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We Fly The R66; Even More Of A Good Thing

Tuesday, September 28, 2010 - Guy R. Maher

Our flight test – and the performance charts – indicated that the R66 should be a good high altitude performer.
Guy R. Maher Photo










The R66 Turbine may be an all-new model and a great evolution in the Robinson line, but anyone who's flown the R44 will still feel right at home.

In the interest of full disclosure, when I arrived at Robinson Helicopter Co. (RHC) to fly the new R66 Turbine, I had no doubt I would like it... I just didn't know how much. In development for well over three years, the R66 is

the natural evolution of the ubiquitous R22 Frank Robinson designed in his home 35 years ago.

I'd like to say the R66 is an R44 all bulked up, but it's more of a new helicopter than you might think. Right off the bat, RHC decided to go for a completely new type certificate under Part 27 of the United States Federal Aviation Regulations, rather than trying to slip it by as an R44 variant — something that would have been in keeping with many of the "new" aircraft brought to market under the older and less-stringent certification rules. And while there are many similarities between the R44 and R66, there are many significant differences, too.

The Subtleties

In overall length, the R66 is exactly the same as the R44: 38.25 feet from the tip of the forward main blade to the very end of the tail stinger. The main rotor diameter is also the same, 33 feet, but with an increased chord length of roughly 1.5 inches, depending on the blade section. At 60 inches, the tail rotor diameter is two inches longer than that of the R44 (with 0.4 inches more chord on the blades). Meanwhile, the cabin width has gone from 50.5 to 58 inches, and one inch has been added to its length, which is evident in the rear seat legroom. (To counterbalance the wider cabin, a horizontal end plate was added to the bottom of the tail's lower vertical fin, which helps with nose-down pitch during auto rotation.) The skid width has increased from 86 to 92 inches, and the maximum height, at the rotor hub, is eight inches taller, although the R66 can still roll under a 12-foot door on its standard wheels.

The most dramatic change is seen from the front — the R66's cabin has a distinctive oval shape. The difference in profile is subtler, although the lower windshield line starts a more pleasing continuous flow up through both the front and rear cabin door windows. The rear cooling fan intake, which is on top of the aft cowl on the R44, has been replaced by louvers in the forward tail boom and small intake air inlets forward of the lower mast fairing. The exhaust ejector protrudes from the upper rear cowling area, just below the tail boom. I'm told heat will not be a problem for the tail boom, but operators will certainly stay busy keeping the lower tail boom area clean.

The Specifics

Robinson has done an amazing job arranging what goes behind those cowlings and fairings. The Rolls-Royce RR300 (250-C300/A1) engine is mounted on a 37-degree angle, with its lowest point at the bottom rear of the cowl. The 300-shaft-horsepower engine is de-rated to 270 s.h.p. for the five-minute takeoff range, and 224 s.h.p. for maximum continuous power (MCP). Engine control is very simple: there is no FADEC (full-authority digital engine control), rather, each collective has a twist-grip throttle that is usually either in the idle or full-open position. Engine anti-ice has been incorporated, and is activated through a solenoid-actuated switch on the center pedestal, allowing hot compressor discharge air to flow to the compressor nose bearing support.

The RR300 incorporates an engine monitoring unit (EMU) that digitally records continuous gas generator/compressor r.p.m. (N1), turbine r.p.m. (N2), engine torque (TQ) and measured gas temperature (MGT). In addition to counting start cycles, the EMU records any exceedances for N1, N2, TQ and MGT. The RR300 also incorporates a hydromechanical governor, which attempts to maintain 100 percent engine output shaft r.p.m. when the throttle is fully open. And, there is a collective-mounted, momentary toggle switch to trim or "beep" the governor setting to exactly 100 percent, if needed.

The transmission is direct-drive from the engine — no belts — and sits high in a deck directly behind the cabin firewall. The 73.6 US gallon usable fuel system is now a single bladder, lined cell that meets the new Part 27 crashworthiness standards. Plus, it's U-shaped (going under the transmission) for increased capacity and negligible changes in center of gravity with fuel burn. Refueling is via a single-point on the left-hand side.

In addition to having the under-seat storage found in the R22 and R44, the R66 has a full-width, 18-cubic-foot baggage compartment. Access is through a nearly two-foot-square door on the pilot's side of the helicopter. The compartment has a 300-pound capacity, with a 50-pound-per-cubic-foot load limit. I can already envision how utility operators might put down floor decking and straps, and make good use of this large and highly functional area.

Of course, the extra passenger and storage capacity is pointless if you can't lift off. The nicely equipped ship I flew (full-gyro, nine-hole panel, with a Garmin GNS 430 plus second comm, transponder and audio panel) had an empty weight of 1,317 pounds. Add air conditioning (which you can order now) and useful load is still around 1,350 pounds — half the 2,700-pound maximum takeoff weight. That leaves room for a full-fuel cabin load of over 850 pounds, or 200 more than a similarly equipped R44 Raven II.

There is also (wink-wink) a "tie-down" hard point under the cabin, in line with the rotor mast and rated for about 900 pounds. RHC isn't pursuing an external-load-hook installation, but third parties can take advantage of this robust tie-down hard point.

Preflight is easier than in the R44, due to large access panels on each side of the fuselage. There is no problem getting a clear view of the engine, accessories or drivetrain components under the cowls. And, there are more foot placement areas for the climb to the top of the rotorhead. There is also an auxiliary power receptacle inside the engine compartment on the pilot side. Finally, RHC has cleverly installed small LED lights that shine on the hydraulic reservoir and transmission oil sight glasses when the left access door is open.

The Start-Up

The extra cabin width of the R66 is found on the outside shoulder — there's no need to add bubble windows here just for space. There is also more space between the anti-torque pedals, making for the most natural sitting position of any Robinson yet. As in the R44s, the trademark T-bar cyclic and the collective here are hydraulically boosted.

The panel is typical RHC design: clean and simple. Gone is the row of warning lights in the R22 and R44. Instead, a new annunciator panel, on the top of the main instrument panel, provides easy-to-read details, even in bright light. The torque meter replaces the R44's manifold pressure gauge. The dual tachometer displays main rotor r.p.m. (Nr) and N2. And there actually is an avionics master switch! There is also a cigarette-lighter-style power receptacle, for portable accessories, at the circuit breaker panel below the left front seat.

Starting the R66 is incredibly similar to the fuel-injected R44 Raven II. With all the familiar prestart checks done, the pilot turns the igniter key to "enable." This key is in the same place as the magneto key in the R44. The fuel cutoff control is exactly the same knob — and in the same position — as the R44 Raven II mixture control, and is placed in the same prestart cutoff position. (One critical note: do not push it in before the start or it will be an expensive lesson!) Like the Raven II, the starter button is on the end of the collective. Now, here's where things get a bit different. With the throttle closed (idle position), the starter is pressed — then released. There is no need to hold it. Once N1 has achieved 15 percent and MGT is verified as below 150 degrees Celsius, the fuel cutoff is pushed on, just as the mixture control is pushed in on the R44.

Light-off should occur within three seconds and the pilot then does nothing but monitor MGT. If light-off doesn't occur within three seconds, or if the MGT goes to its limit, the fuel cutoff is pulled back out and the starter is motored for 10 more seconds before being stopped by turning off the igniter switch. At 58 percent N1, the combined starter-generator kicks off, and once N1 is stabilized at 65 to 67 percent, the 160-amp capacity generator is panel-switch-activated to supply the 28-volt DC electrical power. I performed three starts in the R66. On one, the MGT stayed in the green; on the other two, it smoothly ventured slightly into the yellow, but comfortably below any limit. A one-minute warm-up is required before going to 100 percent.

The before-takeoff checklist is quite short — checking gauges, engine anti-ice, hydraulics, annunciator panel and low-rotor r.p.m. horn. After smoothly rolling in the throttle to 100 percent N2/Nr, RHC chief test pilot Doug Tompkins and I were ready to go.

Let's Go Flying

Although I flew the R66 on three different occasions during my visit, all performance numbers here were recorded during a flight for which I asked RHC to load the helicopter with ballast to its maximum gross weight (MGW).

Pulling in pitch for my first time felt a little heavier than in the R44. I picked up into a 10- to 15-knot crosswind and hover stability was all R44, and more. The R66 hovers in a more distinctive left-side-down attitude, but it's very comfortable.

The outside air temperature (OAT) was 26 C, or about 79 F, field elevation was at sea level and the R66 required 78 percent TQ — of an available 100-percent, five-minute limit — to hover in ground effect. The MGT was a cool 600 C. For reference, 782 C is the five-minute limit, and 706 C is the maximum continuous.

Pedal turns, even those to the left, and hovering in an 11-knot tailwind, never produced a TQ reading of more than 80 percent. A series of hovering maneuvers (backwards, sideways and quick stops in multiple directions) were all rock solid, with plenty of pedal authority. Leaving the airport, the R66 gave quite a show. Pulling in 100 percent TQ for a zero-airspeed vertical climb resulted in a steady 900 feet-a-minute (f.p.m.) rate. I finally quit at pattern altitude and assumed the best rate of climb speed of 60 knots, posting a 1,350-f.p.m. climb rate. When I reduced power to a maximum continuous power (MCP) of 83 percent TQ, the climb rate settled in at 950 f.p.m. Measured gas temperatures at 100 percent TQ and 83 percent TQ were 690 C and 630 C, respectively — never getting into the five-minute range.

My first cruise checks came at 2,000 feet mean sea level and an OAT still at 26 C. At MCP, with an MGT of 640 C, the indicated airspeed showed 112 knots, for a true airspeed of 118 knots. Reducing power to 75 percent TQ (an MGT of 620 C) yielded 106 knots indicated airspeed and 112 knots true.

Some general notes about cruising speed. All science aside, the R66 seemed comfortable at 110 to 115 knots indicated, which is similar to the R44. However, during photo missions, when I was in the R44, the R66 pulled away fairly easily — even with both ships similarly loaded and both using MCP.

The R66 ride in cruise was quite nice, and nicely quiet. I asked Tompkins if the transmission was mounted differently from the R44 and he said it wasn't. I never detected a pronounced "two-per" vibration, such as one might get in the R44 in the higher range. Rather, the R66 just had small, randomly occurring verticals.

Even when pushing the R66 to its MGW never-exceed speed (Vne) of 130 knots, the ride was fairly smooth. Although, when we flew at a weight under 2,200 pounds, and I sampled the 140-knot Vne, I did detect a steady two-per — but even then it was still comfortable. I also didn't notice the ride change that I'm accustomed to in the R44 as cruise speed picked up. The Lycoming piston engine may have something to do with the overall differences, as it has its own vibration characteristics, whereas the smooth-running RR300 has none.

I Can See for Miles and Miles

Overall visibility in the R66 is great, as the windshield is set back farther at the top than the R44. And even though the cabin is wider, the added front space (even with the larger nine-hole panel) and low cabin door window profile make for great sightlines.

That visibility came in handy when I finished my cruise checks and did some maneuvering. Ground reference maneuvers, yanking and banking, and steep turns of 45 to 60 degrees bank all revealed rock-solid handling. If it weren't for the imbalance due to the tilted T-bar cyclic, the R66 would have maintained a decent hands-off bank attitude.

Next, I did more climbing. Spot checks included a 1,300 f.p.m. climb rate passing through 5,500 feet at 100 percent TQ. A cruise check at 5,500 feet resulted in 105 knots indicated airspeed at MCP, 107 knots true. (If you bring the power back to 74 percent TQ it will cost two knots, but the fuel savings will be worth it.) I entered another climb at 80 percent TQ and the climb rate stabilized at 850 f.p.m. passing through 6,500 feet.

For some higher altitude work, I leveled off at 7,000 feet mean sea level, where the OAT was 19 C. I went into an out-of-ground-effect (OGE) hover over a target, which required 86 percent TQ, and the MGT was still in the green at 690 C. The left pedal required was typically about one inch from the stop. I only hit the stop once, entering a left turn, but never felt like I was losing authority — even when stopping a right pedal turn into a

right-quartering tailwind.

The R66 proved that there was obviously plenty of power left for much higher work, especially since we were at MGW, less the fuel burned to climb. If this were an OGE hover for news coverage, the R66 could do it. When I increased my speed to just above effective translational lift — but still below 20 knots — I could maintain the same altitude in a tight loiter, but with a whopping TQ reduction to 60 percent and an MGT reduction from 690 C to 600 C.

Smart flying will make this helicopter a great altitude performer, with less effort and greater kindness to the engine. My tests confirmed the OGE book performance (which also shows in-ground-effect hovering at well above 10,000 feet). My tests further showed this helicopter normally should be torque limited, unless the conditions are hot and high.

Bringing It Down

With the high work completed, it was time to come down. And a fun way of doing that (when it's intentional) is via the autorotation. The first check was at 100 percent Nr and normal speed of 65 knots. The rate stabilized at 1,500 f.p.m. Minimum rate of descent, 1,350 f.p.m., was achieved at 60 knots and an Nr of 90 percent. Finally, maximum glide distance was achieved at 90 knots and 90 percent, at a descent rate of 1,700 f.p.m.

In the R66, the auto is everything it is in the R44 — and more. It seems to want to float forever. Rotor r.p.m. is very easy to control, and if there isn't a lot of aggressive maneuvering required, just set the collective and forget it until the flare and touchdown. The key to a successful touchdown is patience. Even when we were heavy and with no wind, the flare and touchdown were nearly a non-event. The best touchdowns came by waiting until the last minute to pull in final pitch; those big blades have plenty of inertia. When Tompkins suggested the first hovering autorotation, he was sitting there with his leg up, collective arm draped over his knee, like he was watching a parade. So, I thought, "Well, this must be easy." It was. Roll off the throttle and the ship settles gently until a little pull at the bottom — even when starting from 10 feet.

What is very unlike the R44 when doing autos is how the helicopter responds to the throttle being rolled off. In the R44, chop the throttle and the ship immediately yaws left — you know something has happened. Not so in the R66. Even in the hover, chop the throttle and that turbine spools down in such a way there is no need for quick right pedal action. In fact, even with delayed response there was no demand for much pedal, despite the fact the needles were definitely split. (Tompkins did tell me that with real engine cutoff, during height-velocity curve plots, the yaw was more significant.)

Also, when doing power recoveries, the throttle must be brought in a bit sooner than in the R44. However, the power application was smoother with the RR300, with no tendency for the helicopter to want to wiggle in yaw as the needles are joined. When we did some hydraulics-off work, the R66 felt just a bit heavier on the controls, with a more obvious interaction between collective and cyclic than in the R44, but it was very manageable. Tompkins then suggested a stabilized, slow, decelerating approach, terminating in a minimal-speed, run-on landing; I complied, with very gratifying results.

Normal and steep approaches were predictable in every sense. In a very steep approach at near MGW, power management was a snap, and there was plenty left at the bottom if needed. Normal touchdowns occurred at a nearly level attitude, slightly favoring the toes of the skids first, although I'm sure this will vary depending on center of gravity.

The Shutdown

Shutdown is a simple matter of rolling the throttle to idle, waiting for a two-minute cool down, then pulling the fuel cutoff knob out and watching the MGT to confirm no residual fire in the combustor. After one minute, the rotor brake can be applied. Then, set all switches to off and you're done.

On the flight we performed at MGW, I noted the fuel used was 26.6 gallons of Jet A, for a burn rate of 20.46 gallons an hour. This seemed a very fair test, as the majority of the 1.3-hour flight was at MCP or above, with

only about 10 minutes at idle power. Average fuel burn rates in the low 20s seem very doable in the R66. Frank Robinson targeted the R66 to replace the slew of aging Bell 206s. It's also a natural progression from the R44 for those wanting more room, more useful load, more baggage and passenger capacity, and turbine reliability... well, except for the fact that RHC exploded the whole "turbine reliability" argument years ago with its de-rated piston engines. Regardless, if you like the R44, you'll love the R66. RHC took its time in development and really appears to have gotten it right. With confirmed orders pushing 90 units and certification expected by the time you read this, the R66 is set for a strong launch. Waiting customers will not be disappointed.

For more details about the R66, see **Dollars and Sense** and **This is No R44, Son**

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Dollars and Sense
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A sharp eye will spot the R66 differences from the R44 – more uniform and pleasing sweep to the windows, and air intakes below the mast and forward tail boom. Guy R. Maher Photo

At this year's Heli-Expo, the R66 Turbine's introductory price of $770,000 US was announced with the caveat that it might not last long (see p.26, Vertical, Apr-May 2010). It didn't. On Aug. 1, the official price sheet was published and the MSRP was increased to, a still attractive, $790,000.

So, what are some of the other important numbers new owners and dealers will have to contend with? First, once upgrades like a Garmin GNC 420, air conditioning and gyros are included, it can be figured a nicely equipped R66 will run around $835,000.

The requirements for R66 dealers will be a bit stiffer than for piston dealers. They are required to have a United States Federal Aviation Regulation (FAR) Part 145 repair station designation (or its equivalent outside the U.S.)

— surely in recognition of the added technical aspects of maintaining the turbine engine. They also must send at least one airframe and powerplant mechanic to both the Robinson R66 maintenance course and the Roll-Royce RR300 engine maintenance course.

There's no doubt the maintenance cost of the R66 will be a key attraction for those customers wanting a turbine helicopter. Robinsons have a solid reputation of going from 100-hour inspection to 100-hour inspection with minimal maintenance required. The proven airframe and drivetrain design is known for reliability and low-cost maintenance. So, the only difference is the RR300... and its C20 heritage should give buyers confidence.

The R66 will carry a factory warranty of two years or 2,000 hours. The airframe and engine overhaul requirements are classic Robinson — every 12 years or 2,000 hours (rather than the traditional 2,200 hours), whichever comes first. There is also one additional engine overhaul target and that's if it reaches 3,000 start cycles. Direct operating cost is projected to be under $300 an hour, and that should be pretty accurate.

The Robinson Helicopter Co. (RHC) also recognizes that pilot training will be a more significant component for R66 customers. To that end, prior to the delivery of a dealership's first R66, it must send at least one flight instructor to the RHC safety course, and complete an R66 pilot checkout course conducted or approved by RHC. (I went through this process, receiving my pilot-in-command [PIC] and instructor signoffs, and can attest that it's very thorough.) RHC recognizes it will initially be doing a considerable amount of R66 training and familiarization flights until the dealerships get up to speed on the training aspect.

Interestingly, in RHC's R66 purchase agreement addendum, the only R66-specific training requirement is for the pilot checkout stated above — along with attending the safety course. The PIC must have at least 200 hours total and 20 in an R44 or R66 to carry passengers. Certified flight instructors teaching in the R66 must have at least 500 hours total time and 50 hours in either an R44 or R66, or in combination. (In other words, it appears that R44 time can satisfy all of these hour requirements, except for the R66 flight time necessary for the basic pilot or instructor checkout.)

At press time, the U.S. Federal Aviation Administration still had not decided whether the Special FAR that is in place for the R22 and R44 would be required for the R66. Hopefully it won't, because it is (like with the R44, in my opinion), unnecessary.

Insurance is the final component of the key numbers for the R66. For those using the RHC influenced Pathfinder program, a sample quote reveals that a 200-hour pilot with 40 hours in the R66 will spend about $20,000 annually for coverage. Of course, there are so many different situations (and who's going to have 40 R66 hours right off?) that the rates will vary some, for sure. I'm guessing R44 time will go a long way to helping out the new R66 driver.

Caitlyn Jones-Henry of Sutton James Inc., a U.S. based insurance broker specializing in Robinsons, indicated that, "The carriers are definitely interested in the R66. Right now the concerns are to quote it either like a 206, or as a new market that has to prove itself." She then added, "All underwriters will look at everyone — even the low-timers. Training and experience will certainly be a factor for determining rates, and the lesser-experienced pilots may have to get some additional instruction or mentoring when they get their ships. But, for sure we've had calls, and the standard turbine markets are looking at this."

Does it make sense to spend nearly twice that of an R44 Raven II to get an R66? Well, nearly 90 customers have already determined the R66 is a more cost-effective turbine helicopter than existing used or new options. And that's just what RHC had in mind when it pulled the trigger on its R66 development program. – Guy R. Maher

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This is No R44, Son
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Although neatly arranged, the sub panel design below the main instruments takes the important MGT gage [top right] out of the pilots direct line of sight. Guy R. Maher Photo

Regardless of how great a new or existing helicopter design is, leave it to pilots to find things to take issue with and/or add to the "want" list. Fortunately, when it comes to the R66 Turbine, there aren't many needs or wants.

The biggest issues with the R66 relate to concerns for those pilots transitioning from the R44 and who have no turbine time. Clearly, many pilots over the past 18 years of R44 production have crossed over without a problem to the Bell 206 or similar turbines. However, those are entirely different airframes with little commonality to the R44, and, as such, tend to put the pilot on more of an "alert — this is different" status.

Accordingly, some of the minor concerns I had with the R66 include:

1. As with any turbine helicopter, there is the clear risk of over torquing or over temping. But the R44 pilot who

may occasionally pull a couple of extra inches of manifold pressure over the charted limit at the bottom of a hot and heavy approach with no ill effects will be in for a shock if he or she does that in an R66. Over-torque and/or over-temp the R66 and the engine monitoring unit will let you and your mechanic know it's time to break out the wallet.

2. The small measured gas temperature gauge could be a little more prominent, specifically because of that over-torquing/over-temping risk. It is installed below the engine torque (TQ) gauge on the lower panel, and not in the same line of sight as the TQ gauge.

3. The dual tachometer for engine/rotor r.p.m. is not as friendly and easy to read as the TQ gauge.

4. The standard-equipment traditional clock has a sweep second hand — but no start-stop function. "Punching a clock" should be an automatic pilot action when starting a turbine engine, to ensure the engine is lighting off in the proper timeframe and that starter and other engine time limits are being honored.

5. There is no mention of any minimum voltage for starting on the checklist. The worst thing that can happen to a piston pilot who tries to start an R44 with a weak battery is that it doesn't start. Try this in an R66 and the result can be catastrophic.

Of course, none of my "concerns" come even close to hurting my overall great impressions of the R66. But, for those of us helping transition brand-new turbine pilots with lots of R44 time into the R66 — we need to take extra care to heavily emphasize how unlike the R66 is to the R44 in some key aspects. – Guy R. Maher

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