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Aircraft Type and Registration:	Robinson R22 B; G-CLYV
No. and Type of Engines:	1 Lycoming 0-320 B2C
Aircraft Serial Number:	1677
Year of Manufacture:	1991
Date and Time (UTC):	14 August 1996; 1715 hrs
Location:	Killary Harbour, Co. Galway
Type of Flight:	Private
Persons on Board:	Crew 1 Passenger 1
Injuries:	Crew Nil Passenger Nil
Nature of Damage:	Aircraft suffered power failure and landed in 3 metres of sea water.
Commanders Licence:	Private Pilots Licence (Helicopter)
Commanders Age:	N/A
Commanders Flying Experience:	Total 695 hrs Last 90 days 50 hrs Last 28 days 1.2 hrs
Information Source:	AAIU Field Investigation

History of the Flight

The pilot collected the aircraft at 0900 hours on the day of the accident, at Galway Airport. He refuelled the aircraft, putting a total of 18 gallons (Imperial) into the tanks. He then flew to his home, a distance of 3 miles. At approximately 1400 hours, the pilot, accompanied by a friend, departed from his home, and flew to a campsite near Tully Cross, Co. Galway, a distance of approximately 40 miles. He landed there and after a cup of coffee, he flew three short flights, carrying friends who were staying on the campsite. Total flight time since leaving Galway was approximately 1 hour at this point.

He then departed for Galway, routing via Killary Harbour, with the same passenger who had accompanied him on the outward flight. As the aircraft flew down Killary Harbour, which is a steep sided fjord, and at approximately 6 miles from Tully Cross, the aircraft yawed left.

The pilot checked the cockpit instruments and all appeared to give normal indications. He believed, at the time, that this yaw may have been caused by turbulence.

Some 3 or 4 minutes later, the aircraft again yawed to the left. Again all engine parameters were in the green, and the pilot suspected a bird strike, possibly to the vertical fin. He circled and picked out a possible landing site, but as the aircraft appeared to have no problem, he elected to continue Eastwards towards the head of the fjord, at a reduced speed, where better landing areas were available. He noted a small fishing boat near the shore. The aircraft yawed then again, followed, approximately 10 seconds later, by two more yaws and sounds similar to engine backfire. The engine then appeared to falter.

The helicopter was at approximately 800 ft. when the engine started to loose power. The terrain in the immediate area was steeply graded, so the pilot elected to land in the water, close to the shore, and the small boat. He landed about 20 feet from the shore line. The aircraft sank immediately, in approximately 3 metres of water.

The pilot and passenger successfully evacuated the aircraft. However, their escape was partially impeded by life jackets which were carried in the aircraft, but were not worn during this flight. These life jackets were of the auto-inflate type, commonly used by leisure sailors. The life jackets inflated automatically as the aircraft sank, thereby restriction egress through the relatively small doors of the R22.

The pilot and passenger made their way to the shore and the boat man offered assistance. A diver from a nearby adventure school arrived shortly thereafter. The pilot asked him to dive to the aircraft to turn off the main fuel cock, to prevent fuel seepage from the aircraft into the bay, which is a noted fishing area. He also asked the diver to retrieve two valuable cameras which were in the aircraft. The diver turned the fuel cock off and retrieved the cameras.

The aircraft suffered little structural damage as it landed on the water. The main damage was a broken tail rotor blade. However, subsequent damage caused by salt water resulted in the aircraft being written-off. The pilot and passenger stated that they were uninjured in the accident.

Recovery

The accident occurred approximately one hour after high water. The AAIU Inspector arrived at the scene at low water the next day, at approximately midday, which coincided with low water. The aircraft was then just clear of the water, lying approximately 20º tail down and 10º left side down.

At this stage, both fuel tanks were completely full of water. Rolls of 70 mm film were found in the luggage compartment under the passenger's seat and the fuel cock was fully off. The aircraft was recovered just before high tide that day, and brought to a nearby pier. The fuel filter bowl contents were then examined, and were found to contain fuel. There was no water in this fuel. The aircraft was then recovered to the AAIU facility at Gormanston, Co. Meath, for further examination.

Further Examination

The aircraft's fuel system was checked and no defects were found. No fuel was found in the carburettor bowl. The ignition system was found to be functioning correctly and was in good condition. The carburettor heat was found to be off, but was fully operable. The electrical system functioned correctly. One circuit breaker was found to be in the popped position. This circuit breaker controlled the following circuits:-

- Main Rotor Gear Box Temperature Lights
- Map light
- Outside Air Temperature Gauge
- Carburettor Air Temp Gauge
- Fuel Gauges
- Engine Hour Meter
- Engine Oil and Temperature Gauges

When the circuit breaker was reset these systems gave normal indications, and the circuit breaker did not pop again. However, the auxiliary fuel tank gauge was inoperative.

The engine showed no external damage. The engine could be partially rotated, but could not be turned through a full cycle. The inability to completely rotate the engine was found to be solely caused by a build-up of deposits in No. 4 cylinder. This prevented any attempt to run the engine.

These deposits were found to be consistent with salt deposits frequently found in hot engines that have been immersed in salt water. Such deposits were probably produced when salt water entered the cylinder through an open exhaust valve. The flash boiling of the salt water, caused by the hot cylinder and the exhaust gases, produced the substantial deposit which then prevented the piston reaching top dead centre. No other defect was found in the engine. In particular, no evidence of a stuck valve or bent valve push rod was found.

The possibility of engine failure due to partial closure of the fuel shut-off valve was examined. This valve is situated in a shelf directly behind the passenger's left shoulder, beside the door. There is no lock or safety on this valve, and it is not impossible that a loose shoulder harness strap or other loose objects could cause the valve to partially close. However, the pilot stated that he had positively checked the tightness of the passengers straps and that there were no loose objects in the cockpit in the area of the valve, and in particular, the cameras were stored in the locker under the passenger's seat.

The absence of water in the fuel filter bowl, when the bowl was inspected immediately after recovery, was examined, as this was an indication that the fuel valve may have been closed when the aircraft entered the water. In tests conducted at Gormanston, where water was introduced into the fuel tank, with the fuel valve open, the water rapidly sank to the bottom of the filter bowl. However, in the accident situation it is probable that the initial flow of sea water into the fuel tanks was very limited. The only point of entry of water into the tanks was through the fuel tank vent lines.

These lines run from the top of both tanks, up the inside of the main rotor mast fairing, and terminate with an inverted "U" end, located near the rotor head, where they are open to the atmosphere. The tops of the vent pipes would have been, at most, ½ metre under the water level, and may have been clear of the surface, immediately after the accident. The inverted "U" end may have produced an air lock, which would have prevented or slowed the entry of water into the tanks. Because the aircraft was lying tail down, any initial entry of water would have rested in the bottom rear of the tank, and would not have entered the pipe to the filter bowl, which is located at the front on the tanks. As the tide was receding at the time of the accident, the water level would have reduced below the vent pipe ends shortly after the accident, preventing any inflow to the tanks. The diver also closed the valve about this time, which prevented the passage of water to the filter bowl. When the aircraft was totally submerged during the next high tide, the increase water head would have cleared the airlock, and the tanks flooded, with the water displacing the lighter aviation gasoline. The fuel would then exit through the vent pipes.

The aircraft's carburettor bowl tested to determine why no fuel was found in it. The carburettor bowl was filled with fuel and the carburettor immersed in water. The fuel made its way out of the bowl through a air vent, and the bowl filled with water. This test demonstrated that the absence of fuel in the post-accident inspection was not a positive indication of fuel starvation prior to the landing in the sea.

Finally, the possibility of carburettor icing was explored. Information on the weather in the Killary Harbour area was provided by Met Eireann, the Irish Meteorological Service. The cloud base in the area was 2200 ft. The estimated temperature at 800 ft was 15ºC and the dew point was 11ºC. Plotting these valves on the appropriate chart, as shown in Annex A, shows that the aircraft was operating in edge of the zone of probable serious carburettor icing, at any power setting.

The pilot's action of reducing speed and altitude after the second yaw would have resulted in a reduced power setting, and such a reduction would have exacerbated the onset of carburettor icing. It may be noted that the automatic engine speed governor fitted to the R22 B could disguise the initial power loss due to the onset of carburettor icing, as the system would open the throttle to rectify a minor power loss, without the pilot becoming aware of the initial onset of the icing problem.

Safety Notice

The Robinson R22 flight manual contains a Safety Notice SN-25, warning pilots of the dangers of carburettor icing in temperatures below 16ºC, particularly when power is reduced. This notice further states that carburettor heating is ineffective once power is reduced.

It concludes by stating in capitals:-

"WHEN CONDITIONS CONDUCIVE TO CARB ICE EXIST AND YOUR MANIFOLD PRESSURE IS BELOW 18 INCHES, IGNORE THE CAT GAGE AND APPLY FULL CARB HEAT".

In the above warning, CAT Gage means Carburettor Air Temperature Gauge

Conclusions

No evidence of a technical failure in the aircraft was found. The initial yawing of the aircraft was probably caused by the initial onset of carburettor icing. The actions of the pilot, in reducing power, inadvertently increased the temperature drop across the carburettor venturi, thereby increasing any icing problem. The probable cause of the loss of engine power was carburettor icing.

Safety Recommendations (SR)

1. Pilots of light piston engined aircraft, and in particular helicopters, need to be aware of the dangers posed by carburettor icing, even in moderately warm conditions. Consideration of AIC NR 11/97, "Induction System Icing on Piston Engines as Fitted to Aeroplanes, Helicopters and Airships", issued by the IAA, is recommended. **(SR 17 of 1998)**

2. The IAA should warn pilots of the dangers to impeded egress posed by automatically inflating lift jackets. **(SR 18 of 1998)**

3. While probably of no relevance to this accident, the manufacturers of the R22 should consider modification of the fuel shut-off valve to prevent inadvertent closure in flight. **(SR 19 of 1998)**

ANNEX A

The graph shown below is reproduced from the Irish Aviation Authority (IAA) Aeronautical Information Circular (AIC) NR 11/97, titled "Induction system icing on piston engines as fitted to aeroplanes, helicopters and airships". The conditions prevailing at 800 ft, when the accident occurred to G-CLYV, have been superimposed on this graph. The result shows that serious icing of the carburettor could be encountered, at any power setting, at the time of the accident.