sourced from the Civil Aviation Safety Authority publication 'VFR Flight Guide' issued September 2001.

Appendix E: Proposed CASA changes to Civil Aviation Safety Regulations

E.1 Classification of Emergency Medical Service operations

Emergency medical services (EMS) helicopter operations had since inception been classified as Aerial Work. In February 2001, the Civil Aviation Safety Authority (CASA) Board reviewed the classification of operations policy developed under the regulatory reform program, including that for EMS operations. As a result of the review, it was determined that EMS operations would remain classified as Aerial Work.

E.2 CASA pilot requirements

Among other requirements, Civil Air Regulation (CAR) 5.17 stated that the duration of a flight crew rating or grade of rating remains in force for a period set out in the Civil Aviation Orders (CAO). CAO 40.2.1 paragraph 5.1 states that an instrument rating remains in force for a period of 1 year (as defined). In contrast, CAO 40.2.2 paragraph 4.1 states that a night Visual Flight Rules (VFR) rating remains in force until the holder of the rating no longer holds a flight crew licence.

Included in the instrument flying training syllabi for the award of various aircraft licences, was the requirement for pilots to experience instrument flight under limited panel conditions. There was no stipulated amount of instrument flying required for the award of a night VFR rating (either airplane or helicopter). Instead, there was the requirement that the applicant for a helicopter grade of night VFR rating satisfy the requirements set out in subsection 1, of appendix 1, to CAO 40.2.2. This appendix did not include a requirement for limited or partial panel flying.

E.3 Proposed Part 61

On 18 July 2003, CASA released document number 0309FS NPRM 'Flight Crew Licensing' Proposed Civil Aviation Safety Regulation (CASR) Part 61. The response closing date to the Notice of Proposed Rule Making (NPRM) was 29 September 2003. According to CASA, the regulation was to be promulgated in the fourth quarter of 2004, to take effect in the third quarter of 2005 or 12 months after gazettal, which ever is the latest.

Paragraph 4.3.3 of the proposed CASR Part 61 'Remove differences between current Australian and Internal Civil Aviation Organization (ICAO) flight crew licensing standards' stated that a recent audit by ICAO had identified a significant number of minor differences between Australian flight crew licensing requirements and the ICAO standards for personnel licensing and attempted to address those discrepancies. According to the proposed CASR Part 61 paragraph 4.3.5 'Commercial Pilot Licence':

> The Australian CPL for helicopters currently does not meet the ICAO requirement to provide for 10 hours of instrument flight training. Helicopter operators have viewed this proposal as too expensive and unnecessary. However, helicopters are able to operate under VMC [visual meteorological conditions] criteria that are significantly less than for aeroplanes and probably preclude reference to a visual horizon. There have also been a number of 'VFR flight into IMC [instrument meteorological conditions]' occurrences in helicopters in recent years that indicate the lack of instrument flight training for helicopter pilots may be a problem.

The proposed CASR Part 61 included the requirement for candidates for the award of helicopter category ratings at the various levels of helicopter licences[109] to have completed stipulated periods of helicopter instrument instruction time. At the various licence levels, those periods included:

- applicants for the award of a commercial pilot licence (CPL) (helicopter) who undergoes training on an approved course, not less than 10 hours. Of that instrument time, not more than 5 hours may be in a CASA-approved helicopter synthetic trainer
- applicant for the award of a CPL (helicopter) licence who undergoes training on other than an approved course, not less than 10 hours instruction on helicopters. Of that instrument time, not more than 5 hours may be in a CASA-approved helicopter synthetic trainer
- applicant for the award of an ATPL (helicopter), 30 hours instrument time as a pilot in helicopters[110]. Of that time, not more than 10 hours may be instrument ground time in a CASA-approved helicopter synthetic training device.

E.4 Annex J to CASR Part 61 – Night flying and Night VFR rating

In the background to subpart J of CASR Part 61, CASA stated that:

> Australia has had a Night VFR rating for many years and both Australian and overseas experience indicates the safety benefits of continuing to issue the rating. Australia has weather and terrain that are conducive to night VFR operations but it also has large areas lacking ground lighting and with sparsely scattered radio navigation aids.

Annex J to Part 61 proposed that the night VFR rating be permanently valid, but with a biennial flight review requirement[111]. The holder of a night VFR rating will not be authorised to exercise the privileges of that rating unless he or she has:

- completed the biennial flight review
- passed a night VFR rating flight test within the previous 24 months.

E. 5 Proposed CASR Part 133

On 27 March 2003, CASA released NPRM draft document number 0301OS, 'Air Transport and Aerial Work Operations – Rotorcraft' proposed CASR Part 133. The response closing date to the NPRM was 30 May 2003. According to CASA, transitional arrangements for this part included that existing holders of Air Operator Certificates authorising rotorcraft operations will be required to comply with Part 133 after September 2004. Private operators conducting certain prescribed operations after September 2004 will be required to comply with the relevant provision in CASR Part 133. As at 14 May 2004, CASA CEO Directives 1&2/2004 had placed the further development of CASR Part 133 'on-hold'.

The intention of this Part was to update and consolidate into one Part, all regulatory requirements additional to those contained in CASR Part 91 that relate to the operation of rotorcraft. Further, Part 133 would respond to Parts 119 and 142 relating to certification and training requirements.

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109 Private, commercial and air transport pilot licences.

110 ICAO annex 1 specifies that applicants for an ATPL (helicopter) licence must have 30 hours instrument flight experience and 50 hours night flying as pilot in command or co-pilot in a helicopter.

111 Contrasts with the extant regulations and orders, which do not include a biennial flight review requirement.

The new Part would apply to holders of certificates authorising air transport operations and aerial work operations, and would also apply to some private operations, such as sling loading and winching. Those activities proposed as Aerial Work have yet to be finalised. However, aerial work activities are proposed to include:

Air ambulance flights. In the case of a rotorcraft, that means a flight that is generally planned in advance[112],

- the purpose of which is to facilitate medical assistance where immediate and rapid transportation is not essential, but carriage by air is essential, to the well-being of a patient (including inter-hospital transfer)
- for which the rotorcraft is especially equipped.

EMS operations. EMS operations are defined as operations by an organisation established for the purpose of using rotorcraft to provide one or more of the following services:

- firefighting
- law enforcement
- search and rescue.

EMS flight. EMS flights are defined as flights by rotorcraft, the purpose of which is to facilitate emergency medical assistance, where immediate and rapid transportation is essential, by carrying one or more of the following:

- medical personnel
- medical supplies (including equipment, blood, organs and drugs)
- ill or injured persons and other persons directly involved.

E. 6 Proposed CASR Part 133 – Instruments and equipment

CASR 133.630 (2) of subpart 133K referred to:

> night VFR flight by a rotorcraft involving flight over water beyond 10 nm from land, or over land areas where rotorcraft attitude cannot be maintained by adequate illumination of surface features or by reference to ground features or by reference to ground lighting or a visible horizon, [and stipulate that] the operator must ensure that the rotorcraft is:
>
> (a) equipped with an approved automatic stabilisation system; or
>
> (b) carries a two-pilot crew.

Paragraph (7) of subpart 133.630 to 133K required that:

> If the flight attitude, height and position of the rotorcraft cannot be maintained by reference to adequately illuminated external objects, the operator must ensure that the rotorcraft does not operate over water at night unless the rotorcraft, in addition to complying with the lighting requirements of subregulation 133.1310(2), and complies with (5) [of this subpart] in respect of instruments[113], required for flight under the IFR.[114]

---

112 The methodology for assessing when medical assistance is required immediately, or rapidly is not defined.

113 CASR subpart 91.570 lists those instruments and equipment proposed to be fitted to the rotorcraft for flight under the IFR. Includes the requirement for an attitude indicator that complies with sub regulation 91.570(5) and an approved stand-by attitude indicator that complies with sub regulations (5) and (6) and that is readily visible to the pilot(s) and has an alternate power supply.

114 CASR Part 91 is 'on-hold' pending the outcome of CASA CEO Directives 1/2004 and 2/2004. Directive 1/2004 includes a requirement for the Standards Consultative Committee to review the option of a Part 135, in addition to the planned Parts 121A and 121B. In the event that a Part 135 is proposed by the SCC, recommendations are to be developed for divisions between the Parts. Directive 2/2004 includes a requirement for the Committee to review the content of Part 91 and to evaluate the need for each proposed rule from a safety risk viewpoint.

In addition to proposing conversion training requirements when changing to a rotorcraft for which a new type or class rating is required, Part 133.945 defined the required flight crew checks, or training requirements necessary before commencing line flying under supervision[115]. Additional flight checks are proposed after that period under supervision.

E. 7 Proposed CASR Part 133 – Operational procedures

Subpart 133.201 'Passenger flights under IFR or night VFR' to subpart 133.D, over water flight requirements for rotorcraft stated:

An operator engaged in rotorcraft air transport operations involving the carriage of passengers under the IFR or night VFR must conduct those operations in a multi-engined rotorcraft, unless otherwise approved under this Part.

115 The requirement for, and content/methodology of that supervision are not defined by the proposed CASR. That contrasts with the content of CASR Part 121B Air Transport Operations – Small Aeroplanes, which defines pilot supervision requirements, and the methodology and duration of that supervision.

Appendix F: Previous Australian helicopter EMS accidents

ATSB Occurrence number BO/199301330

On 12 May 1993, a Bell 206L helicopter was operating a night VFR medical evacuation flight to North Fraser Island, Queensland. Enroute, the helicopter was forced to descend to about 1000 feet to remain below the overcast. As the helicopter approached the destination it entered rain and the pilot commenced a descent. The rain became heavier and the pilot lost sight of all but one of the three light sources at the destination. The helicopter subsequently struck trees and began to vibrate. The pilot closed the throttle and flared the helicopter, which came to rest upright about 400 m short of the intended landing point. The aircraft was substantially damaged but there were no injuries. The investigation determined that there was pressure on the pilot to complete the evacuation.

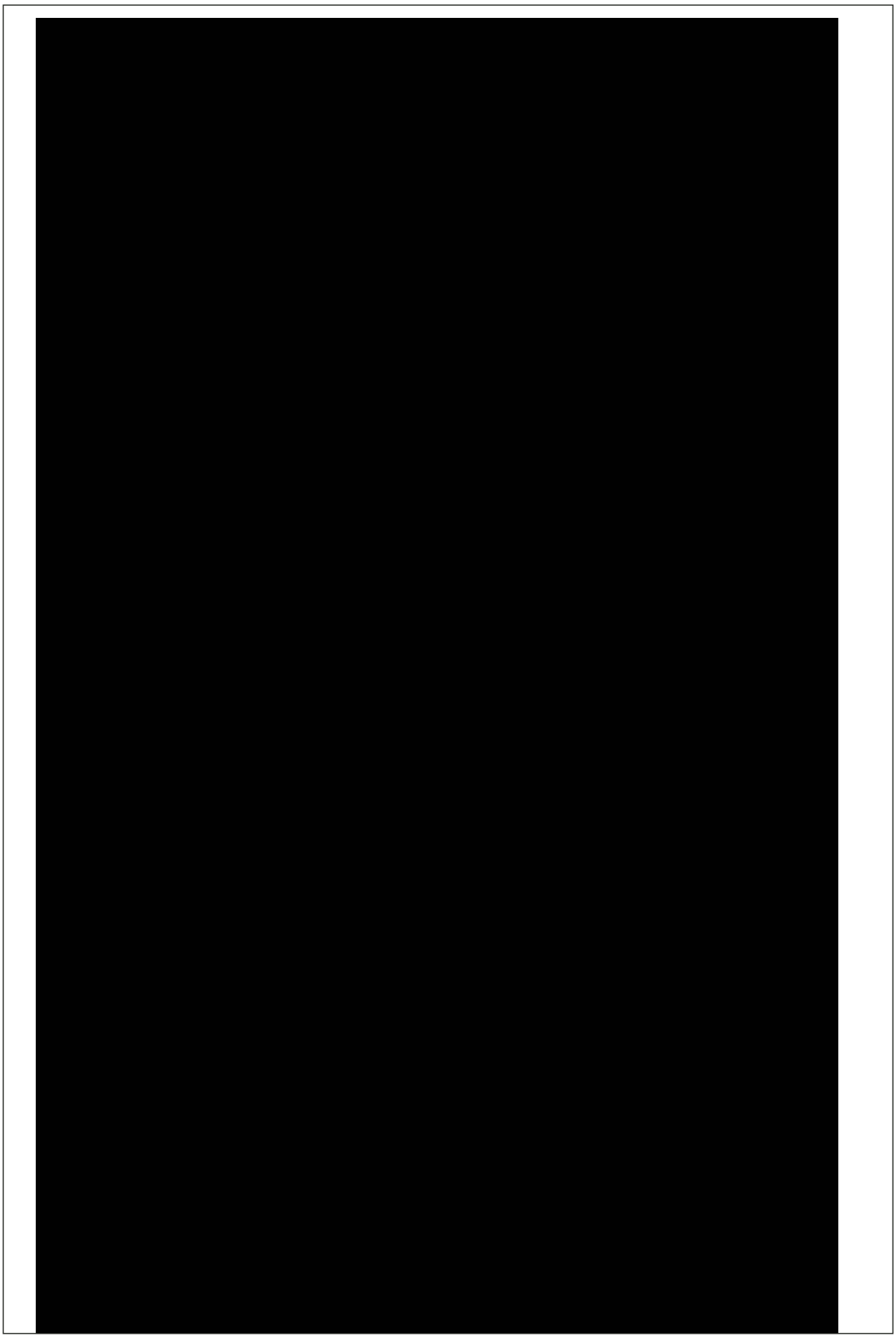
ATSB Occurrence number BO/199701421

On 2 May 1997, a Bell 206L helicopter was destroyed by fire at Tartrus Station, Queensland. In preparing the helicopter for the next flight, the pilot turned on the valve for the medical oxygen system. Witnesses then heard a loud bang and gas escaping as the pilot was thrown clear of the helicopter, which caught fire and burned. The pilot received significant ear and chest injuries in the blast. The investigation determined that the design of the particular oxygen system was not consistent with design best practice. In addition, the investigation revealed significant deficiencies in the control, design, construction, installation and maintenance of medical oxygen systems for use in aircraft.

ATSB Occurrence number BO/200003130

On 24 July 2000, a Bell 206L-3 helicopter was operating a night VFR medical evacuation flight to Rockhampton Hospital. During the flight, the pilot became aware that the helicopter's fuel state was low and decided to divert to Marlborough. By the time the helicopter arrived at Marlborough, fog had formed in the area. After overflying the landing area three times while the fog was thickening , the helicopter lost power and impacted the ground about 300 m from the intending landing point. All five occupants received fatal injuries. The investigation concluded that the most likely reason for the engine power loss was fuel starvation. Once power had been lost, the pilot was unable to execute a safe landing in fog.

Appendix G: JAR-OPS 3.005(d) Helicopter emergency medical services



Appendix 1 to JAR-OPS 3.005(d) (continued)

(3) *The crew.* Notwithstanding the requirements prescribed in Subpart N, the following apply to HEMS operations:

(i) *Selection.* The Operations Manual shall contain specific criteria for the selection of flight crew members for the HEMS task, taking previous experience into account.

(ii) *Experience.* The minimum experience level for commanders conducting HEMS flights shall not be less than:

(A) Either:

(A1) 1 000 hours pilot in command of aircraft of which 500 hours is as pilot-in-command on helicopters; or

(A2) 1 000 hours as co-pilot in HEMS operations of which 500 hours is as pilot-in-command under supervision; and, 100 hours pilot-in-command of helicopters.

(B) 500 hours operating experience in helicopters gained in an operational environment similar to the intended operation (See ACJ to Appendix 1 to JAR-OPS 3.005(d) sub-paragraph (c)(3)(ii)(B)); and

(C) For pilots engaged in night operations, 20 hours VMC at night as pilot-in-command; and

(D) Successful completion of training in accordance with sub-paragraph (e) of this Appendix.

(iii) *Recency.* All pilots conducting HEMS operations shall have completed a minimum of 30 minutes flight by sole reference to instruments in a helicopter or in a synthetic training device (STD) within the last 6 months. (See ACJ to Appendix 1 to JAR-OPS 3.005(d) sub-paragraph (c)(3)(iii).)

(iv) *Crew composition* See ACJ to Appendix 1 to JAR-OPS 3.005(d), subparagraph (c)(3)(iv)

(A) *Day flight.* The minimum crew by day shall be one pilot and one HEMS crew member. This can be reduced to one pilot only in exceptional circumstances.

Appendix 1 to JAR-OPS 3.005(d) (continued)

(B) *Night flight.* The minimum crew by night shall be two pilots. However, one pilot and one HEMS crew member may be employed in specific geographical areas defined by the operator in the Operations Manual to the satisfaction of the Authority taking into account the following:

(B1) Adequate ground reference;

(B2) Flight following system for the duration of the HEMS mission (see AMC to Appendix 1 to JAR-OPS 3.005(d), sub-paragraph (c)(3)(iv)(B)(B2));

(B3) Reliability of weather reporting facilities;

(B4) HEMS minimum equipment list;

(B5) Continuity of a crew concept;

(B6) Minimum crew qualification, initial and recurrent training;

(B7) Operating procedures, including crew co-ordination;

(B8) Weather minima;

(B9) Additional considerations due to specific local conditions.

(4) *HEMS operating minima.*

(i) *Performance Class 1 and 2 operations.* The weather minima for the despatch and en-route phase of a HEMS flight are shown in the following Table. In the event that during the en-route phase the weather conditions fall below the cloud base or visibility minima shown, VMC only capable helicopters must abandon the flight or return to base. Helicopters equipped and certificated for IMC Operations may abandon the flight, return to base or convert in all respects to a flight conducted under IFR, provided the flight crew are suitably qualified.

Appendix H: Previous Australian helicopter night VFR occurrences

ATSB occurrence number BO/199401431

On 31 May 1994, a Bell 206BIII helicopter engaged in a private flight with the pilot and a passenger on board were involved in a fatal occurrence near Rosebud, Victoria. Both occupants received fatal injuries. The pilot was night VFR qualified, but not IFR qualified. The accident occurred after last light. A review of the pilot's training indicated that when flying away from the direction of ground lighting that the pilot had experienced difficulty in controlling the helicopter and the instructor had to take control of the helicopter.

ATSB occurrence number BO/199700583

On 26 February 1997, a Hughes 369HS helicopter engaged in marine pilot transfer lifted off of a ship's deck and the main rotor blades struck an overhead crane. One passenger on board was fatally injured.

ATSB occurrence number BO/199801298

On 10 April 1998, a Bell 206B helicopter engaged in marine pilot transfer operations struck the water and sank after descending unnoticed into the water. The pilot received minor injuries.

ATSB occurrence number BO/200003130

On 24 July 2000, a Bell 206L helicopter was operating a night VFR medical evacuation flight to Rockhampton Hospital. During the flight, the pilot became aware that the helicopter's fuel state was low and decided to divert to Marlborough. By the time the helicopter arrived at Marlborough, fog had formed in the area. After overflying the landing area three times while the fog was thickening , the helicopter lost power and impacted the ground about 300 m from the intending landing point. All five occupants received fatal injuries. The investigation concluded that the reason for the engine power loss was probably fuel starvation. Once power had been lost, the pilot was unable to execute a safe landing from autorotation in fog.

ATSB occurrence number BO/200102083

On 27 April 2001, a Bell 407 helicopter was engaged in a search and rescue flight off shore near Gladstone, Queensland when the helicopter impacted the water during the approach to drop a life raft. 'Black hole' effect optical illusion may have been a factor in that occurrence. There was no celestial lighting available at the time of the occurrence.

Appendix I: CHC (Australia) flying staff instruction – night VFR operations[116]

Standby crews at the commencement of shift are required to examine the aircraft, recent company documents, NOTAMs and prevailing and forecast weather to prepare for activation for tasking. When and if tasking is received, the information should be examined together with any updates of conditions.

Following this:

a. Lowest Safe Altitude- Determine the lowest safe altitude for the route to be flown.

b. Meteorological Information- Using any local knowledge of the area examine the forecast available.

Area forecast

- Confirm valid for the likely duration. Read and understand the overview.
- Determine the cloud amounts and their distribution to determine if they will reduce celestial lighting to the extent where adequate illumination of the ground or water may be impaired or will impact on the ability to maintain LSALT and separation from the cloud as described under the conditions for VMC contained in the AIP.
- Visibility – Given the forecast in-flight visibility, what is the likelihood of being able to maintain the necessary in-flight visibility (5000m)

Terminal area forecast

- Review departure and destination forecast to gain an overview.
- Review other locations to gain a better understanding of en-route conditions.
- Determine if the departure/destination locations have a Trend Type Forecast valid for the arrival/departure time.
- Determine applicability of INTER/TEMPO statements.

Alternates

- Following the review of meteorological information make a decision on the need to provide for an alternate or carry holding fuel. The right alternate minima are:
- Cloud more than SCT below a ceiling of 1500ft.
- Visibility less than 8000m.

Other information

- Review sunrise/sunset times to determine end/beginning of day-light, as this may have an impact on possible alternate solutions.
- Review moonrise/moonset/phase of moon to determine possible additional illumination for the task.

116 Information in this document was previously contained in other sections of the Operations Manual, but collected and contained in this section for clarity and to form a step by step checklist for aircrew.

Decision

Review the likely in-flight conditions, on the task, against the requirements set out in the references/requirements below to determine if the task can be:

1. rejected outright
2. accepted and undertaken successfully (with no adjustments)
3. accepted and commenced with a possibility of a need to make a decision en-route to continue or terminate the task
4. delayed until daylight or meteorological conditions improve.

Evaluation

Given the meteorological forecast and likely in-flight conditions determine whether an attempt will be made to complete the task. However, a plan must always be formulated (before departure and subsequently updated) to safely terminate the mission if less that the required conditions are encountered en-route.

Communication

After deciding on a course of action the client must be informed. They must be advised in a timely and factual manner (giving relevant reasons for any rejection).

For situations 3 and 4, the client needs to be made aware of the reasons for a possible termination or delay and advice given of the likelihood of a successful completion of a task. On these occasions the client may elect to conduct the task using another method of retrieval. In the event of 1 or 4, a voyage report is to be submitted with appropriate weather detail attached if a factor.

Reference information

During night flights navigation may be by the use of radio navigation aids or by reference to the ground or water. However, when operating at or below 2000 ft above the ground or water, navigation must be by visual reference to the ground or water. In any event CHC Australia will only operate under the VFR at night where there are areas and or objects sufficiently illuminated (celestially or artificially), to provide attitude reference unless the aircraft is fitted with a functioning stabilisation system or crewed by two pilots.

The AIP, ENR 1.2 lists the requirements of flight under the Visual Flight Rules.

Below 10000 ft the requirements are:

- 5000 m visibility
- 1000 ft vertical clearance from cloud
- 1500 m horizontal clearance from cloud

except when operating in class G airspace and at or below 3000 ft AMSL or 1000 ft AGL when we may operate clear of cloud and in sight of ground or water.

Visibility is defined in AIP, GEN 2.2-21. The requirement for assessing the need for an alternate aerodrome are listed in AIP, ENR 1.1, paragraph 72.

By night the alternate minima are:

- ceiling 1500 ft
- visibility 8 km.