Robinson Helicopter Safety Course

January 2005
It's been a few years since I attained my PPL(H), and many pilots around the Internet recommend this course, be it at the factory, or elsewhere. Therefore, I jumped at the opportunity to partake in the course being hosted at Costock. Here then, is a record of the few days' events.

17th January 2005 - *Day One*
Well, what a day!

We (inevitably) started with coffee and introductions - our host was Richard Sanford, Accident/Technical Investigator with RHC; there was nine of us taking part with varying skill sets. Some student pilots, low-time pilots like me, and other pilots with CPL and a bit of experience.

We got underway, with discussion about accidents and how the safety course has proven to help prevent different types of accidents in the US; then followed some specific examples of UK accidents - including two graphic videos of R22 wire strikes. Most of today was really just common sense, and I don't think there was anything much that wasn't taught on the PPL syllabus. What are different are having the common mistakes explained and the consequences of getting it wrong shown quite so dramatically. For example, with the wire strike scenario, you cannot see the wires against a background of land - so you fly over the posts, always assuming they have wires, compromise an into wind approach to avoid wires, etc. I say common sense, but the videos kind of show that common sense, worryingly, isn't always with us. Some still images of wire strike accident wreckages followed - some fatal, some lucky.

Moving on, we discussed Energy Management and Low Rotor RPM conditions and how this is critical to, well, flight. This included information about the de-rated Lycoming engine; I don’t think I had ever really understood what "de-rated" means, though this course cleared that up nicely. Firstly, the engine is de-rated by Lycoming - to reduce weight for the Robinson, a modification was made to reduce the amount of metal in the engine. This causes Lycoming to rate the engine at a lower power than the original. Secondly, Robinson de-rates the engines by imposing pilot limitations, such as 104%, and the MCP charts. Aside from increasing reliability by not over working the engine, this means there is quite a margin over the published limitations for when you do really get it wrong!

At this point I was introduced to some new information; for PPL I was taught how to enter an autorotation (i.e. flare, and dump the lever!), the reasoning behind was all adequately explained at that level. Today, though, explained the math behind some of that theory.

The energy available to us is kinetic and potential - kinetic in the form of rotor rpm and forward speed; potential in the form of height. Energy is, for our purposes here, is horsepower x seconds. Now, the math go something like a usable 100 hp x sec is in the rotor system at 104%. 90 hp x sec is required to maintain normal flight, therefore you have 100/90 = 1.1 seconds to find some energy before it’s too late! The energy that’s immediately available is the forward airspeed, which varies over the speed range, but as an example, 100 hp x sec is recoverable by reducing airspeed from 90 to 84 knots. Therefore, the thing to do in the case of a decaying rotor RPM is to move the cyclic aft! For every 1000 ft you have 2200 hp x sec of energy available and knowing that 75 hp x sec is required for the rotor system in an autorotation, you start getting into some clever math about how long you have on the way down. I really found this section interesting, and certainly help alleviate some fears of the low-inertia rotor system.

Just to push the point home about low rotor rpm, we were shown a video of a UK accident, where the cameraman recorded the vertical descent of an R22 Mariner with the rotor blades, stationary. As if that hadn't had the desired effect, it cut to video of the crash scene, including the bodies of the two occupants. Now, I regularly, almost fanatically, read the AAIB reports every month, but nothing one reads in the bulletins can illustrate the severity of accidents like these images; it's very, very sobering. It certainly makes you think about what you do when you take the controls of the helicopter, the consequences of a minor misjudgment, or momentary lapse of concentration. I guess, above all else, it forces a respect of the machine.

After lunch, the course moved on to look at Vortex Ring; Dynamic Rollover and Low G conditions. Generally, I think this was covered well enough on my PPL course, so I'll not post much detail about them. Suffice to say, there were plenty of photographic examples of the results of getting these conditions wrong, along with American military training videos!

We also examined Loss of Tail-rotor Effectiveness, again, covered on the PPL course (by author Wagtendonk), but it certainly doesn't hurt to be reminded of the detail. What I hadn't really appreciated before though, is that once an uncontrolled yaw takes hold, and the helicopter starts spinning and accelerating, the governor is going to cause you a problem. It maintains rotor speed relative to the helicopter; it doesn't, however maintain rotor speed relative to the air (or ground). Therefore, the rotor speed through the air actually decreases and the helicopter sinks - just what you need when you're being disoriented by a spinning helicopter!

With that, the day was more or less over, albeit for a couple more accident videos showing natural human reactions to situations that perhaps resulted in a worse outcome than if the pilot had done nothing. Easy to say that with hindsight!

It was a thought provoking, sobering and at times scary, but nevertheless fascinating day.

18th January 2005 - *Day Two*

Today's schedule was always going to be dependent on the weather as flying was to be involved. The day started out bright and clear, if a little windy; and much to our surprise given the forecasts yesterday! So the plan was to split into two groups, one to fly, one to cover the aircraft systems. Living close to Costock, I elected to be in the afternoon flying group - the weather wasn't very promising.

Once again, a lot of today's material is either common sense, or covered in the PPL syllabus, so I won't go into the detail unless it is interesting or necessary!

Our four strong group started by freezing in the hangar, looking over the systems of the R22 Beta II. Carburetor icing was going to be a theme of the day, so Richard started by looking at the carburetor temperature gauge and a simple easy method to check it is reading correctly. First flight of the day, compare it to the OAT. Easy? But I hadn't ever thought about it.

Richard talked us through various different scenarios with switches in different positions - for example, Master Battery off in flight, nothing happens apart from the battery is no longer trickle charged. The Landing Light is only on when the Master switch and the Clutch switch are on - this prevents discharging the battery in the inadvertent case where you leave the Master Battery on. Apparently Frank Robinson had done this, so changed the system accordingly! Chances are you've tried to start the helicopter with the rotor brake engaged - I have. But there are two other scenarios where the starter will not engage. The Low Rotor Horn circuit breaker is out, or the clutch is in. The clutch system is doubly protected - the 1.5A fuse protects the bulb, the 4.5A circuit breaker (CB) protects the actuator; with the CB out, the warning light is lit, thus clearly indicating a problem!

Back inside for a much needed hot coffee and some theory. Firstly we concentrated on the drive system; of note here was the "whirl mode" of the tail rotor drive shaft. As the shaft rotates, at a particular frequency it will not rotate in a clean straight line, rather it will start to form a sine wave about the axis. There are three whirl modes that we were concerned with: Whirl mode one occurs in the late 50% RRPM, and is 180° of a sine wave along the shaft length. Whirl mode two is around 60-61% RRPM, is the full 360° sine wave. Both of these modes are passed very quickly, but there are dampers within the tail boom to cancel the effect. Whirl mode three is the critical one, a 720° sine wave that occurs at around 130% - this isn't damped, and the results are such that the tail rotor drive shaft moves around so much in the tail cone, it makes contact; and it also causes the shaft to shorten. So, don't push it to 130% RRPM.

Then, we took a look at carburetor icing. Most of us will know roughly the theory of it - don't rely on carburetor temp gauge below 18" MAP, pull full carburetor heat before descents, etc. One of the things I was taught was that carburetor heat wasn't really necessary at high power settings - the interpretation of high power setting being the 5-minute take off power. The theory of that was that the throttle was wide open, and any icing wouldn't affect it. However, the de-rated engine, as described yesterday, plays a key part here - the 5 minute take off power isn't full throttle, by a long way. Richard has obtained the angles of the carburetor butterfly, and the resultant graph clearly shows that at that 5 minute take-off power, the butterfly is only open in the region of 50°-60°; in other words, just over half way. But then to see a diagram of the aperture that kind of angle allows, you realize that it's not very much at all. Therefore, carburetor icing can occur at our 'high' power settings.

Then one more nugget of information regarding having carburetor heat applied when you need the power. We are taught to look up our MCP/take off power from the chart, and never to exceed it. I'm not a small bloke by any stretch of the imagination, and this has always worried me as I've always flown close to the limits. However, the point that I had missed was that that MAP chart is based on density altitude (heat changes that) and it is the MAP required to get a particular horsepower output. In fact, full carburetor heat provides around 40°C above standard. The rule of thumb is that for every 4°C above the standard 15°C there is a 1% power loss. In our case then, we are looking at a 10% reduction in power. For the Beta II (different numbers are used for the different engines/helicopters), the MCP is 124 bhp - so with full carburetor heat, that MAP setting means the power is reduced by 12 bhp. The Lycoming power chart shows that 1" of manifold pressure is around 8 bhp, so to get the 124 bhp for MCP, we can add 1.5" (12 ÷ 8) to what the chart has given us.

With that it was lunch - we met up with the morning flyers and discovered that on the final return to Costock the wind had picked up to gust 33 knots. Whilst at lunch, the rain arrived and with it, really any chance of afternoon flights. So, we juggled the course around and covered the Pilot’s Operation Handbook (POH) this afternoon, rather than the scheduled Wednesday morning.

The afternoon opened with a look at the use of the governor, and the recent changes to the start-up checklists. Overspeed in the engine and rotor systems. VNE and VNO in the R22 and R44 - and what the limits are based on. For the R22, VNE is simply determined by the forward cyclic travel. For R44, it is to do with fatigue loading, which is why there are several different VNEs.

Moving on, we debated the Height Velocity diagram (avoid curve) - the main point of contention centered on whether the diagram applies to approach as well as take off. In effect, it doesn’t, as it’s primarily related to power on take-off. After a quick coffee, with the rain beating down outside, we were treated to a video of flight-testing on R22 #2. I thought it very interesting to see the test pilots exploring the limitations of the aircraft in order to produce the height velocity chart.

There followed a discussion regarding the infamous rule 5, in which the more experienced pilots in the group disagreed with Richard's interpretation. We find out tomorrow what the correct interpretation should be!

We had run out of time to take the exam, so that will happen tomorrow, and fingers crossed for some nice weather too.

19th January 2005 - *Day Three*
First thing to get out of the way was the exam - duly taken. We each marked someone else's paper so if anyone got a question wrong, we would at least talk about the question and reason for the correct answer. I'm pleased to say that I obtained 88%, and the questions I had got incorrect largely related to either instructors or a misunderstanding/interpretation of the question, so I wasn't too bothered by them.

Then today was flying day! The weather held off sufficiently for flights to happen this morning, only one EMH instructor flying today, so I was second to go out. The whole flight was conducted without the governor switched on; the reason was to get used to flight in conditions where the RPM isn't being regulated by the governor - and to get used to the low rotor horn/light in such a way that you don't panic an autorotation in response!

My instructor took the helicopter into the hover, but handed over to me in the hover, we transitioned away and flew east. The first exercise was to listen to the tone of the engine in normal flight, then reducing the RPM to demonstrate the different tone of the engine. It was quite marked, and I also noted additional vibration on the airframe. We performed a couple of autorotations, with a governor off recovery; then vortex ring demonstration (first time with a VR demonstration that I've encountered the pitching/rolling and yaw - before I've only really had the stick shake on the incipient stages!) All straight forward and as long as one keeps calm, pretty benign.

Then it was into Nottingham for some low level work. First thing was to get the helicopter on the ground - governor off. No problem with that, so back to the hover - this is where things get trickier, the correlator pushes the RPM up, so as the lever is raised to get the helicopter light on the skids, you have to keep a close check on the RPM, and keep backing off the throttle. It was all fairly straight forward, with a bit of concentration. Then we looked at the change in RPM in spot-turns, in a left-turn, RPM decreases, to the right, increases. Then we looked at what happens if the RPM gently decays in the hover (well, we were slowly hover-taxiing for stability). As one expects, RPM down, the helicopter sinks, you arrest the sink with the collective. RPM back up, lever down to compensate.

Back to Costock, and en route my instructor pulled the two breakers for the tachs, so flying governor off, with no gauge to show the RPM. He backed off the throttle, and asked me to reset it to where I thought was top of the green, by sound alone. Really quite an easy task as the tone is so different. Even just a couple of percent of drop, not enough to put the horn/light warning on, is noticeable. I flew us back into Costock, and landed the aircraft after an entire flight without using the governor.