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Swiss Accident Investigation Board SAIB

Aviation Division

Final Report No. 2125 by the Swiss Accident Investigation Board SAIB

concerning the accident involving the Robinson R44 II helicopter, registration HB-ZJG

on 25 August 2010

Giirebad, Pfyn/TG

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Ursache

Der Unfall ist darauf zurückzuführen, dass während der Endphase einer Autorotation ein Hauptrotorblatt mit dem Heckausleger des Helikopters kollidierte, weil unzweckmässige Steuereingaben vorgenommen wurden.

Der Motorausfall während der Autorotationsübung aufgrund eines technischen Problems in der Einspritzeinheit hat wesentlich zum Unfall beigetragen.

Die Erfahrung des Fluglehrers auf Flächenflugzeugen hat möglicherweise ein Steuerverhalten begünstigt, welches für Helikopter nicht zweckmässig ist.

General information on this report

This report contains the Swiss Accident Investigation Board's (SAIB) conclusions on the circumstances and causes of the accident which is the subject of the investigation.

In accordance with Art 3.1 of the 10th edition, applicable from 18th November 2010, of Annex 13 to the Convention on International Civil Aviation of 7 December 1944 and Article 24 of the Federal Air Navigation Act, the sole purpose of the investigation of an aircraft accident or serious incident is to prevent accidents or serious incidents. The legal assessment of accident/incident causes and circumstances is expressly no concern of the accident investigation. It is therefore not the purpose of this investigation to determine blame or clarify questions of liability.

If this report is used for purposes other than accident prevention, due consideration shall be given to this circumstance.

The definitive version of this report is the original in the German language.

All times in this report, unless otherwise indicated, are stated in local time (LT). At the time of the accident, Central European Summer Time (CEST) applied as local time in Switzerland. The relation between LT, CEST and UTC is: LT = CEST = UTC + 2 hours.

Final Report

Aircraft type	Helicopter Robinson R44 II	HB-ZJG
Operator	Swiss Jet AG, Postfach 303, 8058 Zurich Airport, Switzerland	
Owner	Swiss Jet AG, Postfach 303, 8058 Zurich Airport, Switzerland	

Flight instructor	Swiss citizen, born 1981			
Helicopter licence	Commercial pilot licence helicopter – CPL (H), first issued by the Federal Office of Civil Aviation (FOCA) on 17 November 2006.			
Essential ratings	R44, NIT(H) Night flying with helicopters, radiotelephony FI(H) Flight instructor on helicopters, valid till 10 January 2011			
Flying hours	**total**	778:22 hours	**during the last 90 days**	33:58 hours
Helicopter	**on the accident type**	268:40 hours	**during the last 90 days**	33:42 hours
	as flight instructor	279:26 hours	**on the accident type**	252:56 hours
Licence, aeroplane	CPL(A), commercial pilot's licence (aeroplane), first issued by the Federal Office of Civil Aviation (FOCA) on 21 June 2004			
Essential ratings	A320 COPI with IR CATIII, valid till 12 February 2011 SEP(land), valid till 6 June 2012, with IR CATI valid till 4 June 2012			
Flying hours airplane	**total**	2480 hours	**during the last 90 days**	274 hours
Medical fitness certificate	First class, no restrictions, valid from 2 February 2010 till 16 February 2011.			

Trainee pilot	Swiss citizen, born 1982			
Licence	Trainee pilot licence helicopter (trainee (H)), first issued by the Federal Office of Civil Aviation (FOCA) on 13 May 2008			
Essential ratings	None			
Medical fitness certificate	First class, no restrictions, valid from 26 April 2010 till 19 May 2011.			
Flying hours	**total**	108:11 hours	**during the last 90 days**	20:27 hours
Helicopter	**on the accident type**	108:11 hours	**during the last 90 days**	20:27 hours

Coordinates	712 817 / 273 380	**Elevation**	433 m AMSL
Date and time	25 August 2010, 16:45		

Type of operation	VFR training
Flight phase	Autorotation/emergency landing
Accident type	Main rotor struck the tail boom

Injuries to persons

Injuries	Crew	Passengers	Total number of occupants	Others
Fatal	0	0	0	0
Serious	0	0	0	0
Minor	0	0	0	0
None	2	0	0	Not applicable
Total	2	0	0	0

Damage to aircraft Badly damaged

Other damage None

1 Factual information

1.1 History of the flight

The flight instructor began his flying activities on airplanes in 2001 and on helicopters in 2004.

On Tuesday 24 August 2010, the instructor was free. On the morning of 25 August 2010 at 05:30 he began his flight duty with an operator where he was employed full time. In his capacity as first officer he flew two round trips on an Airbus A320 type aircraft with four flight segments, with a total flying time of 5:36 hours block time.

The flight instructor and his trainee pilot then wanted to make a training flight in eastern Switzerland. For this purpose, they met at approximately 15:15 at the Swiss Jet AG base, which is east of the threshold of runway 28 just outside Zurich Airport. The flight instructor was working part-time as a flight instructor on helicopters in this aviation company. He did not receive any remuneration for his activities asvhelicopter flight instructor. A flying time of approximately 1:15 to 1:30 hours was planned to practise emergency procedures (emergency training) with regard to the skilltest for acquisition of the trainee's private pilot licence (PPL).

The trainee pilot had already been training as a helicopter pilot for approximately two years and had flying experience of approximately 108 hours on helicopters.

The trainee pilot prepared the Robinson R44 Raven II helicopter, registration HB-ZJG, and filled the tank with 90 litres of AVGAS from the Swiss Jet mobile filling unit. The briefing was conducted outside, next to the helicopter.

At approximately 15:55, HB-ZJG took off from the Swiss Jet area and exited the Zurich control zone via departure route E. Radio navigation procedures were then carried out between the Zurich east beacon and Frauenfeld and various attitudes were flown. In addition, the trainee pilot, under the instruction of the flight instructor, practised confined area approaches north-west of Pfyn/TG. They practised "quick stops" and a hover autorotation in a forest clearing. To initiate this exercise, the flight instructor, with prior warning, *"rapidly"* closed the throttle. The subsequent revving-up of the engine for the next take-off, on the basis of the successful hover autorotation, was normal. When they left the clearing, the flight instructor ordered an aborted take-off, which was performed successfully. This was followed by another take-off from the forest clearing, with a climb to 3000 ft AMSL. The next planned exercise was to perform an autorotation from a height of more than 500 feet AGL (above ground level). For this purpose, a field east of Giirebad was reconnoitred; the instructor and the trainee pilot had already practised autorotations on this field the day before. The trainee pilot's mission was to turn onto the approach axis for the autorotation and inform the flight instructor when he would initiate the autorotation, with a view to completing it at a defined point on the field. When the trainee pilot informed the instructor that he would now begin, the latter shut off the throttle. The trainee pilot controlled the helicopter in the autorotation descent in the direction of the agreed landing point.

According to the instructor's description, the autorotation exercise proceeded as follows:

"When we had turned onto the final approach axis, my trainee said that he would now commence, whereupon I closed the throttle. He initiated the autorotation correctly. After initiating the autorotation, I usually check whether the engine is responding normally by slightly opening the throttle. When I did this, i.e. after a few seconds in autorotation descent, I noticed that the manifold pressure was approximately 29 inches, the oil pressure was zero and the oil pressure warning lamp was on. I said something like: "Now it's stalled." I checked whether the mix-

ture was set to rich, the ignition was set to BOTH and that the fuel shut-off valve was open. At approximately 1000 ft AGL I took over the controls, saying "My controls". "

As the autorotation exercise progressed – it had now become an emergency situation due to the engine failure – the flight instructor tried, in the flare, to store as much energy in the main rotor as possible. The helicopter first contacted the ground with the rear part of the landing skids.

The instructor described this as follows:

"I felt when we touched the ground with the rear part of the landing skids, resulting in a forward pitching moment. My reaction was to pull back on the cyclic stick."

As they slid, the front tubes of the two landing skids dug a few centimetres into the dry, loose soil (Annex 1). In the course of the deceleration, a main rotor blade struck the tail boom and seriously damaged it (Annex 2). The crew did not notice this.

After the crew had exited the helicopter, they noticed the damage to the tail boom and the main rotor blade.

Before the flight involved in the accident, the instructor had carried out approximately 25 so called 'full touch-down autorotation' on the helicopter models R22, R44 and JetRanger, of which about 10 have been on R44. This about 10 full touch-down autorotations on R44 he flew a trainee while he attended the course to become a flight instructor, always with a FII (flight instructor instructor) on board. The other full touch-down autorotations the flight instructor conducted were during flight instructor check flights and while he attended a safety awareness course. The flight instructor attended such a safety awareness course in 2002 at the manufacturers facilities in Torrance, California. During this course he performed some full touch-down autorotations in R22, then still as a privat pilot and with an experienced flight instructor on board.

During his activities as flight instructor he always conducted training autorotations using the power recovery technique.

1.2 Meteorological information

The following information on the weather at the time and location of the accident was provided by MeteoSwiss.

Cloud	*1-2/8 at 12,000 ft AMSL, 5-6/8 at 15,000 ft AMSL*
Weather	*---*
Visibility	*more than 20 km*
Wind	*Variable at 2-4 kt*
Temperature/dewpoint	*23 °C / 10 °C*
Atmospheric pressure	*QNH LSZR 1019 hPa, QNH LSZH 1018 hPa*
Position of the sun	*Azimuth 245°, elevation 34°*
Hazards:	*None detectable*

1.3 Aircraft information

The Robinson R44 Raven II helicopter is a four-seater of conventional design, equipped with a semi-rigid two-blade main rotor system. The primary structure of the fuselage consists of welded steel tubing and riveted aluminium sheets. The tail boom, which houses the drive shaft and the control rods for the tail rotor, is of monocoque construction, i.e., the outer formed sheets absorb the mechanical forces acting on the tail boom.

The engine is an air-cooled 6-cylinder injection engine of the Lycoming IO-540-AE1A5 type. The coupling between the engine and the drive train consists of four belts which can be tensioned using an electric motor. These belts (vee-belts) transfer engine power to the upper sheave in which the freewheel is installed and from which a shaft extends to the main rotor transmission and the tail rotor, respectively. The chassis consists of two tubes which are turned up at the front (skid type landing gear).

1.4 Autorotation for training purposes

1.4.1 General

The Robinson R22 and R44 types are used for instruction and training in many countries. Accordingly, there is a great deal of experience of emergency exercises with these types. The manufacturer, the Robinson Helicopter Company of Torrance, California, has extensive experience in the training sector, on the basis of the many reports relating to more or less successfully completed practice and training flights. It disseminates this experience in the rotorcraft flight manual (RFM).

In general during training and checkflights a distinction is made between

a) Autorotations with power recovery

b) Full touch-down autorotations. To minimize the risk such autorotations are made only at rare occasions and for demonstration purpose only

1.4.2 Excerpts from the rotorcraft flight manual

Section 4 normal operation of the RFM describes how autorotation training should be conducted.

"Practice autorotation – Power recovery

1. *Lower collective to down stop and adjust throttle as required for small tachometer needle separation*

   CAUTION

   To avoid inadvertent engine stoppage, do not roll throttle to full idle. Roll throttle off smoothly only enough for a small visible needle split.

   NOTE

   Governor is inactive below 80% engine RPM regardless of governor switch position.

2. *Raise collective as required to keep rotor RPM from going above green arc and adjust throttle for small needle separation.*
3. *Keep RPM in green arc and airspeed 60 to 70 KIAS.*
4. *At about 40 feet AGL, begin cyclic flare to reduce rate of descent and forward speed.*

5. *At about 8 feet AGL, apply forward cyclic to level aircraft and raise collective to control descend. Add throttle if required to keep RPM in green arc.”*

1.4.3 Safety Notices

The safety notices listed in section 10 of the RFM include advice on autorotation training. Safety notices SN-27 “Surprise throttle chops can be deadly” (Annex 3) and SN-38 “Practice autorotations cause many training accidents” (Annex 4) address the problem of autorotation training.

1.4.3.1 Excerpt from SN-27 “Surprise throttle chops can be deadly”

”Before giving a simulated power failure, carefully prepare your student and be sure you have flown together enough to establish that critical understanding and communication between instructor and student. Go through the exercise together a number of times until the student’s reactions are both correct and predictable. Never truly surprise the student. Tell him you are going to give him a simulated power failure a few minutes before, and when you roll off the throttle, loudly announce ‘power failure’. The manifold pressure should be less than 21 inches and the throttle should be rolled off smoothly, never ‘chopped‘. (…)

There have been instances when the engine has quit during simulated engine failures. As a precaution, always perform the simulated engine failure within the glide distance of a smooth open area where you are certain you could complete a safe touch-down autorotation should it become necessary. Also, never practice simulated power failures until the engine is thoroughly warmed up. Wait until you have been flying for at least 15 to 20 minutes.”

1.4.3.2 Excerpt from SN-38 "Practice autorotations cause many training accidents"

“Each year many helicopters are destroyed practicing for the engine failure that very rarely occurs.

Many practice autorotation accidents occur when the helicopter descends below 100 feet AGL without all the proper conditions having been met. As the aircraft descends through 100 feet AGL, make an immediate power recovery unless all of the following conditions exist:

1. *Rotor RPM in middle of green arc*
2. *Airspeed stabilized between 60 and 70 KIAS*
3. *A normal rate of descent, usually less than 1500 ft/min*
4. *Turns (if any) completed*

Instructors may find it helpful to call out ‘RPM, airspeed, rate of descent’ prior to passing through 100 feet. At density altitudes above 4000 feet, increase the decision point to 200 feet AGL or higher.

A high percentage of training accidents occur after many consecutive autorotations. To maintain instructor focus and minimize student fatigue, limit practice to no more than 3 or 4 consecutive autorotations.

There have been instances when the engine has quit during practice autorotation. To avoid inadvertent engine stoppage, do not roll throttle to full idle. Reduce throttle smoothly for a small visible needle split, then hold throttle firmly to override governor. Recover immediately if engine is rough or engine RPM continues to drop.”

1.4.4 Autorotation exercise becomes autorotation with the engine shut down

During the autorotation descent the flight instructor and his trainee realised that the engine had stopped. The instructor decided not to attempt to start the engine and to take over the controls himself.

Among other things, the helicopter manufacturer states in the RFM concerning "Power failure above 500 feet AGL":

> 5. *"A restart may be attempted at pilot's discretion if sufficient time is available*
> 6. *At about 40 feet AGL, apply forward cyclic to level ship and raise collective just before touchdown to cushion landing. Touch down in level attitude with nose straight ahead."*

Concerning a restart of the engine in the air, the appropriate RFM chapter reads as follows:

„Air restart procedure

Caution: *Do not attempt restart if engine malfunction is suspected or before safe autorotation is established. Air restart is not recommended below 2000 ft AGL.*

1. *Mixture – Off.*
2. *Throttle – Closed.*
3. *Starter – Engage.*
4. *Mixture – Move slowly rich while cranking."* (bold printed in the original document)

1.5 Technical investigations

The following investigations were carried out:

1.5.1 Fuel grade

Analysis of a fuel sample resulted in the usual specifications for the type of fuel in the tank.

1.5.2 Engine and throttle rigging

- Throttle rigging in accordance with the Robinson maintenance manual, all settings within the permitted tolerances
- Fuel filter: no contamination
- Injectors: no contamination
- Plugs: within the permitted tolerances
- Solenoids and ignition cable: no anomalies
- General visual inspection, engine (leaks, cracks, condition, etc.): no anomalies
- Idle mixture check: fuel flow was 350 ml/min. According to the Robinson maintenance manual it should be 166-188 ml/min.

According to the technical documentation and the statements of the maintenance company mechanic responsible for the maintenance of HB-ZJG, no anomalies relating to idle speed existed prior to the accident. The mechanic confirmed that the idle speed, which according to the maintenance manual should be 58-62%

was always set at the upper limit, to avoid shutdown of the engine during autorotation exercises.

The excessively high fuel flow when idling prompted further investigations. By repeatedly changing the electric fuel pump and the fuel injection unit (fuel injector servo), it was possible to localise the problem to the fuel injection unit.

This fuel injection unit was tested by a specialist company on a test bench. The results showed that when idling, the instability of the fuel flow rate was actually ± 10 lb/hr rather than the permitted ±5 lb/h.

When the injection unit was dismantled, a non-centred built-in membrane was found. In certain flight conditions, this could lead to the above-mentioned fuel flow instability. The incorrect centring of this membrane must have occurred during the most recent assembly of the injection unit. According to the technical documentation for helicopter HB-ZJG, the fuel injector servo had not been removed since the delivery of the helicopter from the factory.

2 Analysis

2.1 Technical aspects

In idling mode, the non-centred membrane in the fuel injection unit could occasionally lead to an excessively high fuel flow and hence an excessively rich mixture. This in turn could lead to unstable idling, making shutdown of the engine during autorotation more likely.

2.2 Human and operational aspects

2.2.1 Autorotation exercise

This training flight took place within the normal and usual framework until the final autorotation.

The manufacturer mentions the following measures in the RFM in Section 4 “Normal operation” and Section 10 “Safety tips”, in order to prevent engine shutdown during autorotation exercises after power reduction by the flight instructor:

- *“Section 4, Practice Autorotation: Lower collective to down stop and adjust throttle as required for small tachometer needle separation*

  CAUTION

  To avoid inadvertent engine stoppage, do not roll throttle to full idle. Roll throttle off smoothly only enough for a small visible needle split.

- *Section 10, Safety Notice SN-27: Also, never practice simulated power failures until the engine is thoroughly warmed up. Wait until you have been flying for at least 15 to 20 minutes.*

- *Section 10, Safety Notice SN-38: There have been instances when the engine has quit during practice autorotation. To avoid inadvertent engine stoppage, do not roll throttle to full idle. Reduce throttle smoothly for a small visible needle split, then hold throttle firmly to override governor. Recover immediately if engine is rough or engine RPM continues to drop.*

The procedure documented by the helicopter manufacturer in the Rotorcraft Manual in Section 4 Normal Operation stated *".. adjust throttle as required for small tachometer needle separation*". This procedure entails keeping the engine speed constantly above 80% and therefore within the adjustment range of the RPM governor. As soon as the instructor reduces engine speed via the throttle, the RPM governor attempts to regulate the speed back to 100%. The instructor must therefore hold the throttle fairly firmly to override the governor. At the same time the instructor should release the collective, on which the throttle is fitted, until the trainee pilot can control rotor speed with smooth movements and does not get the impression that the instructor has operated the collective. This is not easy to achieve in practice. Consequently, in many flight schools this manufacturer's procedure has been modified so that on initiation of an autorotation the throttle grip is rolled back fully to the idling position. This means that the governor does not constantly have to be overridden, so the trainee can fly his autorotation without the influence of the instructor. The instructor applied this procedure in the present case.

In the procedure which was applied, the instructor did not obey the instruction “*Do not roll throttle to full idle”*. The adopted procedure, which includes closing the throttle to the idle stop, had also always been applied by the flying school. If a helicopter is technically in order, the engine is warmed up thoroughly well before initiating the first autorotation and the idle speed is in the region of the upper tolerance limit of 62%, experience shows that this does not cause the engine to shut down.

2.2.2 Emergency landing after autorotation

The selected site and the approach direction head to wind were chosen deliberately by the instructor so that a safe landing would have been theoretically possible in the event of an actual autorotation.

For the final phase of an actual autorotation, the manufacturer of the helicopter describes the following procedure: *"at about 40 feet AGL, apply forward cyclic to level ship and raise collective just before touchdown to cushion landing. Touch down in level attitude with nose straight ahead*."

On fixed-wing aircraft, the attitude of the aircraft must be increased in the landing phase; this is associated with rearward control inputs, i.e. pulling on the joystick. In the case of helicopters, a forward joystick input is essential to bring the helicopter to a horizontal attitude for a landing after an autorotation descent. It is conceivable that the instructor's experience with fixed-wing aircraft may have played a part in the inadequate transition from the nose-up attitude after the flare to the necessary horizontal attitude (ship level) for approaching the ground. While decelerating during the slide, the instructor pulled back on the cyclic, resulting in the impact of the main rotor blade with the tail boom. This pulling-back on the control stick may be regarded as an instinctive but incorrect response, which must be consciously avoided particularly by pilots flying mainly on fixed-wing aircraft.

It should also be noted that at the time of the accident the instructor had already been awake for 12:15 hours and had already completed 9 hours of flight duty time with the airline. For this reason, a certain amount of fatigue cannot be excluded.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- The helicopter was licensed for VFR transport.
- Both the mass and balance of the helicopter were within the permitted limits according to the RFM at the time of the accident.
- The observed variations in the fuel injector servo fuel flow resulted in an excessively rich mixture when idling, and this contributed to the engine shutdown.
- The last 100-hour inspection took place on 21 July 2010 at TSN 349:21 hours airframe and TSN 349:21 hours engine.
- At the time of the accident, the helicopter had an in-service time of 376:09 hours.
- The last condition check by the FOCA took place on 6 April 2009.

3.1.2 Crew

- The crew were in possession of the necessary licences for the flight.
- There are no indications of the flight instructor or the trainee pilot suffering health problems during the flight involved in the accident.
- At the time of the accident the flight instructor had already been awake for 12:15 hours and had already completed 9 hours of flight duty time with the airline.
- The crew had previously made training flights together.
- In addition to his experience as a helicopter pilot, the flight instructor had much greater flying experience on fixed-wing aircraft.
- Before the flight involved in the accident, the instructor had carried out about 10 autorotations on the R44 model with a full touch-down from the flight instructor seat, attended by an check-instructor.

3.1.3 History of the flight

- The selected site was suitable for an autorotation exercise.
- The engine shut down after the initiation of the autorotation exercise.
- At the time of the engine failure, the situation was favourable with regard to a safe landing.
- An inadequate forward control input to the cyclic led to first contact with the ground in a nose-up attitude.
- Pulling back on the cyclic during the slide resulted in the main rotor blade striking the tail boom.

3.1.4 General conditions

- The weather had no influence on the accident.

3.2 Cause

The accident is attributable to the fact that a main rotor blade struck the tail boom of the helicopter, because inappropriate control inputs were made during the final phase of the autorotation.

The engine failure during the autorotation exercise, which was due to a technical defect in the fuel injection unit, contributed considerably to the accident.

The flight instructor's experience on fixed-wing aircraft possibly favoured a type of control behaviour which is not appropriate for helicopters.

Payerne, 23 April 2012 Swiss Accident Investigation Board

This final report was approved by the management of the Swiss Accident Investigation Board SAIB (Art. 3 para. 4g of the Ordinance on the Organisation of the Swiss Accident Investigation Board of 23 March 2011).

Berne, 23 February 2012

Annexes

Annex 1: Final position of the helicopter with embedded landing skids

Annex 2: Point of impact of main rotor blade with tail boom

Annex 3: Safety Notice SN-27

ROBINSON
HELICOPTER COMPANY

Safety Notice SN-27

Issued: Dec 87 Rev: Jun 94

SURPRISE THROTTLE CHOPS CAN BE DEADLY

Many flight instructors do not know how to give a student a simulated power failure safely. They may have learned how to respond to a throttle chop themselves, but they haven't learned how to prepare a student for a simulated power failure or how to handle a situation where the student's reactions are unexpected. The student may freeze on the controls, push the wrong pedal, raise instead of lower the collective, or just do nothing. The instructor must be prepared to handle any unexpected student reaction.

Before giving a simulated power failure, carefully prepare your student and be sure you have flown together enough to establish that critical understanding and communication between instructor and student. Go through the exercise together a number of times until the student's reactions are both correct and predictable. Never truly surprise the student. Tell him you are going to give him a simulated power failure a few minutes before, and when you roll off the throttle, loudly announce "power failure". The manifold pressure should be less than 21 inches and the throttle should be rolled off smoothly, never "chopped". Follow through on all controls and tighten the muscles in your right leg to prevent the student from pushing the wrong pedal if he becomes confused. And always assume that you will be required to complete the autorotation entry yourself. Never wait to see what the student does. Plan to initiate the recovery within one second, regardless of the student's reaction.

There have been instances when the engine has quit during simulated engine failures. As a precaution, always perform the simulated engine failure within glide distance of a smooth open area where you are certain you could complete a safe touch-down autorotation should it become necessary. Also, never practice simulated power failures until the engine is thoroughly warmed up. Wait until you have been flying for at least 15 to 20 minutes.

Annex 4: Safety Notice SN-38

ROBINSON
HELICOPTER COMPANY

Safety Notice SN-38

Issued: Jul 2003 Rev: Oct 2004

PRACTICE AUTOROTATIONS CAUSE MANY TRAINING ACCIDENTS

Each year many helicopters are destroyed practicing for the engine failure that very rarely occurs.

Many practice autorotation accidents occur when the helicopter descends below 100 feet AGL without all the proper conditions having been met. As the aircraft descends through 100 feet AGL, make an immediate power recovery unless all of the following conditions exist:

1) Rotor RPM in middle of green arc
2) Airspeed stabilized between 60 and 70 KIAS
3) A normal rate of descent, usually less than 1500 ft/min
4) Turns (if any) completed

Instructors may find it helpful to call out "RPM, airspeed, rate of descent" prior to passing through 100 feet. At density altitudes above 4000 feet, increase the decision point to 200 feet AGL or higher.

A high percentage of training accidents occur after many consecutive autorotations. To maintain instructor focus and minimize student fatigue, limit practice to no more than 3 or 4 consecutive autorotations.

There have been instances when the engine has quit during practice autorotation. To avoid inadvertent engine stoppage, do not roll throttle to full idle. Reduce throttle smoothly for a small visible needle split, then hold throttle firmly to override governor. Recover immediately if engine is rough or engine RPM continues to drop.

Annex 5: Non-centred membrane in the fuel injection unit