Federal Public Service
Mobility and Transport
Air Accident Investigation Unit

Air Accident Investigation Unit (Belgium)
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Safety Investigation Report

ACCIDENT TO
A ROBINSON R-44 IN ROESELARE
ON 5 SEPTEMBER 2014

Ref. AAIU-2014-20- Roeselare
Issue date: 15 December 2015
Status: Final

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FOREWORD

This report is a technical document that reflects the views of the investigation team on the circumstances that led to the accident.

In accordance with Annex 13 of the Convention on International Civil Aviation, it is not the purpose of the aircraft accident investigation to apportion blame or liability. The sole objective of the investigation and the Final Report is the determination of the causes, and define recommendations in order to prevent future accidents and incidents.

In particular, Art. 17.3 of EU Regulation 996/2010 stipulates that a safety recommendation shall in no case create a presumption of blame or liability for an accident, serious incident or incident.

Safety recommendations and Safety messages
When AAIU(Be) issues a **safety recommendation** to a person, organization, agency or Regulatory Authority, the concerned person, organization, agency or Regulatory Authority must provide a written response within 90 days.
That response must indicate whether the recommendation is accepted, or must state any reasons for not accepting part or all of the recommendation, and must detail any proposed safety action to give effect to the recommendation.

AAIU(Be) can also issue a **safety message** to a community (of pilots, instructors, examiners, ATC controllers), an organization or an industry sector for it to consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to a safety message, although AAIU(Be) will publish any response it receives.

The investigation was conducted by the AAIU(Belgium) with the support of the US NTSB and Robinson helicopters.
The report was compiled by L. Blendeman

NOTE:

1. For the purpose of this report, time will be indicated in UTC, unless otherwise specified.
2. ICAO doc. 9859 was used for the identification of the hazard and the consequence.

SYMBOLS AND ABBREVIATIONS

EU	European Union
‘	Minutes
°	degree
°C	Degree Centigrade
‘	Feet
“	Inch
AAIU(Be)	Air Accident Investigation Unit (Belgium)
AC	Aircraft
AR/KB	Arrêté Royal / Koninklijk Besluit
BCAA	Belgian Civil Aviation Authority
deg	degrees
E	East
EASA	European Aviation Safety Agency
EBKT	Kortrijk Wevelgem airfield
FAA	Federal Aviation Administration
FH	Flight Hour
h	hour
ICAO	International Civil Aviation Organisation
Km	Kilometer
kt(s)	knots
LH	Left Hand
mbar	millibar
msn	Manufacturer serial number
N	North
OPS	Operations
para	paragraph
PIC	Pilot In Command
PPL (H)	Private Pilot Licence (Helicopter)
RPM	Revolutions per Minute
US NTSB	United States - National Transport Safety Board
UTC	Coordinated Universal Time

SYNOPSIS

Date and time of the accident:	5 September 2014 at 18.00 UTC
Aircraft:	Robinson R-44 Raven (I) MSN 1294
Accident location:	On a parking lot in Roeselare N 50° 57' 04.2" E 003° 06' 18.6"
Aircraft owner:	Southern aircraft consultancy (Trustee)
Type of flight:	General Aviation – Cross country
Persons on board:	2
Fatalities:	2

Abstract:

Both pilots were friends and had a special interest in car racing; the passenger had his son competing in the rally 'ConXioN Tour of Flanders' that day.

Both pilots met on the Kortrijk-Wevelgem airfield (EBKT) for a flight above the race track, ending by the gathering in the exposition hall of Roeselare.

The helicopter was sighted taking off again around 18.00 UTC from an open field close to the exposition hall. The helicopter flew above the building of the exposition hall when witnesses heard a sudden decrease in the rotor/engine sound frequency.

The helicopter fell vertically to the ground and crashed on a car parking lot. The helicopter caught fire.

Both occupants were killed.

Cause(s).

The accident was caused by the engine stoppage at low height and low airspeed caused by one of the crew mistakenly pulling the mixture control knob to the cut-off position when trying to pull the carburetor heat control knob.

The post-impact fire was caused by the rupture of the fuel tanks and subsequent leaking of fuel on the hot parts of the engine or damaged electrical components.

Contributing factor(s)

The following contributing factors were identified

- Non-compliance with the minimum required altitude when flying above crowded area.
- Time pressure
- The fuel bladder tanks were not installed. [safety issue]
- The guard to be placed around of the mixture control (although efficient when installed and covered by the POH procedures) can be removed. [safety issue]

1. Factual Information

1.1. History of flight.

Both pilots were friends and had a special interest in car racing; the passenger had his son competing in the rally ‘ConXion Tour of Flanders’,that day.
Both pilots met on the Kortrijk Wevelgem (EBKT) airfield for a flight above the race track, ending by the gathering in the exposition hall of Roeselare.

The helicopter took off from EBKT at 16.45 UTC and proceeded North. The helicopter flew over the car racing tracks at low altitude, before landing in Roeselare 25 minutes later (17.10).

The two pilots went to the exposition hall where the car racing pilots were gathering after the race.

The helicopter pilots went back to the helicopter around 18.00 in order to land in EBKT before dusk (approximately sunset + 30 minutes).

The helicopter was sighted taking off around 18.00 from an open field close to the exposition hall. The helicopter flew above the building of the exposition hall, when witnesses heard a sudden decrease in the rotor / engine sound frequency.

The helicopter fell vertically to the ground and crashed on a car parking lot. The helicopter caught fire.

Both occupants were killed.

1.2. Injuries to persons.

Injuries	Crew	Passenger	Others	Total
Fatal	1	1	0	2
Serious	0	0	0	0
Minor	0	0	0	0
None	0	0	0	0
Total	1	1	0	2

1.3. Damage to aircraft.

The helicopter was totally destroyed by the impact and subsequent fire.

1.4. Other damage.

Slight damage on the parking lot fence and ground. Several cars were damaged by the proximity of the fire.

1.5. Personnel information.

Pilot.

Sex:	Male
Age:	42
Nationality:	Belgian
Licence:	Private Pilot certificate (helicopter) issued by the FAA on 15 April 2010
Rating:	Rotorcraft- helicopter.
Medical:	FAA Medical certificate third class.

Further details on experience are unknown since the pilot's log book was destroyed by fire.

The pilot was the beneficial owner of the helicopter, and as such we can assume he flew most of the helicopter's flight time. The helicopter flew 170 FH per year on average. Since the acquisition of the helicopter in July 2009, the helicopter accumulated 850FH.

Passenger (Student Pilot).

Sex:	Male
Age:	45
Nationality:	Belgian
Licence:	Student pilot (FAA) since 30 January 2014.
Medical:	FAA Medical certificate third class.

Reportedly, the student pilot was finishing his qualification and was ready to perform his skill test.

1.6. Aircraft information.

1.6.1. General

The Robinson R44 is a four-place light helicopter produced by the Robinson Helicopter Company since 1992. It is a single engine helicopter with a semi-rigid two-bladed main rotor and a two-bladed tail rotor and a skid landing gear. It has an enclosed cabin with two rows of side-by-side seating for a pilot and three passengers.

The Robinson R44 (I) is certificated by the FAA with Type Certificate No. H11NM, initially issued on 12 December 1992 and last revised (7) on 21 April 2015 with certification basis 14 CFR Part 27. On the same certification basis EASA initially issued Type Certificate No. EASA.IM.R.121 on 28 September 2003 last revision (issue 3) dates from 21 April 2010.

General characteristics

- **Crew:** one or two pilots
- **Capacity:** four, including pilot
- **Payload:** 900 lb (408 kg)
- **Length:** 29 ft 5 in (8.96 m)
- **Rotor diameters:** 33 ft (10.1 m)
- **Tail rotor diameters:** 4 ft 10 in (1.5 m)
- **Height:** 10 ft 9 in (3.3 m)
- **Empty weight:** 1,450 lb (657.7 kg)
- **Max. gross weight:** 2,400 lb (1,134 kg)

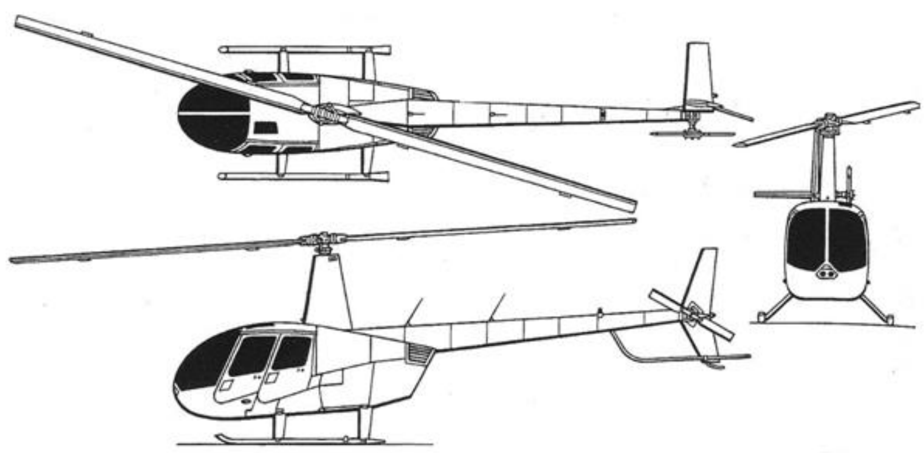

Figure 1: Robinson 44 – 3-view

Airframe:

Manufacturer:	Robinson Helicopter Company
Type:	R44 I
Model:	Raven I
Serial number:	1294
Built year:	March 2003
Registration:	N**
Certificate of registration:	Delivered by the FAA on 24 July 2009
Certificate of Airworthiness:	USA Standard Airworthiness certificate (FAA Form 8100-2) in the normal category, dated 31 July 2009.
Annual Inspection:	Last performed on October 21, 2013.
Airplane total time:	1651.2 FH on 25 July 2014 (last 50-hours inspection).

Engine:

Manufacturer:	Lycoming
Type:	O-540-F1B5
Total flight hours:	1651.2 FH on 25/07/2014
Serial number:	L-261.54-40A

1.6.2. Maintenance

All annual inspections, including the last one performed on 21 October 2013 were signed off by a FAA certified A&P mechanic.

The maintenance of the helicopter between each annual inspections, since 31 July 2009, was performed by a EASA Part-145 Maintenance Organisation (Air Technology Belgium). This includes the routine maintenance (50 and 100 FH, embodiment of modifications and correction of defects).

The sign-off of the maintenance in the log-books and related work reports is done with the reference to the part-145 regulation. No reference to the US regulation was found for the completion of these tasks. (repeat finding of the 9 February 2013 accident with a Cessna P210N aircraft in EBCI).

As an example, the maintenance performed on 22 July 2014 by an EASA part M subpart F Maintenance Organisation based in Belgium included:

- Routine inspection (50 FH and 100FH tasks)
- Application of SB-72A – main rotor blade bond inspection
- The correction of defects, including replacement of the mast fairing, alternator belt, repair of cracks in the cooling panel,

The US regulation states the following:

- 14CFR 91.405 requires the owner of the aircraft to ensure that, after the performance of maintenance (repair of discrepancies between inspections), appropriate entries are made in the aircraft maintenance records indicating the aircraft has been approved to return to service,

- 14 CFR 91.407 prohibits the operation of the aircraft if maintenance record entries are not performed in accordance with 14 CFR 43.

- The approval for return to service after maintenance, preventive maintenance, rebuilding, or alteration is required by US regulation; 14CFR 43.5,

- The persons authorized to return aircraft to service after maintenance are defined by 14CFR 43.7.

- The recording of maintenance on aircraft must be done in accordance with 14CFR 43.9 or 43.11

1.6.3 Performance

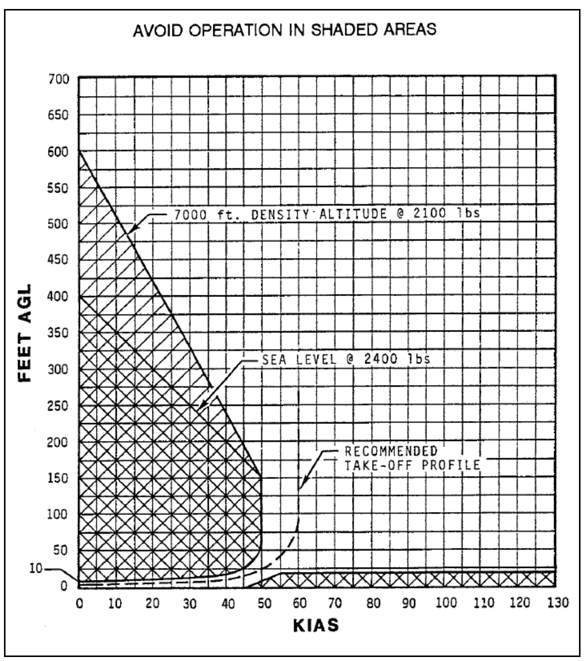

Figure 2: height-velocity diagram from R44 POH

The height – velocity diagram (aka dead man's curve) is a diagram indicating the combinations of height above ground and airspeed that should be avoided due to safety concerns relating to emergency landings. It is dangerous to operate within the shaded regions of the diagram, because it may be impossible for the pilot to complete an emergency autorotation from a starting point within these regions.

1.6.3. Instrument Panel – mixture control

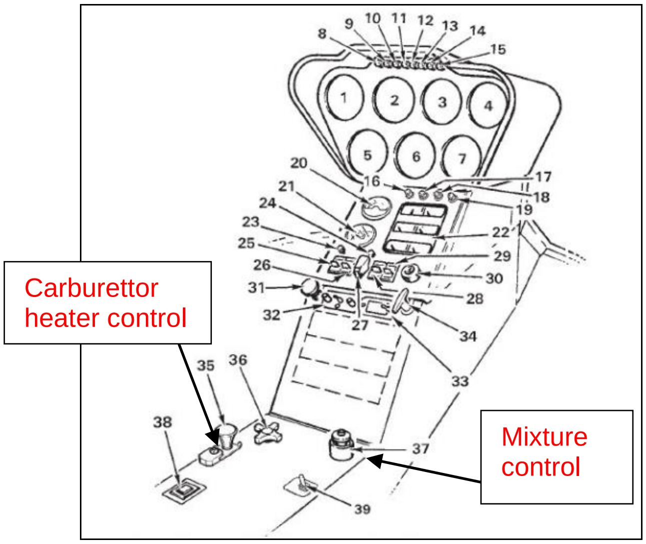

Figure 3: Instrument panel

Figure 4: Mixture control (idle cut-off)

Figure 5: Mixture control (full rich position)

The Robinson Helicopter Safety Notice N°1, first issued in 1981 (in appendix) identifies the risk of inadvertently actuating the mixture control in flight. The knob is specifically shaped, and a small plastic guard is foreseen.

When the plastic guard is installed, the inadvertent operation of the mixture control in flight is prevented.

The Pilot Operating Handbook describes in both the 'engine shutdown' and 'before starting' procedures the operations with the mixture control guard.

POH - Normal procedures

BEFORE STARTING ENGINE

Seat belts	Fastened
Fuel shut-off valve	ON
Cyclic/collective friction	OFF
Cyclic, collective, pedals	Full travel free
Throttle	Full travel free
Collective	Full down, friction ON
Cyclic	Neutral, friction ON
Pedals	Neutral
Rotor brake	Disengaged
Circuit breakers	In
Carb heat	OFF
Mixture	Full rich
Mixture guard	Installed
Trim and landing light switches	OFF
Avionics switch (if installed)	OFF
Clutch	Disengaged
Altimeter	Set
HYD and governor switches	ON

SHUTDOWN PROCEDURE

Collective down, RPM 60-70%	Friction ON
Cyclic and pedals neutral	Friction ON
Trim switch (if installed)	OFF
CHT drop	Throttle closed
Clutch switch	Disengage
Wait 30 seconds	Mixture OFF
Mixture guard	Back on mixture
Wait 30 seconds	Apply rotor brake
Clutch light	Extinguishes
Avionics, alt, battery, and ignition switches	OFF

POH - Emergency procedures

POWER FAILURE BETWEEN 8 FEET AND 500 FEET AGL

1. Lower collective immediately to maintain rotor RPM.
2. Adjust collective to keep RPM between 97 and 108% or apply full down collective if light weight prevents attaining above 97%.
3. Maintain airspeed until ground is approached, then begin cyclic flare to reduce rate of descent and forward speed.
4. At about 8 feet AGL, apply forward cyclic to level ship and raise collective just before touchdown to cushion landing. Touch down in level attitude and nose straight ahead.

1.7. Meteorological conditions

At EBOS (Ostend) airport:
Wind direction: 340 – 350 degrees
Wind speed: 8 kt
Visibility: 4000 m
Mist
Clouds: scattered at 600ft
Broken at 800ft
Temperature: 18°C – dew point: 16°C
QNH: 1014 mb

At LFQQ (Rijssel) airport
Wind direction: 320 degrees
Wind speed: 7 kt
Visibility: 4500 m
Mist
Clouds (no significant clouds)
Temperature: 20°C – dew point 17°C
QNH: 1014 mb

At EBKT (Kortrijk)
Reportedly,
Visibility 3 km, ceiling 900 ft

At EBFN (Koksijde) airport
Wind direction: 350 degrees
Wind speed: 8 kt
Visibility: 4900 m
Mist
Clouds; few (1/8) at 600 ft
broken (5/8) at 800 ft
broken (7/8) at 1000 ft
Temperature: 18°C – dew point 17°C
QNH: 1014 mb

septembre 2014 — Sun in Brussels

Month: septembre Year: 2014 Go

2014	Sunrise/set		Daylength		Astro. Twilight		Naut. Twilight		Civil Twilight		Solar noon	
sep	Sunrise	Sunset	Length	Diff.	Start	End	Start	End	Start	End	Time	Mil. km
1	06 h 56 ↗ (76°)	20 h 28 ↖ (284°)	13:32:15	−3:43	04 h 53	22 h 30	05 h 39	21 h 44	06 h 22	21 h 02	13 h 43 (47,4°)	150,974
2	06 h 58 ↗ (76°)	20 h 26 ↖ (283°)	13:28:31	−3:43	04 h 55	22 h 27	05 h 41	21 h 42	06 h 23	21 h 00	13 h 42 (47,0°)	150,938
3	06 h 59 ↗ (77°)	20 h 24 ↖ (283°)	13:24:46	−3:44	04 h 58	22 h 25	05 h 43	21 h 39	06 h 25	20 h 58	13 h 42 (46,6°)	150,901
4	07 h 01 ↗ (77°)	20 h 22 ↖ (282°)	13:21:02	−3:44	05 h 00	22 h 22	05 h 45	21 h 37	06 h 27	20 h 56	13 h 42 (46,3°)	150,863
5	07 h 02 ↗ (78°)	20 h 19 ↖ (282°)	13:17:16	−3:45	05 h 02	22 h 19	05 h 47	21 h 34	06 h 28	20 h 53	13 h 41 (45,9°)	150,826

Figure 6: sunrise / sunset table

Sunset on the 5th September 2014 would occur at 18:19 UTC.

1.8. Aids to Navigation

The flight of the helicopter from EBKT to Roeselare from 16:45 to 17:10 was recorded on the radar (both primary and secondary).

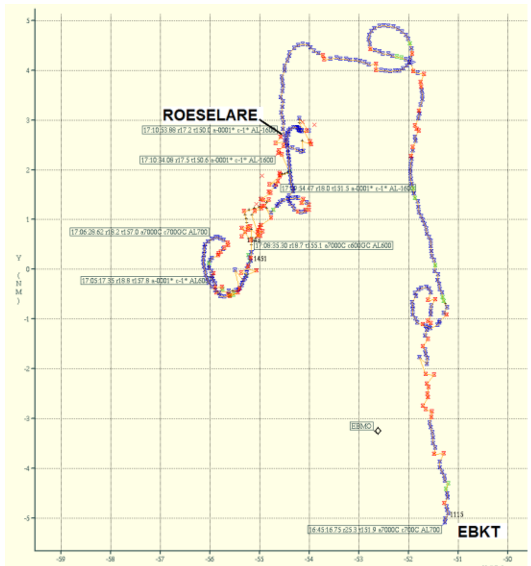

Figure 7: flight 16:45 – 17:10

Regarding the flight of the accident, the radar got a few blimps related to the take-off of the helicopter in Roeselare and the subsequent crash.

The first detection after take-off from Roeselare is at 18:01:45.65 in mode A/C, followed by a primary only track update (with same track number as the first detection in mode A/C) at 18:01:49.60. Thereafter no detections of the aircraft are found. Last reported altitude was 400 feet; QNH 1014 hPa = +-25 feet correction = 425 feet or +-130m height.

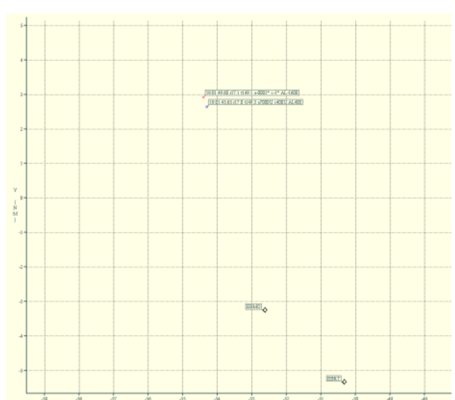

Figure 8: Accident flight – radar data

1.9. Communication

No communication was recorded from the helicopter.

1.10. Aerodrome information

The helicopter landed and took off again on an open field, adjoining the ring road R32.

Figure 9: helicopter landing after the flight from EBKT

The take-off and landing of helicopters outside airfields is regulated by the Ministerial Decree of 29 May 2013.

1.11. Flight Recorders

The helicopter was not equipped with a flight recorder, nor was it supposed to.

1.12. Wreckage and Impact information

A witness stated the helicopter took off from the open field, went in hover flight at 3m from the ground then turned 180°, away from the main road, before climbing.

Other witnesses saw the helicopter flying above the exposition hall at low height. A witness report hearing the helicopter, and when it reached the exposition hall he noticed a strong lowering in sound intensity.

Another witness standing in the car parking lot saw the helicopter coming down with some forward speed up to 5m height (more likely 10-15m owing to the damage of the helicopter), stopping and falling vertically to the ground.

The helicopter fell on the stroke of grass between the row of parked cars and the parking lot fence. The helicopter did not hit any person or vehicles in its fall.

People rushed to the helicopter, but backed away as it caught fire shortly after impact.

Figure 10: crash area

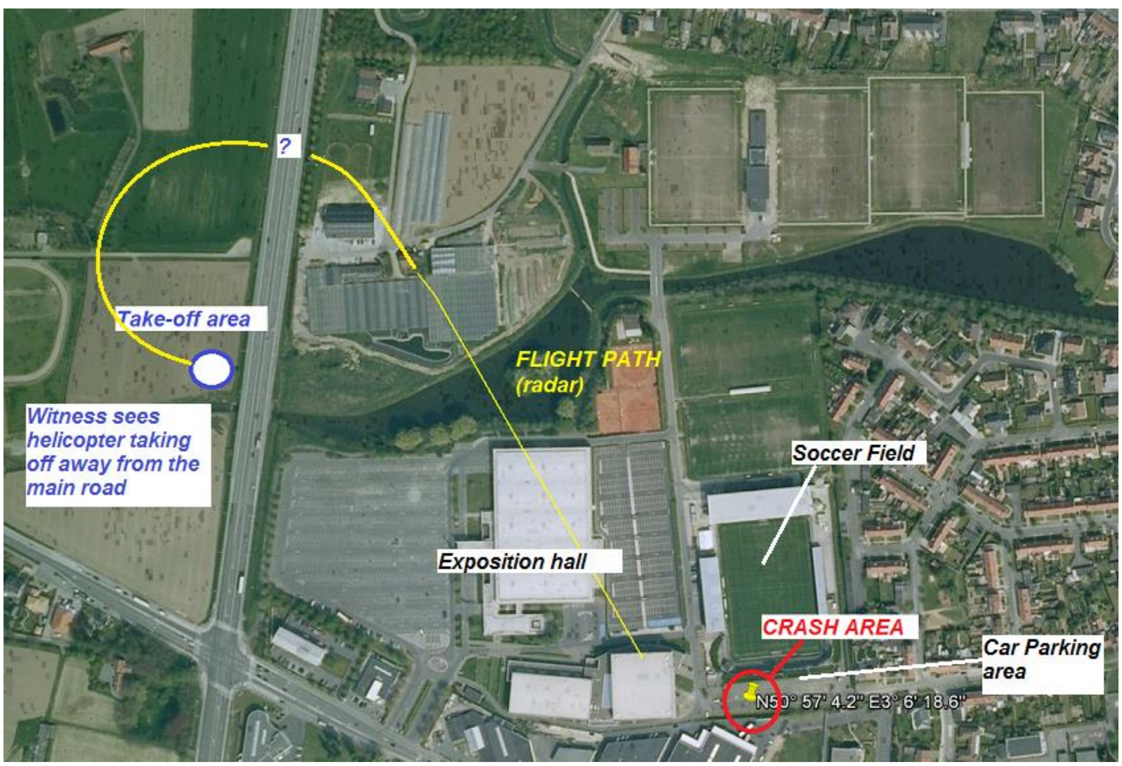

Figure 11: Flight path

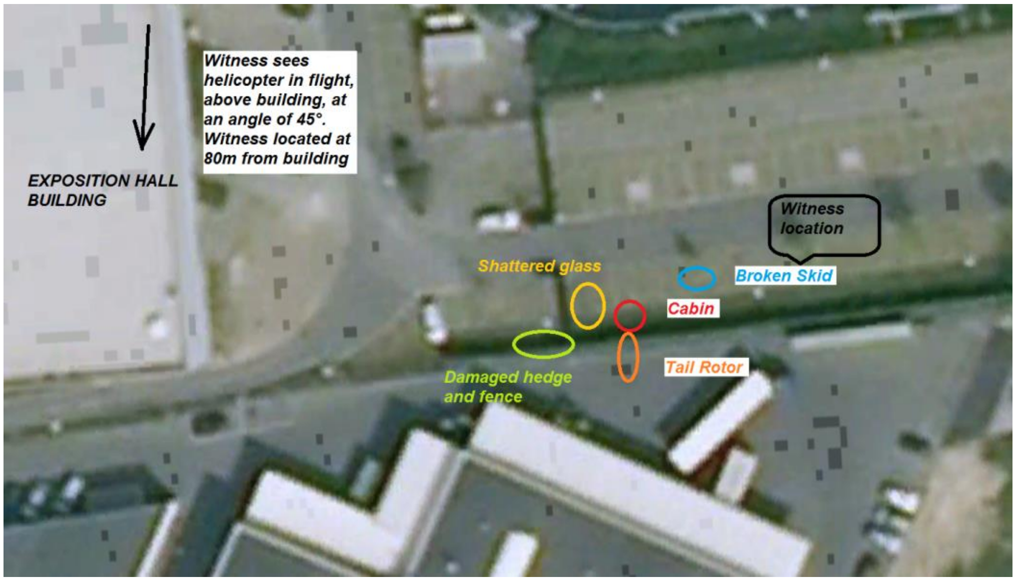

Figure 12: crash scene

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The position of the bodies inside the wreckage indicate the pilot was sitting on the left seat, and the passenger-student pilot was sitting on the right seat.

Wreckage inspection

The wreckage was inspected by AAIU(Be) investigators on site on the day of the accident. A deep inspection was performed later, on 16 September with the support of an investigator of Robinson Helicopter Company, with the presence of the judicial investigator.

Main rotor blades

The main rotor blades were still attached to the hub, and the leading edges showed little to no rotational movement at impact.

One blade was resting on the, still intact, windscreen of a car

Figure 13: main rotor

Engine

The top spark plugs of all cylinders were removed. Some of them were covered with oil deposit. After removal of the this deposit, it was clear that all spark plug electrodes were in good condition, meaning that there was no mechanical damage, deformation, or excessive carbon deposit.
The 3 left rocker valve covers were removed and after removal the crankshaft was turned.
The crankshaft could be turned by hand.
It was verified that the valve train (camshaft …) was connected to the crankshaft as all the valves of the LH cylinders were moving properly.

Carburetor and fuel controls

The carburetor was still attached to the oil sump. It was burned but not broken.
The wiring of the temperature probe was burned and separated of the probe.
The mixture control steel wire was separated from the mixture lever of the carburetor. By contrast, the screw, the nut and the washer attaching the wire on the control lever of the carburetor were still in place.
The mixture lever was positioned on the “R” rich stop under the effect of a security spring.
The carburettor heater valve showed a straight trace in the middle of the valve, corresponding to a medium position.

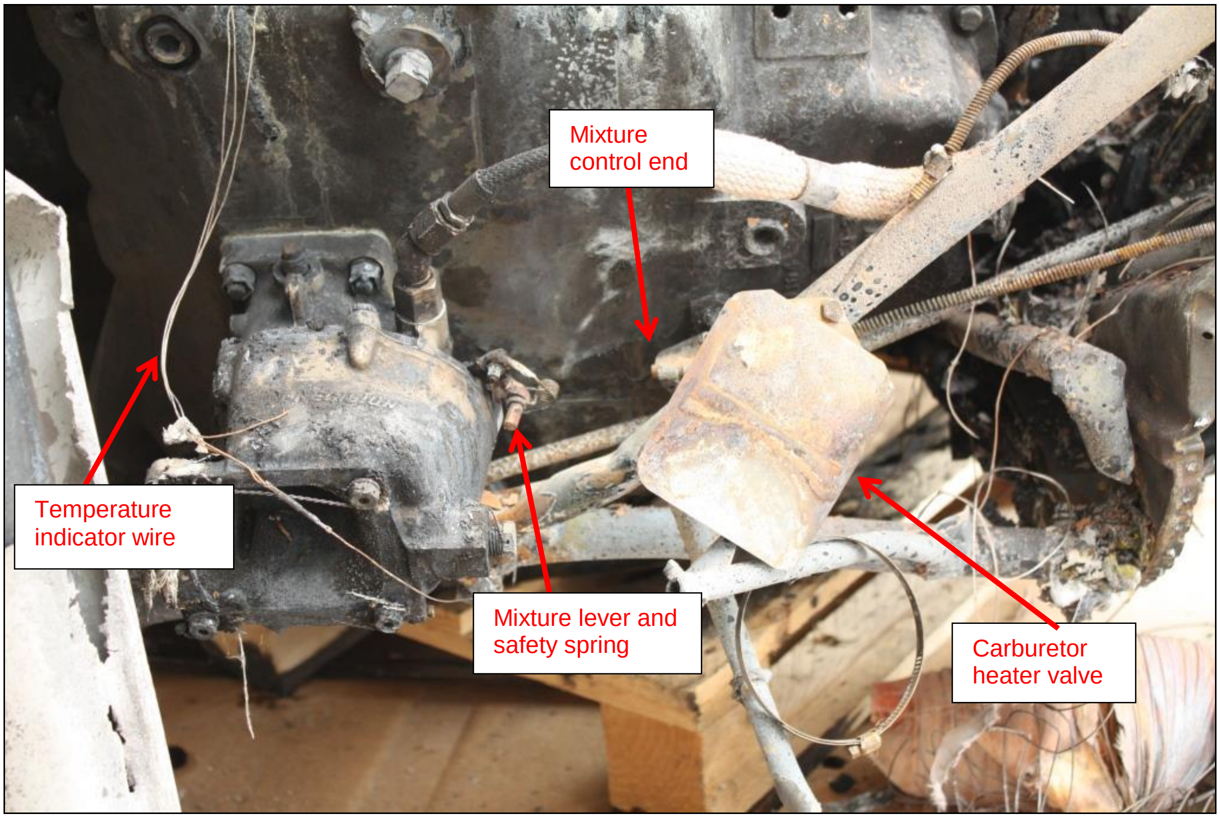

Figure 14: Fuel system components

The throttle control (broken further) was still attached to the throttle valve lever of the carburetor and the butterfly was found in an almost fully closed position.

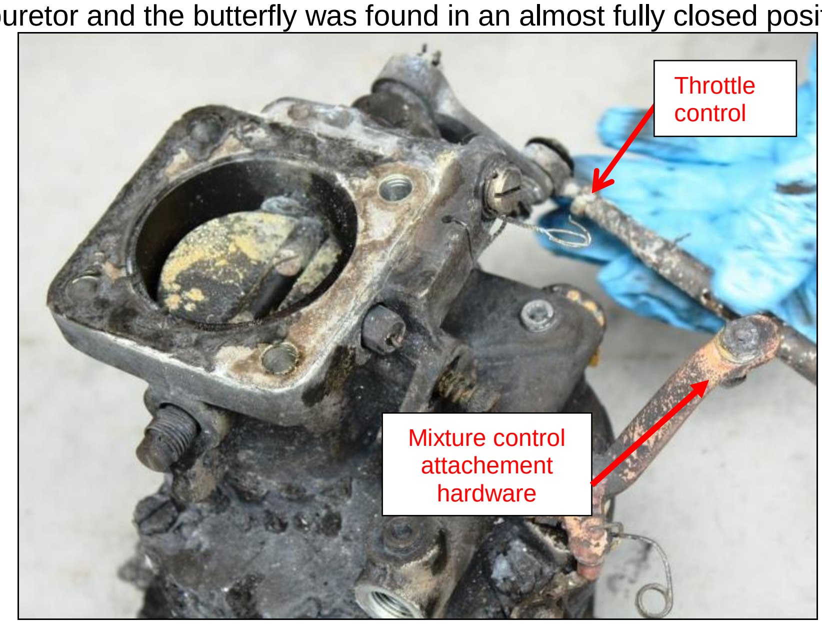

Figure 15: Fuel controls

The fuel screen filter was disassembled showing remains of molten rubber from the fuel hose. No other trace of contamination was found.

The carburetor was disassembled to gain access to the float chamber. This showed the float had molten under the effect of the heat. No more fuel was present.
The main nozzle was removed and was found uncontaminated.
The float needle was disassembled. The rubber end of the needle became lose when trying the remove the traces of burned rubber.

Fuel mixture and cut-off

Figure 16: Mixture control

The sheath of the mixture cable is found still attached at its last attaching point on the oil sump. The carburetor end of the steel wire stops exactly at the end of the sheath.
The other end of the mixture control was found fully pulled back meaning it was in cut off position. The sheath of the mixture control shows few signs of elongation.

There was no trace of the plastic mixture guard found on the mixture control or in the wreckage.

The fuel shut off valve was severely molten. Its position could not be determined.

Flight controls
The LH cyclic control was found broken at its attachment on the top of the T-Bar, probably caused by a violent contact with a body at impact.

Figure 17: T-bar

1.13. Medical and Pathological information

There was no autopsy performed on the body of the two occupants.

1.14. Fire

The helicopter did not immediately catch fire upon impact.

Due to the impact, the fuel tanks ruptured and the fuel was ignited by exposed electrical wires or by the fuel leaking on the hot parts of the engine. People in the vicinity had the time to reach the wreckage before the fire started; they reported seeing the occupants wounded and unconscious and noticed fuel leaking.

As the autopsy was not performed, it is impossible to determine whether the occupants of the helicopter died from the impact, or from the fire that followed.

The helicopter was equipped with the original aluminium tanks located above the engine firewall, either side of the main transmission.

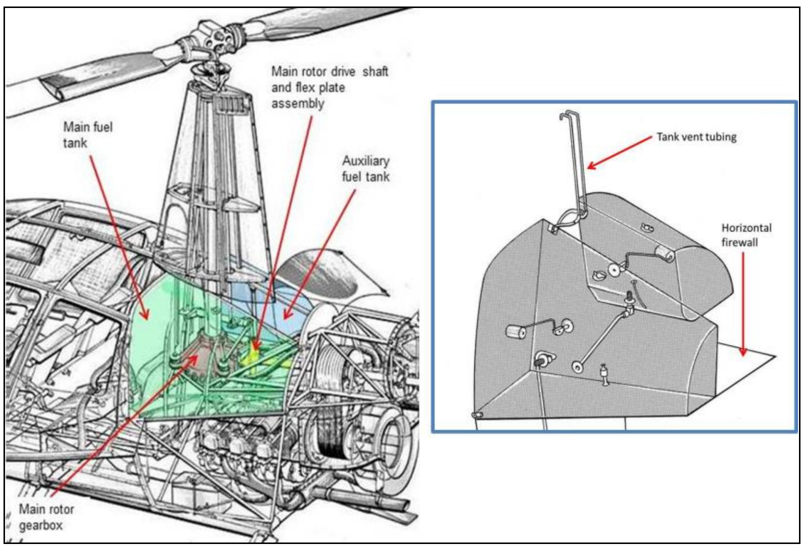

Figure 18: Fuel tanks

There were in the past several accidents with Robinson R44 helicopters involving a post-impact fire due to the rupture of the fuel tank upon impact.

On 3 October 1994, a new rule (§27.952) was published in Title 14 of the US Code of Federal Regulations (CFR), laying down new design standards for crash resistant fuel systems (CRFS). Since the R44 had an earlier certification basis, it was and is not required to meet this regulation.

However, in order to improve the R44's fuel system resistance to impact, the manufacturer of the Robinson R-44 issued a Service Bulletin SB-78B in December 2010 (revised 28 September 2012) to require the retrofit of the all-aluminum fuel tanks with bladder-type tanks.

Service Bulletin SB-78 (copy in appendix) advised that the fuel tank retrofit should occur as soon as possible but no later than December 31, 2014. On September 28, 2012, the SB-78 was revised to move up the date for the fuel tank retrofit to April 30, 2013.
In order to encourage owners to apply the modification, Robinson helicopters offered a 1000 USD rebate (copy in appendix).

The application of the Service Bulletin was however not considered mandatory by the FAA, that issued a Special Airworthiness Information Bulletin (SW-13-11) in December 2012 recommending its application (in appendix).

The Australian Transport Safety Board released an investigation report (AO-2013-055 - Collision with terrain involving Robinson R44 helicopter, VH-HWQ at Bulli Tops, near Wollongong NSW on 21 March 2013). The report includes a study on the risk of post-impact fire in helicopter accidents and concluded that a higher proportion of accidents (12%) resulted in post-impact fire when Robinson R44 helicopters are involved compared with other piston-engine helicopter types (6%).
(https://www.atsb.gov.au/publications/investigation_reports/2013/aair/ao-2013-055.aspx)

Following a crash of a R44 on 25 November 2012, the US NTSB issued a recommendation on 15 January 2014 to the FAA (ref A-14-001; *www.**ntsb**.gov/safety/safety-recs/recletters/A-14-001.pdf*) to :

> Require owners and operators of existing R44 helicopters to comply with the fuel tank retrofit advised in Robinson Helicopter Company Service Bulletin SB-78B to improve the helicopters' resistance to a postaccident fuel tank leak. (A-14-001)

Several Civil Aviation Regulators issued an Airworthiness Directive to mandate the incorporation of Bladder Fuel tank in the Robinson R44 helicopter. EASA issued AD 2014-0070 on 2 April 2014 mandating the installation of the fuel bladder cell within 24 months after the effective date of the AD. (copy in appendix)

ATSB released three safety recommendations to the EASA and FAA aimed to increase the number of existing helicopters that are fitted with a crash-resistant fuel system or have an equivalent level of safety in respect to post-impact.

The application of the SB was discussed between the Maintenance organisation and the owner. An entry was made in the maintenance file, stating “compliance required by 31.12.2014”. Reportedly, the owner contacted the maintenance organisation and made clear he wanted to have the SB applied in a near future. The Service Bulletin was not yet applied at the time of the crash.

1.15. Carburetor icing and carb heat system

Under certain moist atmospheric conditions when ambient temperature is close to dew point (relative humidity is more than 50%) and at temperatures of -6ºC to +32ºC, it is possible for ice to form in the engine induction system, even in warmer weather. Unlike airplanes which take off at full throttle, helicopters take off using power as required, making them vulnerable to carburettor ice because the throttle butterfly valve is not in a fully open position, causing a large drop of pressure and consequently a large drop in temperature downstream of the valve.

To prevent the formation of icing, the engine is equipped with a system which preheats the incoming air supply to the carburettor (called carb heat).

In the cockpit of the R44 a carburettor air temperature (CAT) gauge is installed, which is wired to a temperature probe in the carburettor downstream of the throttle butterfly valve. This allows the flight crew to monitor the temperature within the carburettor. When the needle is in the yellow caution band (see Figure 19), carb heat has to be applied by pulling the carb heat control (see Figure 3).

Figure 19: CAT indicator

As from MSN 0202, the R44 helicopter is equipped with a carburetor heat assist system. This is designed to automatically apply a level of heat corresponding to the amount of power being applied via a mechanical correlation to reduce pilot workload. Lowering the collective adds heat and rasing collective reduces heat. A friction clutch allows the pilot to override the system and increase or decrease heat as required. The carb heat control can be locked in the off position by a latch when it is obvious that condtions are not conducive to carburetor ice.

Robinson Helicopter Company has issued the Safety Notice SN-25 (twice revised) to draw the attention of pilots to the dangers of carburettor icing.

2. Analysis.

Propulsion

The inspection of the wreckage indicates that the engine and the main rotor was stopped upon impact.

Position of the mixture control knob.

The mixture control knob was found bent, indicating the knob was pulled before impact. There were no traces left of the plastic guard (but the area was totally burned)

The position of the mixture control knob upon impact corresponds to the idle cut-off (ICO) position, as compared to another Robinson R44 helicopter.

Figure 20: mixture control after accident

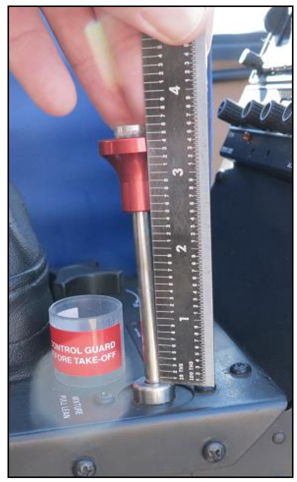

Figure 21: mixture control on other R44 in ICO

Pulling the mixture control knob to the idle cut-off position would interrupt the fuel flow to the engine, with the engine stoppage as a result.

The plastic guard is aimed to protect the inadvertent operation of the mixture. When installed, it is virtually impossible to pull the mixture control knob. The guard is nevertheless removable, and must be replaced after each engine shutdown (as instructed in the POH).

Carburettor Ice

The ambient temperature was 18°C, with a dew point of 16-17°C, and it was misty, with a reduced visibility.

The conditions for a carburettor icing were reunited, and taking off in such condition would require the use of the carburettor heater during take-off.

Normally, the carburettor heater control knob should be unlocked and pulled up after engine start. The knob would gradually and automatically adjust by the carb heat assist system), with the carburettor heater valve closing when power is applied to the engine.

The rationale for pulling the carburettor heater control up, in flight after take-off would be that either the icing condition were severe (CAT needle in the yellow arc), or that the pilot did not pull it after starting the engine (due to stress to get back on time) and found out carburettor heater was needed while in flight.

Who was at the controls ?

The helicopter was fitted with dual controls, and could therefore be piloted from either (left or right) front seats. Nevertheless, the most usual position for the pilot in command in a helicopter is the right seat (the controls for the left position are removable, unlike the controls on the right side – see POH section 7-5).

After the accident, the man who held a valid pilot certificate was found sitting on the left seat while the student pilot was sitting on the right seat. The picture (figure 9) showing the helicopter after landing shows the same seating configuration (faces blurred), and the control column in position for a pilot-in-command on the right hand side. The cyclic is center-mounted to a cross tube which pivots on the center cyclic post. On the picture, the left grip is visible when zooming in, meaning the right side was used to control the helicopter.

The student pilot was technically able to fly the helicopter. However, still being a student, he was only allowed to fly alone under the supervision of an instructor, or with an instructor. The pilot sitting on the left seat was not qualified as an instructor.

It is impossible to determine with certainty who was effectively at the controls during the crash, but there is a strong possibility that the student pilot was at the controls during the first flight from EBKT and the flight leading to the crash.

Confusion of controls

The inadvertent actuation of the mixture control instead of the carburettor heater control is addressed in Robinson Safety Notice N°1, part of the R44 POH (in appendix).

The carburettor heater control knob is located on the left side of the central console, behind the cyclic control post.

The mixture control knob is located also on the central console, but at the right side. It is surrounded by a small plastic tube (guard) (see figure 5) that needs to be removed to operate the knob, and replaced afterwards, for the next flight. The plastic guard was not found when inspecting the wreckage (although it might have completely destroyed during the fire).

The mixture control knob was put in the cut-off position in flight, shutting down the engine at low altitude. The logical explanation to this situation might be an inadvertently activation of the mixture control knob up to the cut-off position, confusing it with the carburettor heater control;

- If the pilot-in-command was the student pilot, it might have been influenced by his inexperience;
- If the pilot-in-command was the pilot, sitting on the left seat, which is an unusual position, he might have routinely reached the knob behind the cyclic post.

Contributing factors to this inadvertent activation could have been:

- The plastic guard on the mixture control knob has not been replaced in position after the previous flight.
- Time pressure. The helicopter took off at 18:00, while the sunset would occur at 18:19 and the helicopter had to be flown to EBKT before sunset. This might have induced some stress, although there was sufficient time available.

The flight

There are few data available regarding the take-off and crash of the helicopter. The radar records only two points, which owing to the imprecision of the radar, cannot give an accurate indication of the speed.

The take-off from the open field was done away from the main road and the exposition hall building, in order to avoid flying in the vicinity of the lighting poles and above the traffic of vehicles on the road.
The flight should have been further conducted (Royal Decree of 15 September 1994, article 74) in order to fly over the exposition hall building, the adjoining car parking area and the soccer field at a minimum height of 1000 ft (300 m) above the highest obstacle (i.e. the roof of the exposition hall building).

The last reported altitude is quite accurate as measured by the secondary radar and gives an altitude of 130 m. The elevation of Roeselare is 20 m, meaning the helicopter flew at an height of 110 m (330 ft) above ground when flying over the exposition hall building and when the engine stopped.

Witnesses report seeing the helicopter above the exposition hall building “at low height”.

The height-velocity diagram indicates that flying at 330 ft at a speed lower than 15 kias is still within the area in which operations must be avoided.
The height – velocity diagram is among others based on the pilot’s reaction time. If the student pilot was at the controls, his reaction time might have been slower than expected, due to his inexperience and the fact that his left hand was on the fuel mixture knob instead of the collective. The same may apply to the pilot due to his unusual seating position and the fact that his left hand would have been on the cyclic and his right hand on the mixture control knob..

The helicopter was flying at low height and low airspeed that could not provide sufficient safety margin in the case of an engine failure, above an area crowded with people, cars and buildings with few open area to safely land the helicopter.

Post-impact fire.

The helicopter was not fitted with a crash-resistant fuel system allowing the wreckage to catch fire. It is afterwards impossible to determine whether the occupants of the helicopter died from the impact, or from the fire that followed as no autopsy has been performed.

3. Causes

3.1. Findings:

- One occupant of the helicopter was holding a valid private pilot certificate (helicopter), delivered by FAA.
- The second occupant was a Student pilot.
- The man/occupant holding a pilot certificate was sitting on the left seat
- The student pilot was sitting on the right seat.
- The helicopter was registered in the USA. Some discrepancies with respect to the US regulation was found in the maintenance records.
- No technical failure prior to the crash was found in the wreckage.
- The main rotor had little to no rotation at impact.
- The mixture control was found extended at a position corresponding to the idle cut-off and bent.
- The wreckage was inspected and no pre-impact damage was found.
- No autopsy was performed on the bodies of the occupants of the helicopter.
- The meteorological conditions required the use of the carburetor heater.
- The helicopter fell vertically with negligible forward speed.

3.2. Cause and contributing factor

Cause(s).

The accident was caused by the engine stoppage at low height and forward speed caused by one of the crew inadvertently pulling the mixture control knob to the cut-off position when trying to increase the carburetor heat.

The post-impact fire was caused by the rupture of the fuel tanks and subsequent leaking of fuel on the hot parts of the engine or a damaged electrical component.

Contributing factor(s)

The following contributing factors were identified:

- Non-compliance with the minimum required altitude when flying above crowded area.
- Time pressure
- The fuel bladder tanks were not installed. [safety issue]
- The guard to be placed around of the mixture control (although efficient when installed, and covered by the POH procedures) can be removed. [safety issue]

4. Safety recommendations.

Safety issue: inadvertent operation of the mixture control in flight:

The guard around the mixture control and POH provisions were introduced to prevent human errors, such as confusing the carburetor heater control and the mixture control. The current procedure is quite intensive and still sensitive to human errors, as the guard might fall on the floor when removed and therefore can be misplaced, get lost, etc..).
The following recommendation is about trying to make the process less sensible to human errors.

Recommendation BE-2016-0002:
It is recommended that Robinson Helicopter Company further improves the guard system of the mixture control on the Robinson R44 I (Raven I) to prevent the unintentional operation of the mixture control leading to a possible engine shutdown in flight.

Safety issue: aluminium fuel tanks

Considering:

- The post-impact fire was caused by the rupture of the aluminium fuel tanks, and the subsequent fuel leakage;
- the safety recommendations made by ATSB and NTSB to FAA regarding the application of Robinson Helicopters SB78;
- the issue of AD Notes by the CASA and EASA to mandate the application of Robinson Helicopters SB-78;
- the helicopter involved in this accident was N-registered, but as such, was flying exclusively in Europe;
- The number of N-registered Robinson R44 flying in Europe (a quick review identified 4 others N-registered R44 operating from Belgium);

The following recommendation is made;

Recommendation BE-2016-0003:
It is recommended that the FAA requires owners and operators of existing R44 helicopters to comply with the fuel tank retrofit advised in Robinson Helicopter Company Service Bulletin SB-78B to improve the helicopter’s resistance to a post-accident fuel tank leak.

5. APPENDICES:

ROBINSON
HELICOPTER COMPANY

Safety Notice SN-1

Issued: Jan 81 Rev: Feb 89; Jun 94

INADVERTENT ACTUATION OF MIXTURE CONTROL IN FLIGHT

Cases have been reported where a pilot inadvertently pulled the mixture control instead of the carb heat or other control, resulting in sudden and complete engine stoppage. The knobs are shaped differently and the mixture control has a guard which must be removed and a push-button lock which must be depressed before actuating. These differences should be stressed when checking out new pilots. Also, in the R22, it is a good practice to always reach around the left side of the cyclic control when actuating the lateral trim. This will lessen the chance of pulling the mixture control by mistake. Always use the small plastic guard which is placed on the mixture control prior to starting the engine and is not removed until the end of the flight when the idle cut-off is pulled. Replace the guard on the mixture control so it will be in place for the next flight.

If the mixture control is inadvertently pulled, lower the collective and enter autorotation. If there is sufficient altitude, push the mixture control in and restart the engine using the left hand. DO NOT disengage the clutch.

ROBINSON
HELICOPTER COMPANY

Safety Notice SN-25

Issued: Dec 86 Rev: Nov 99

CARBURETOR ICE

Carburetor ice can cause engine stoppage and is most likely to occur when there is high humidity or visible moisture and air temperature is below 70°F (21°C). When these conditions exist, the following precautions must be taken:

During Takeoff - Unlike airplanes, which take off at wide open throttle, helicopters take off using only power as required, making them vulnerable to carb ice, especially when engine and induction system are still cold. Use full carb heat (it is filtered) during engine warm-up to preheat induction system and then apply carb heat as required during hover and takeoff to keep CAT gage out of yellow arc.

During Climb or Cruise - Apply carb heat as required to keep CAT gage out of yellow arc.

During Descent or Autorotation -

R22 - Below 18 inches manifold pressure, ignore CAT gage and apply full carb heat.

R44 - Apply carb heat as required to keep CAT gage out of yellow arc and full carb heat when there is visible moisture.

ROBINSON
HELICOPTER COMPANY

Safety Notice SN-25

Issued: Dec 1986 Rev: Jul 2012

CARBURETOR ICE

Avoidable accidents have been attributed to engine stoppage due to carburetor ice. When used properly, the carburetor heat and carb heat assist systems on the R22 and R44 will prevent carburetor ice.

Pressure drops and fuel evaporation inside the carburetor cause significant cooling. Therefore, carburetor ice can occur at OATs as high as 30°C (86°F). Even in generally dry air, local conditions such as a nearby body of water can be conducive to carburetor ice. **When in doubt, assume conditions are conducive to carburetor ice and apply carb heat as required.**

For the R22 and R44, carburetor heat may be necessary during takeoff. Unlike airplanes which take off at full throttle, helicopters take off using power as required, making them vulnerable to carburetor ice. Also use full carb heat during run-up to preheat the induction system.

On aircraft equipped with the carb heat assist system, the control knob should be left unlatched unless it is obvious that conditions are not conducive to carburetor ice.

Carburetor heat reduces engine power output for a given manifold pressure. Approximately 1.5 in. Hg additional MAP is required to generate maximum continuous power (MCP) or takeoff power (TOP) with full heat applied. The additional MAP with carb heat does not overstress the engine or helicopter because power limits are still being observed. Since the engine is derated, it will produce TOP at lower altitudes even with full heat. However, avoid using more heat than required at high altitudes as the engine may reach full throttle at less than MCP or TOP.

ROBINSON
HELICOPTER COMPANY
2901 Airport Drive, Torrance, California 90505 Phone (310) 539-0508 Fax (310) 539-5198

R44 SERVICE BULLETIN SB-78B

DATE: 20 December 2010 **REV B:** 28 September 2012

TO: R44 and R44 II owners, operators, and maintenance personnel

SUBJECT: Bladder Fuel Tank Retrofit

ROTORCRAFT AFFECTED: R44 helicopters S/N 0001 thru 2064, and R44 II helicopters S/N 10001 thru 12890, unless previously accomplished.

TIME OF COMPLIANCE: As soon as practical, but no later than 30 April 2013.

BACKGROUND: This bulletin requires R44 helicopters with all-aluminum fuel tanks to be retrofitted with bladder-type tanks. In addition to a factory retrofit program, a field kit is now available. To improve the R44 fuel system's resistance to a post-accident fuel leak, this retrofit must be performed as soon as possible.

COMPLIANCE PROCEDURE:

Order one KI-196-1 kit for R44, or one KI-196-2 kit for R44 II, from RHC Customer Service and install per kit instructions. Kit includes main and auxiliary bladder tanks, installation hardware, hoses, and instructions. Kit instructions also available online at www.robinsonheli.com/servelib.htm.

Alternately, return helicopter to RHC for factory retrofit (ref. R44 SL-36).

Note: Retrofit requires substantial sheet-metal work. Paint refinishing for aesthetics may be desired.

Approximate Cost:

Parts: $6800 for KI-196-1 or -2 kit. Reference helicopter model and serial number. Fuel tanks are supplied painted white.

Labor: Approximately 40 man-hours (paint refinishing not included).

Note: Normal Service Center discounts do not apply. (Refer to RHC memo dated 28 May 1997.)

THE DESIGN ENGINEERING ASPECTS OF THIS BULLETIN HAVE BEEN SHOWN TO COMPLY WITH APPLICABLE FEDERAL AVIATION REGULATIONS AND ARE FAA APPROVED.

ROBINSON
HELICOPTER COMPANY
2901 Airport Drive, Torrance, California 90505 Phone (310) 539-0508 Fax (310) 539-5198

03 September 2013

To: All R44 Dealers, Service Centers and Owners

Re: US$ 1,000 REBATE FOR BLADDER FUEL TANK RETROFIT KITS EXTENDED

Our records indicate that some R44 owners have either not installed the KI-196 Fuel Tank Retrofit kit in accordance with Service Bulletin SB-78B, or have not applied for the US$ 1,000 rebate.

Please note that Compliance with SB-78B was due no later than 30 April 2013 and requires immediate attention. KI-196 kits are currently in stock at the factory and available for immediate delivery.

To encourage compliance with SB-78B and to provide the US$ 1,000 rebate to as many owners as possible, RHC will continue to accept requests for credit from owners who have complied with SB-78B that were not covered under warranty.

To receive the rebate, the owner must provide RHC with the aircraft serial number, RHC invoice number and a copy of the logbook page which includes the date of installation and the mechanic's signature.

Please contact your RHC customer service or technical representative for any additional assistance or questions.

Regards,
Robinson Helicopter Company

Kurt Robinson
President

FAA
Aviation Safety

SPECIAL AIRWORTHINESS INFORMATION BULLETIN

SUBJ: JASC Code 2810 Fuel Storage Robinson Helicopter Company Bladder Fuel Tank Retrofit

SAIB: SW-13-11
Date: December 26, 2012

This is information only. Recommendations aren't mandatory.

Introduction

This Special Airworthiness Information Bulletin (SAIB) alerts owners and operators of the availability of a fuel tank bladder retrofit program for enhanced safety on Robinson Helicopter Company (Robinson) Model R44 and R44 II helicopters.

Background

Robinson Helicopter Company has issued Service Bulletin SB-78B, Revision B, dated September 28, 2012, which specifies that R44 helicopters with aluminum fuel tanks be retrofitted to add bladder-type tanks and associated fuel system components. In addition to a factory retrofit program, a field kit is also available. The new bladder tank and fuel system components will improve the R44 fuel system's resistance to a post-accident fuel leak and possible fire.

Recommendation

We recommend that owners/operators of Robinson helicopters incorporate SB-78B, Revision B, dated September 28, 2012.

For Further Information Contact

Danny Nguyen, Aerospace Engineer, FAA Los Angeles Certification Office, ANM-140L, 3960 Paramount Boulevard., Lakewood, CA 90712; phone: (562) 627-5247; fax: (562) 627-5210; e-mail: danny.nguyen@faa.gov.

For Related Service Information Contact

Robinson Helicopter Company, 2901 Airport Drive, Torrance, CA 90505, phone: (310) 539-0508; fax: (310) 539-5198; e-mail: www.robinsonheli.com.

EASA	AIRWORTHINESS DIRECTIVE
	AD No.: 2014-0070 **Date: 19 March 2014** Note: This Airworthiness Directive (AD) is issued by EASA, acting in accordance with Regulation (EC) No 216/2008 on behalf of the European Community, its Member States and of the European third countries that participate in the activities of EASA under Article 66 of that Regulation.

This AD is issued in accordance with EU 748/2012, Part 21.A.3B. In accordance with EC 2042/2003 Annex I, Part M.A.301, the continuing airworthiness of an aircraft shall be ensured by accomplishing any applicable ADs. Consequently, no person may operate an aircraft to which an AD applies, except in accordance with the requirements of that AD, unless otherwise specified by the Agency [EC 2042/2003 Annex I, Part M.A.303] or agreed with the Authority of the State of Registry [EC 216/2008, Article 14(4) exemption].

Design Approval Holder's Name:	**Type/Model designation(s):**
ROBINSON HELICOPTER COMPANY	R44 helicopters

TCDS Number:	EASA.IM.R.121
Foreign AD:	None
Supersedure:	None

ATA 28	**Fuel – Tank – Replacement**
Manufacturer:	Robinson Helicopter Company
Applicability:	R44 helicopters, serial numbers (s/n) 0001 through 2064, and R44 II helicopters, s/n 10001 through 12890.
Reason:	The United States National Transportation Safety Board (NTSB) investigated a number of R44 helicopter accidents in which the fuel tanks were breached, resulting in leaking fuel and a post-crash fire. While analysis showed that these events should all have been survivable with minor or no injuries to the occupants, they resulted in fatalities and serious thermal injuries. Prompted by these occurrences, in 2010 Robinson Helicopter Company issued R44 Service Bulletin (SB) SB-78, currently at Revision B, providing instructions for helicopters with aluminium fuel tanks to be retrofitted to add bladder-type tanks and associated fuel system components. To address this safety issue, the FAA issued Special Airworthiness Information Bulletin (SAIB) SW-13-11 to recommend incorporation of SB-78B, as the new bladder tank and fuel system components will improve the R44 fuel system's resistance to a post-accident fuel leak and possible fire. This FAA SAIB was endorsed by EASA. More recently, based on investigation results, the NTSB issued Safety Recommendation A-14-001. In light of the additional information provided by the NTSB, the Agency has now determined that this safety issue must be considered an unsafe condition that warrants AD action. For the reasons described above, this AD requires retrofit-installation of bladder-type fuel tanks.
Effective Date:	02 April 2014

EASA AD No.: 2014-0070

Required Action(s) and Compliance Time(s):	Required as indicated, unless accomplished previously: Within 24 months after the effective date of this AD, modify the helicopter in accordance with the instructions of Robinson Helicopter Company SB-78, which references Kit Instructions (KI) KI-196 R44-series Bladder Fuel Tank Installation.
Ref. Publications:	Robinson Helicopter Company SB-78 original issue dated 20 December 2010, or SB-78A dated 21 February 2012, or SB-78B dated 28 September 2012. Robinson Helicopter Company KI-196, Revision A dated 5 January 2011, or Revision B dated 10 January 2011. FAA SAIB SW-13-11, dated 26 December 2012. NTSB Safety Recommendation A-14-001, dated 15 January 2014.
Remarks:	1. If requested and appropriately substantiated, EASA can approve Alternative Methods of Compliance for this AD. 2. This AD was posted on 13 February 2014 as PAD 14-038 for consultation until 13 March 2014. The Comment Response Document can be found at http://ad.easa.europa.eu/. 3. Enquiries regarding this AD should be referred to the Safety Information Section, Executive Directorate, EASA. E-mail: ADs@easa.europa.eu. 4. For any question concerning the technical content of the requirements in this AD, please contact the Robinson Helicopter Company, 2901 Airport Drive, Torrance, California 90505, United States of America, Telephone: +1 310-539-0508, Fax: +1 (310) 539-5198. Website/E-mail Technical Support.

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