



## Fuel-related event

# 16 km south-east of Townsville Airport, Qld

## 9 April 2008

### Abstract

On 9 April 2008, the crew of a McDonnell Douglas Helicopter Company MD369ER helicopter registered VH-PLU, experienced a substantial loss of engine power while conducting low-level powerline stringing operations. The helicopter impacted the ground and was seriously damaged. The two occupants were seriously injured.

The investigation determined that the pilot in command was operating the helicopter with a fuel tank quantity that did not guarantee continuous operation of the engine at the flight attitudes experienced during the powerline stringing operation.

As a result of the accident, the operator revised its fuel management procedures for powerline stringing operations.

### FACTUAL INFORMATION

#### History of the flight

On the morning of 9 April 2008, a McDonnell Douglas Helicopter Company MD369ER helicopter, registered VH-PLU, was flown from Innisfail Airport, to a location about 16 km south-east of Townsville Airport, Qld. The flight departed Innisfail with a full fuel load at first light and arrived after about 1.3 hours flight time.

On arrival at Townsville, control of the helicopter was transferred to the operator's training and checking pilot, who became the pilot in command (PIC).

Airborne operations recommenced at about 0853 Eastern Standard Time<sup>1</sup>. The PIC occupied the left seat and the other pilot occupied the right seat in the role of trainee for powerline stringing operations.

The stringing task required a metal cable (draw wire) to be attached to the left side of the helicopter, dragged along the ground, and then passed over a pulley (drum) that was located on the powerline tower. During that operation, the helicopter was flown at a height of about 80 to 100 ft (25 to 30 m) above ground level (AGL), and was occasionally required to hover so that additional lengths of draw wire could be added to the cable that was being pulled.

The PIC had completed four powerline pulls and had commenced the fifth pull when he was required to hover to facilitate ground operations that lengthened the cable being pulled.

The lengthening process was completed and, at about 1000, the PIC commenced the transition from the hover back into line pulling.

The transition to line pulling required the PIC to turn the helicopter slightly towards the cable, attain a nose-up attitude and then roll to the right. Witnesses reported that during the transition, the helicopter achieved a maximum attitude change

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

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of about 15 to 20 ° nose-up, while rolling about 15 to 20 ° to the right.

The crew reported that, on reaching the witness-observed attitude, the engine noise ceased, a loss of power was experienced, and the helicopter descended rapidly to the ground. Witnesses on the ground confirmed that the engine noise ceased prior to the helicopter commencing the rapid descent.

The PIC conducted an autorotation<sup>2</sup> to touchdown. The helicopter impacted the ground at a high vertical velocity, in a right landing skid low, nose-up attitude, which resulted in serious damage<sup>3</sup> to the helicopter (Figure 1).

The pilots sustained serious injuries.

**Figure 1: Accident site**



## Pilot information

The PIC held a Commercial Pilot (Helicopter) Licence (CPL(H)) that was issued in 1995, and a Commercial Pilot (Aeroplane) Licence that was issued in 2001. He had accumulated a total aeronautical experience of about 7,000 flying hours on helicopters, with 1,300 flying hours on the helicopter type. He was appropriately endorsed for the helicopter type and held a valid Class 1 aviation medical certificate.

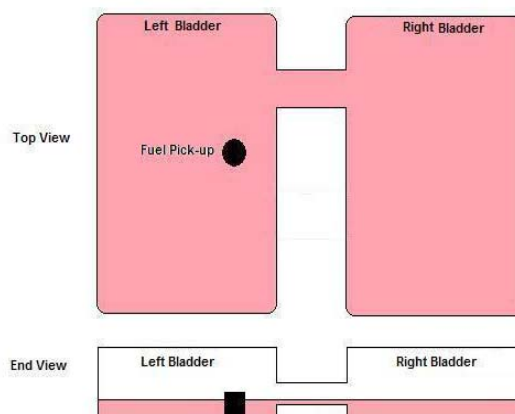
The other pilot held a CPL(H) with a total aeronautical experience of about 4,000 flying

hours on helicopters, about 2,000 flying hours on the helicopter type and a valid Class 1 aviation medical certificate.

## Helicopter information

The helicopter's main airframe fuel system comprised two flexible, rubberised, bladder-type, interconnected fuel cells, located in separate fuel bays beneath the passenger compartment floor. Fuel was delivered to the engine from the left fuel cell. The operator's operations manual stated that the main fuel cells held 62.1 US gallons (235 L), or 421 lbs of usable fuel. The engine fuel pick-up point was located within the left fuel cell, left of the aircraft centreline and slightly above the tank floor (Figure 2).

**Figure 2: Helicopter main fuel cells**



The helicopter was also equipped with an auxiliary fuel cell located within the right rear cargo/passenger area that contained 114 L of usable fuel. Fuel was gravity-fed from the auxiliary fuel cell into the right main cell through an electrically-operated solenoid valve. The total useable fuel capacity, including the auxiliary cell, was 349 L of fuel.

The investigation estimated that the flight from Innisfail to Townsville would have emptied the auxiliary fuel cell, which was confirmed by the on-site inspection (see following discussion).

At the time of the accident, the helicopter had operated for about 2 hours and 30 minutes without refuelling. The fuel tanks remained intact on impact and a total of 85 L of Jet A1 aviation turbine fuel (AVTUR) was recovered. An on-site fuel test did not find any traces of water in that fuel.

<sup>2</sup> Helicopter emergency landing without engine power that utilises the stored (kinetic) energy within the blades to cushion the touchdown

<sup>3</sup> The Transport Safety Investigation Regulations 2003 definition of serious damage included the destruction of the transport vehicle.

The fuel calibration card<sup>4</sup> (Figure 3) that was attached to the helicopter (current as of 30 April 2007) advised that 80 L of fuel would indicate 150 lbs on the fuel gauge, and that 114 L would indicate 200 lbs on the fuel gauge.

**Figure 3: Fuel calibration card**



The PIC reported that he did not normally conduct stringing operations when the fuel gauge reached 100 lbs (52 L in accordance with the fuel calibration card) as ‘...the helicopter gets over on a bit of an angle...’. That increased the risk of the fuel pick-up point rising above the surface of the fuel. The PIC reported that, at the time of the accident, the fuel gauge indicated about 170 lbs (about 94 L by the fuel calibration card) ‘...when they were fairly flat...’.

Following the accident, testing was conducted by the operator to determine the maximum nose-up and roll attitudes that could be achieved with various fuel quantities to avoid fuel starvation (Figure 4). Those results are contained in Table 1.

**Figure 4: Operator testing of fuel levels**



**Table 1: Operator fuel starvation test data<sup>5</sup>**

Fuel (litres)	Nose Up (degrees)	Lateral rotation (degrees)
80	19.5	0
80	10.5	16.3 right
80	0	20 right
100	5	22 right

The helicopter manufacturer advised that a fuel level of more than 87.4 L (about 162 lbs by the fuel calibration card) was required to avoid fuel starvation when operating with a 20° nose-up attitude, when combined with a 20° right roll.

### Powerplant information

The helicopter was equipped with a Rolls-Royce 250-C20R/2 turboshaft engine, serial number CAE295444. The engine and fuel system were examined at the accident site prior to being removed for off-site testing.

The on-site examination found no pre-existing mechanical abnormalities that would have affected the operation of the engine prior to the ground impact. Fuel quality was not considered to be a factor in the accident as the helicopter had been operating normally for in excess of 2 hours since refuelling.

During the examination of the fuel system, it was noted that there was no fuel in the lines between the fuel tank and the airframe fuel filter, and the airframe fuel filter and engine. Miniscule amounts of fuel were found within the airframe fuel filter bowl.

<sup>4</sup> Fuel calibration was carried out with the helicopter positioned wings level, and 2° nose down to simulate the helicopter’s attitude in forward flight.

<sup>5</sup> Combination of helicopter pitch and roll and fuel state at which fuel starvation would have occurred.

Off-site testing of the airframe fuel filter at the Australian Transport Safety Bureau's (ATSB's) technical facilities found it to be serviceable with no significant amounts of particle matter.

The engine was removed and sent to an independent engine overhaul facility, where further tests were conducted under the supervision of the ATSB.

An initial engine run found that the engine experienced an over-speed condition that was traced to fuel control unit (FCU) casing damage. The FCU casing damage was the result of impact forces during the accident.

The damaged FCU was replaced. The engine then successfully completed a 1-hour manufacturer test and evaluation program.

The damaged FCU was subjected to bench testing and disassembly. The testing regime involved 19 steps, of which 17 results were within the manufacturer's operating parameters. The two remaining results related directly to functions controlled within the area of the FCU that was damaged during the accident.

A visual inspection of the internal components of the FCU found them to be within the manufacturers' serviceable limits.

## Organisational information

The operator had a documented standard operating procedure (SOP) for powerline stringing operations that provided the following fuel warning.

**WARNING 6:** Pilots to be aware of and **never exceed** these fuel requirements.

1. *Never operate for more than one hour* from a full tank (242 Litres).
2. *Never start a pull with under 300lbs* indicated (Aircraft level).
3. *Never let the fuel go below 200 lbs* indicated as fuel starvation will lead to an engine failure.

The cockpit fuel calibration card indicated that 300 lbs was equal to 174 L, and that 200 lbs was equal to 114 L.

The operator advised that the fuel figures quoted in Warning 6 of their SOP were derived from their estimate of a safe minimum fuel level required for powerline stringing operations.

## ANALYSIS

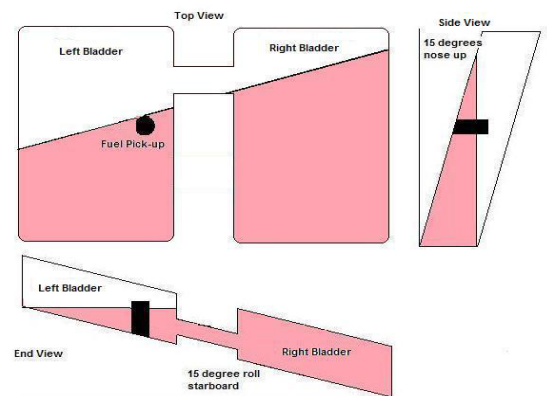
The crew of the helicopter experienced a substantial power loss at an altitude of about 100 ft (30 m) above ground level (AGL). At the time of the power loss, the pilot in command was operating the helicopter in a high nose-up, significant right-roll attitude.

Examination and testing of the engine confirmed that, with the exception of post-impact damage to the fuel control unit (FCU), the engine was capable of operating within normal parameters.

The configuration of the fuel system was such that, when subjected to significant nose-up and right-roll helicopter attitudes, it required an increased amount of fuel to limit the possibility of the fuel pick-up point rising above the fuel surface, and subsequently feeding air to the engine.

During the powerline stringing operation, transition from the hover to line pulling, created a worst-case scenario, resulting in the majority of the fuel being located at areas furthest from the fuel pick-up point (Figure 5).

**Figure 5: Fuel pick-up schematic**



Fuel from the auxiliary fuel cell was expended on the flight from Innisfail. Therefore, at the time of the accident, the helicopter engine had been drawing fuel from the main fuel cell for about 1.2 hours. Following the accident, a total of 85 L of fuel was recovered from the main fuel cell. That flight time, and the fuel quantity remaining, were outside the maximum flight time and minimum fuel requirements of Warning 6 of the operator's standard operating procedure.

A fuel cell capacity of 85 L, when subjected to the reported flight attitude of 20° nose-up and 20°

right-roll, resulted in a fuel surface level that was below the height of the fuel tank pick-up point. That condition caused a disruption in the fuel supply to the engine, which resulted in the loss of power and engine noise described by the crew and ground witnesses.

## FINDINGS

From the evidence available, the following finding is made with respect to the fuel-related event involving McDonnell Douglas Helicopter Company MD369ER helicopter, registered VH-PLU, which occurred 16 km south-east of Townsville Airport, Qld on 9 April 2008. The finding should not be read as apportioning blame or liability to any particular organisation or individual.

### Contributing safety factor

- The helicopter did not contain a fuel quantity that would have ensured a continuous flow of fuel to the engine when operated at the nose-up and right-roll flight attitude required for powerline stringing operations.

## SAFETY ACTION

### Operator

#### *Fuel safety margins during powerline stringing operations*

#### Action taken by the operator

Although not identified by the investigation as a safety issue, as a result of this accident, the operator identified that the requirements of its Standard Operating Procedure AP-WI 611/56, dated 8 August 2001, provided minimal fuel safety margins for the flight attitudes likely to be experienced during powerline stringing operations.

The operator subsequently published a revised Standard Operating Procedure (SOP) that contained more stringent operational requirements.

The revised SOP included the following:

#### 4.1 MD500

4.1.1 The aircraft **should** whenever possible be configured with the auxiliary fuel tank for all stringing operations.

4.1.2 Stringing without the auxiliary fuel tank **shall** be limited to the parameters set out in paragraph 5, limitations.

## 5. LIMITATIONS

### 5.1 MD500

Refer to Para 4 for configuration.

#### 5.1.1 Aircraft configured with auxiliary fuel tank shall:

(i) Start each and every pull with full main and full auxiliary fuel tanks.  
**Note:** auxiliary fuel tank to be activated after no longer than 30 minutes engine time.

(ii) Which ever occurs first from the following:

Never exceed 1 hour 30 minutes engine time

Or Never let fuel level drop below 250lbs indicated  
(This reading to be observed in a stable level hover)

#### 5.1.2 Aircraft configured without auxiliary fuel tank shall:

(i) Start each and every pull with full main fuel tanks.

(ii) Which ever occurs first from the following:

Never exceed 30 minutes engine time.

Or Never let fuel level drop below 250lbs indicated  
(This reading to be observed in a stable level hover)

**WARNING 7:** Pilots to be aware of configuration and fuel requirements set out in paragraph 4 and 5 of this procedure.

## SOURCES AND SUBMISSIONS

### Sources of information

The sources of information during the investigation included the flight crew, the operator, the helicopter's maintenance and other documentation, and the helicopter manufacturer.

### Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the Transport Safety Investigation Act 2003, the Executive Director may provide a draft report, on a confidential basis, to any person whom the Executive Director considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the Executive Director about the draft report.

A draft of this report was provided to the pilot in command, the crew member, the operator, the Civil Aviation Safety Authority (CASA), the helicopter manufacturer and the US National Transport Safety Board (NTSB). A submission was received from the crew member. That submission was reviewed and, where considered appropriate, the text of the draft report was amended accordingly.