R22 Beta II

Pilot's Guide & Operating Manual

for Microsoft Flight Simulator 2024



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CowanSim R22 Beta II — Pilot's Guide & Operating Manual for Microsoft Flight Simulator 2024

Version 1.0 — November 2026. Applies to the CowanSim R22 Beta II package for Microsoft Flight Simulator 2024, all airframe and avionics variants.

A word from CowanSim

We have been building helicopters for Microsoft Flight Simulator for years. The R22 is the one most pilots learn on. It hides nothing from you and it rewards good hands, and that is what we wanted this one to be about: depth you can feel rather than features you can list. A governor and a carburetor that behave like the real ones. A HeliSAS that flies like the Genesys unit. A force trim that works with the hardware people actually own. A walkaround you do on foot. Where the simulator forced a compromise we say so, in the boxes marked IN THE SIM and in the list of simplifications in 5.13. If something in these pages does not match what you see in the cockpit, tell us on Discord or by email (1.5). The manual gets fixed along with the aircraft.

Joshua & Yannek - CowanSim

For flight simulation only

This manual describes a software simulation. It is not a substitute for the Robinson R22 Pilot's Operating Handbook, the Genesys HeliSAS Pilot's Operating Handbook, or any approved training. Real-aircraft data quoted here (limitations, procedures, systems descriptions) is reproduced from public Robinson Helicopter Company and Genesys Aerosystems documents to make the simulation authentic; always refer to the current official publications for real-world operation. Nothing in this document may be used for real-world flight.

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Revision record

Revision	Date	Changes
1.0	November 2026	First release for Microsoft Flight Simulator 2024. All-new manual: 2024 control bindings, force trim and HeliSAS as implemented in the 2024 package, walkaround and ground-handling features, real-aircraft reference data.

How to use this manual

Read Chapters 1 and 3 before your first flight. They get your hardware and the simulator settings right. Chapters 4 to 6 explain the cockpit, the systems, the force trim and HeliSAS. Chapters 7 and 8 are the checklists, 9 covers the tablet, the walkaround and the variants, and 10 is troubleshooting. The appendices hold the quick cards, the glossary, the sources and a gallery. The manual is also in the cockpit: the **R22 Manual** app on the tablet shows it page by page (9.1).

Chapter	What it covers
1 Welcome & Quick Start	Package contents, variants, installation, a first flight in twelve steps
2 The Robinson R22 Beta II	The real aircraft: specifications, limitations, markings, placards, safety notices
3 Setting Up Microsoft Flight Simulator 2024	Settings, control presets, axes, the force trim bindings, buttons, cameras
4 Cockpit Tour	Every instrument, light, switch, lever and click spot
5 Systems	Engine, governor, clutch, rotor brake, rotor RPM, fuel, electrical, lights, avionics
6 Force Trim and HeliSAS	The real HeliSAS, trimming technique, SAS, autopilot modes, coupled approaches
7 Normal Procedures	Walkaround, start, run-up, takeoff, cruise, approach, shutdown, autorotation
8 Emergency Procedures	Power failure, fires, tail rotor, governor and electrical failures, low RPM, low-G
9 Tablet Settings, Walkaround Items, Variants and Options	The R22 Settings and R22 Manual apps, engine bay, covers and doors, dual controls, wheels, Mariner, spray kit, liveries, loading
10 Troubleshooting and FAQ	Symptoms and fixes
Appendices	Binding quick card, limitations and speeds quick card, glossary, sources, gallery

Conventions

Control names that you search for in the MSFS 2024 Controls Options are shown in capitals, exactly as the simulator spells them, for example `SET HELICOPTER FORCE TRIM RELEASE BUTTON`. Cockpit labels are shown in bold capitals such as **GOV OFF**. Checklist lines use the real R22 checklist format: *item* ..... *action*. TIP boxes give practical shortcuts, and FROM COWANSIM boxes explain a choice we made in building the aircraft.

WARNING Marks a procedure or limitation which, in the real aircraft, could lead to an accident if ignored. The simulation reproduces the behavior.

CAUTION Marks something that can damage the simulated aircraft or spoil a flight: an engine overspeed, a hard landing, a trim surprise.

NOTE Background information, mostly about the real aircraft.

IN THE SIM Describes how the CowanSim R22 does something in Microsoft Flight Simulator 2024 where that differs from the real helicopter, or needs explaining in terms of it.

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1 Welcome & Quick Start

Thank you for flying the CowanSim R22 Beta II. This package is a detailed recreation of Robinson's two-seat piston helicopter for Microsoft Flight Simulator 2024. We built it around the real aircraft's systems, limitations and procedures, and around the way helicopter pilots trim and fly.



The CowanSim R22 Beta II in cruise.

1.1 About this product

The R22 is one of the world's most widely used training helicopters. It is light, quick and unforgiving of sloppy technique, and it rewards you once you learn to fly it with your fingertips. The CowanSim R22 Beta II reproduces that character: the low-inertia rotor, the derated Lycoming O-360 with its electronic governor, the belt-driven clutch, carburetor icing and the real warning-light panel. For pilots who want to fly hands-off in cruise, we added a stability augmentation and autopilot system modeled on the Genesys HeliSAS fitted to the Robinson R44 and R66.

What is modeled:

- **Flight controls as in the real aircraft.** T-bar cyclic, collective with twist-grip throttle, governor switch and friction lever, anti-torque pedals, cyclic and collective friction, and removable left-seat (dual) controls.
- **Engine and drive train.** Lycoming O-360-J2A derated to 131 hp (5-minute takeoff) / 124 hp (continuous). A carburetor model that responds to mixture, altitude and carb heat like the real engine. An electronic RPM governor you can override with the twist grip. V-belt clutch with

actuator and CLUTCH light, sprag (overrunning) clutch, rotor brake with BRAKE light, low-rotor-RPM horn and light, and the high-RPM warble.

- **Warning/caution light panel.** LOW FUEL, MR CHIP, TR CHIP, LOW RPM, MR TEMP, OIL, STARTER ON, CLUTCH, GOV OFF, BRAKE and ALT, with the real push-to-test buttons in the engine bay.
- **Fuel system.** Gravity-feed main and auxiliary bladder tanks with interconnect, fuel shut-off valve, gauges, low-fuel sender, refueling through the filler caps, and fuel sampling in the engine bay.
- **14-volt electrical system.** Battery, alternator with low-voltage ALT light and ammeter, main and avionics buses, and the full circuit-breaker panel. Every breaker cuts what it is labeled for (4.8).
- **Force trim and HeliSAS.** An addition modeled on the Genesys HeliSAS of the R44 and R66. The force trim release on the cyclic works like a real force-trim system. A two-axis SAS/autopilot adds HDG, NAV, SPD, ALT and VRT modes on a HeliSAS control panel.
- **Three instrument-panel layouts.** Analog, digital with one navigator, or digital with two, chosen on the tablet (EFB). Three avionics fits: Garmin GNS 530/430, PMS50 GTN 650/750 or, on PC with the TDS patch, TDS GTNXi 650/750 (1.3).

The MSFS 2024 walkaround and ground handling are modeled as well: rotor tie-downs, pitot and bubble covers, cowl panels, oil dipstick, gearbox sight glasses, fuel sample, warning-light test panel and ELT. You can check the tail rotor blade pitch by hand, remove the doors, and push the helicopter around on its ground-handling wheels. A tablet (EFB) on a repositionable mount carries its own R22 Settings and R22 Manual apps.

There are three airframes: Default (skid landing gear), Mariner (fixed utility floats) and Agricultural (spray kit with a working spray system). Rotor downwash raises dust, grass, snow and water spray, the skids kick up dust, and the engine shows heat haze and start-up exhaust. The sound set is complete, and quieter with the headset on (5.10, 5.12).

The Plexiglas bubble has the fine micro-scratches, deeper scratches and fingerprints of a real R22's windshield. Rain and ice form on the glass, and bugs build up until you wipe them off (5.12).

The engine shakes on its mounts, and the cyclic shakes with the rotor. The drive and alternator belts run, and the clutch actuator tensions the belts. The main and tail rotors are fully animated: swashplate, blade pitch, teetering and coning follow the cyclic, collective and pedals (5.12).

In VR, the motion controllers grip the cyclic and collective (3.6). The simulator's night-vision goggles are supported (5.8), and its passenger rides in the left seat (9.9). Cockpit settings stay as you left them from one flight to the next (9.1). There are 43 liveries, 21 of them new (9.8).

1.2 Package contents and variants

The package installs as one aircraft with six selectable variants: three airframes, each with the Garmin GNS 530/430 or the PMS50 GTN 650/750. Three more, with the TDS GTNXi 650/750, are in the package but stay hidden until the TDS patch is installed, which is possible on PC only (1.3). Choose the variant in the aircraft selector before loading a flight. The names below are the ones shown there.



Figure 1-1 The six variants as they appear in the aircraft selector. The PMS50 tiles say what they need.

Airframe	Garmin GNS 530/430 (included)	PMS50 GTN 650/750 [1]	TDS GTNXi 650/750 [2] (PC, with the patch)
Default (skid landing gear)	Default with GNS 530/430	Default with PMS50 GTN 650/750	Default with TDSGTNXi 650/750
Mariner (fixed utility floats)	Mariner with GNS 530/430	Mariner with PMS50 GTN 650/750	Mariner with TDSGTNXi 650/750
Agricultural (spray kit)	Agricultural with GNS 530/430	Agricultural with PMS50 GTN 650/750	Agricultural with TDSGTNXi 650/750

[1] Requires the PMS50 GTN 650/750, a separate product: on PC from pms50.com (free or premium) or the Marketplace, on Xbox from the Marketplace. [2] Requires the TDS GTNXi (payware) from tdssim.com, which is PC only, plus the CowanSim TDS patch (1.3). Install the units per their own instructions; once installed, they appear in the matching CowanSim variant automatically.

The Garmin GNS 530/430 variants use the GNS units built into Microsoft Flight Simulator 2024 and need nothing extra. Every variant also carries a Garmin GTR 225-style COM radio, a GTX 330-style transponder, a Davtron air-temperature gauge and a clock (analog in the analog layout, digital in the digital layouts). The analog layout also has a GMA 350-style audio panel.

All variants share the same cockpit, engine, systems, sounds and liveries. They differ in the airframe equipment (skids, floats, spray kit) and the navigation units. Where the equipment changes the flight model, the airframes differ too. The Mariner is about 31 lb heavier, with a 95 KIAS Vne and a more restrictive aft CG limit. The Agricultural is about 92 lb heavier, with the drag of its tank and booms and its own spray system. The instrument-panel layout (analog, one navigator or two) is a setting on the tablet, not a separate variant (Chapter 9).

Career mode. The R22 is ready for Career mode in Microsoft Flight Simulator 2024. The **Default** flies **Flightseeing** and **Passenger Transport**, and the **Agricultural** flies **Agricultural Aviation**. The **Mariner** is offered no missions for now, because the simulator's Career mode does not yet support float-equipped aircraft. That is a limitation of the simulator, not of the helicopter. The Mariner flies everywhere else as usual.

1.3 Requirements and installation

- Microsoft Flight Simulator 2024 on PC or Xbox. Keep the simulator up to date. The control bindings described in this manual are those of the 2024 Controls Options.
- A joystick or cyclic, and ideally a separate collective (or throttle lever) and pedals. The R22 can be flown with a joystick whose throttle lever serves as the collective, or with an Xbox controller. A dedicated helicopter collective makes a big difference.
- Optional: PMS50 GTN 650/750 for the PMS50 variants; on PC, TDS GTNXi 650/750 and the CowanSim TDS patch for the TDS variants (below).

The CowanSim R22 Beta II is sold and installed through the Microsoft Flight Simulator 2024 Marketplace. Buy it in the Marketplace, let the simulator download and install it, and it appears in the aircraft selector under CowanSim. Updates arrive through the same channel. When a new version is published it shows up in **My Library** as an update to install. Restart the simulator after installing or updating. If a variant does not appear in the selector, check in **My Library** that the R22 package is installed and up to date, then restart the simulator.

The TDS GTNXi variants on PC

The three TDS variants are in the package but hidden, because the TDS GTNXi runs only on PC. A small patch from CowanSim.com switches them on:

1. Install the **TDS GTNXi 650/750** from tdssim.com and make sure it works in the simulator.
2. Download the **R22 TDS patch** from **CowanSim.com** and unzip it. It contains one folder, `cowansim-r-22-2024-tds-patch`.
3. With the simulator closed, copy that folder into your **Community** folder, next to your other add-ons. The simulator shows where its packages live under **Marketplace → My Library**, behind the cog icon by the search bar; the Community folder is inside that Packages folder. By default it is `%APPDATA%\Microsoft Flight Simulator 2024\Packages\Community` for the Steam version and `%LOCALAPPDATA%\Packages\Microsoft.Limitless_8wekyb3d8bbwe\LocalCache\Packages\Community` for the Microsoft Store version.
4. Start the simulator. The three TDS variants now appear in the selector (Figure 1-2).



Figure 1-2 The three TDS variants, as they appear once the patch is installed.

The patch does nothing else. It is a few lines of configuration that make the TDS variants selectable, it needs the TDS GTNXi to be of any use, and it cannot work on Xbox. Marketplace updates of the R22

leave the Community folder alone, so the patch stays installed. To hide the TDS variants again, delete the folder.

1.4 Quick start — your first flight

If you have never flown the R22 before, do these in order. Each step points to the chapter that explains it.

1. **Set up your controls** (Chapter 3). Map the collective and the throttle to *different* axes, the cyclic to `SET CYCLIC LONGITUDINAL AXIS` / `SET CYCLIC LATERAL AXIS`, the pedals to `TAIL ROTOR AXIS`, and bind the force trim release button exactly as described in section 3.4.
2. **Turn the helicopter assists off** (section 3.1): *Assisted Tail Rotor* and *Assisted Cyclic* off, Modern flight model.
3. **Pick a variant** and start on a runway or helipad in the "ready to fly" state. The engine is running, the governor is on and rotor RPM sits at 102–104%. If you have a throttle axis, push it fully open before the flight loads (3.3). (For a full cold-and-dark start from parking, follow Chapter 7.)
4. **Open the tablet** (TAB) once the flight has loaded, go to **R22 Settings** and tell the helicopter whether your stick is spring-centered (section 9.1). Pick the instrument-panel layout you prefer while you are there, and if you fly without pedals, switch **Real Tail Rotor Feel Simulation** off.
5. **Scan the panel**: all warning lights out, engine gauges in the green, CLUTCH light out, carb heat as required (section 5.1).
6. **Lift into a hover.** Raise the collective slowly. As the skids get light, hold the heading with left pedal (the nose wants to go right as power increases) and keep the stick near the center with small corrections. Hover at 3–5 ft (section 7.4).
7. **Transition to forward flight.** Lower the nose a few degrees with the cyclic; as the helicopter accelerates through 15–20 kt it will shudder slightly and want to climb (translational lift). Accelerate to 60 KIAS, then climb at 53–60 KIAS (section 7.4).
8. **Trim.** Hold the force trim release (FTR) button for a few seconds while you ease the stick back to center, keeping the attitude; release, and the helicopter stays where you put it (section 6.2). Re-trim whenever the stick load builds up.
9. **Engage the SAS** with the SAS button on the HeliSAS panel (section 6.3). At or above 44 KIAS set the heading bug and press HDG; above 200 ft AGL press ALT too, and the R22 flies itself while you manage power with the collective.
10. **Cruise** at 75–90 KIAS with rotor RPM at the top of the green arc and manifold pressure inside the limits (section 2.3). Stay below Vne: 102 KIAS (95 in the Mariner) up to 3000 ft DA, less above (placard, Figure 2-3).
11. **Approach** into wind at 60 KIAS. Slow down progressively; keep the descent below 300 ft/min before you slow through 30 KIAS, and come to a hover before touchdown (section 7.7).
12. **Shut down** (section 7.8): collective down, cool at 70–75% until the CHT drops, throttle closed, clutch disengaged; after 30 s mixture off (guard open), after 30 s more rotor brake; switches off once CLUTCH is out.



Figure 1-3 First flight: the cockpit in cruise, with this manual open on the tablet.

> **TIP** Three things make or break the R22 in the sim: a separate collective axis, the force trim bindings (3.4) and the assists being off. Get those right first.

1.5 Support

- Discord: **discord.gg/V33xywEJrT** • Email: **cowansim@outlook.com**
- Support and bug reports go through Discord or email only. Please include your simulator version, the variant and your control hardware.

2 The Robinson R22 Beta II

A short reference to the real helicopter that this product simulates. The figures come from Robinson's R22 Pilot's Operating Handbook (POH) and type-certificate data, and we tuned the simulation to them.

2.1 Description and history

Frank Robinson designed the R22 in 1973 as a simple, affordable two-seat helicopter. The prototype first flew on August 28, 1975. The FAA issued the type certificate in March 1979, and the first customer aircraft was delivered in October of that year. The design grew through the HP, Alpha and Beta models. In 1996 the R22 Beta II introduced the current engine, a Lycoming O-360-J2A derated for the R22, which restored sea-level performance at altitude and in hot weather. Close to 5,000 R22s have been built. It remains the standard primary trainer for a large share of the world's helicopter pilots.

The airframe is a welded steel-tube cabin section with riveted aluminum skins and a monocoque aluminum tailcone, on skid landing gear. The two-blade main rotor is a teetering (semi-rigid) design with coning hinges. The tail rotor is also a two-blade teetering rotor. The engine sits behind the cabin and drives the rotors through V-belts, an electrically tensioned clutch, a sprag clutch and a single-stage spiral-bevel main gearbox. The pilot sits in the right seat. The left-seat controls are removable.



Figure 2-1 The CowanSim R22 Beta II (Default airframe) on the ramp.

2.2 Specifications

Item	R22 Beta II
Seats	2 (pilot in the right seat; solo from the right seat only)
Engine	Lycoming O-360-J2A, four-cylinder horizontally opposed, carbureted, air-cooled, 361 cu in
Power (derated)	131 hp 5-minute takeoff rating; 124 hp maximum continuous, both at 2652 engine RPM (104%)
Engine RPM	2550 RPM = 100%; 2652 RPM = 104% (normal operating); 2703 RPM = 106% (transient maximum)
Main rotor	2 blades, 25 ft 2 in (7.67 m) diameter, teetering with coning hinges; 510 RPM = 100%, 530 RPM = 104%; tip speed 698 ft/s at 104%
Tail rotor	2 blades, 42 in (1.07 m) diameter, teetering; drive ratio 3:2 speed-increasing from the drive line
Drive	Two double V-belts (0.8536:1) to the upper sheave, sprag clutch, 11:47 spiral-bevel main gearbox
Fuel	Bladder tanks (as modeled): main 18.3 US gal total / 16.9 usable; auxiliary 9.7 gal / 9.4 usable; 26.3 gal usable in all. Earlier all-aluminum tanks held 19.2 / 10.5 gal usable. Gravity feed, no fuel pumps; 100LL
Oil	4 to 6 US quarts (4 qt minimum for takeoff)
Electrical	14-volt DC; 60-amp alternator; 12-volt 24 Ah battery
Maximum gross weight	1370 lb (622 kg)
Typical empty weight	880 lb (399 kg) including oil and standard avionics. The simulator shows 869.8 lb for the Default airframe because it counts the 10.2 lb of unusable fuel as fuel.
Maximum per seat	240 lb (109 kg) including the under-seat baggage compartment (50 lb max per compartment)
Never-exceed speed	102 KIAS up to 3000 ft density altitude, reduced above (see 2.3)
Cruise speed	Up to 96 KTAS at maximum gross weight
Range	Approximately 250 nm, no reserve
Hover ceiling	IGE 9400 ft at 1370 lb; OGE 5000 ft at 1370 lb (8000 ft at 1300 lb)
Maximum operating altitude	14,000 ft density altitude
Dimensions	Overall length (rotors turning) 28 ft 9 in (345 in); height to top of rotor hub 8 ft 11 in; skid width 6 ft 4 in; cabin width 3 ft 8 in

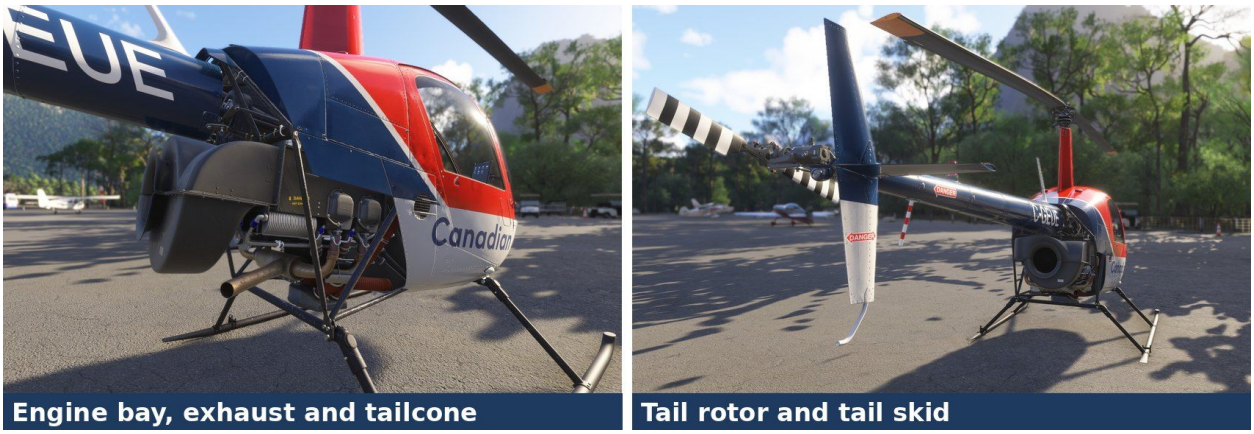


Figure 2-2 Engine bay and tailcone (left); the two-blade teetering tail rotor and tail skid (right).

2.3 Limitations

These are the real aircraft's FAA-approved limitations (POH Section 2), and we tuned the flight model to them. Let the rotor RPM decay and the rotor stalls. Load the helicopter heavily and it runs out of hover power. The simulator itself enforces only some of them. It enforces the red line (102 KIAS, 95 KIAS for the Mariner) as one fixed value at every altitude. With engine stress damage switched on (3.1), it wears the engine once manifold pressure goes above about 25 in Hg or cylinder head temperature above 500 °F. The placard manifold-pressure limits, the oil-temperature limit, the weight limits, the Vne reduction above 3000 ft and the exact CG envelope are yours to respect, as in the real aircraft.

Airspeed

Limit	Value
Vne, up to 3000 ft density altitude	102 KIAS (red line). Power on and power off.
Vne above 3000 ft density altitude	Reduced with density altitude. Read it off the Never Exceed Speed placard (KIAS by pressure altitude and OAT) on the frame above the pilot's head (Figure 2-3). The type certificate gives the schedule in calibrated airspeed: 98 KCAS up to 3000 ft, falling to 83 KCAS at 8000 ft and to 56 KCAS at 14,000 ft. The simulator's own overspeed limit stays at 102 KIAS (95 KIAS for the Mariner) at every altitude.
Doors off	No separate airspeed limit; secure loose items.
Mariner (floats)	Vne 95 KIAS power on to 3000 ft DA; 80 KIAS power off to 7500 ft DA (Mariner supplement).
Airspeed indicator	Green arc 50–102 KIAS; red line 102 KIAS.

Rotor and engine speed

Condition	Minimum	Maximum
Rotor, power on	101% (515 RPM)	104% (530 RPM)
Rotor, power off (autorotation)	90% (459 RPM)	110% (561 RPM)

Condition	Minimum	Maximum
Engine, maximum continuous	—	104% (2652 RPM)
Engine, transient	—	106% (2703 RPM). Intentional operation above 104% prohibited
Low rotor RPM warning	Horn and LOW RPM light below 97% (495 RPM). Disabled with the collective full down	
High rotor RPM warning		Warble in the headset as rotor RPM approaches 110%. In the simulation it starts at 108% (551 RPM)

Powerplant

Item	Limit
Manifold pressure	Variable limit from the Limit Manifold Pressure placard (by pressure altitude and OAT, Figure 2-3). Gauge: yellow arc 19.6–24.1 in Hg marks the variable-limit band; red line 24.1 in Hg. Separate 5-minute takeoff and continuous limits.
Cylinder head temperature	500 °F (260 °C) maximum; green arc 200–500 °F
Oil temperature	245 °F (118 °C) maximum; green arc 75–245 °F
Oil pressure	25 psi minimum at idle; 55 psi minimum in flight; 95 psi maximum in flight; 115 psi maximum during start and warm-up
Oil quantity	4 qt minimum for takeoff
Carburetor air temperature	Yellow arc −15 °C to +5 °C = icing range. Below 18 in Hg MAP the gauge does not read correctly, so apply full carb heat regardless
Fuel	100LL or other approved grades (see POH). Never use automotive fuel

Weight and balance

Item	Limit
Maximum gross weight	1370 lb (622 kg)
Minimum gross weight	920 lb (417 kg)
Maximum per seat	240 lb (109 kg) including baggage compartment
Maximum per baggage compartment	50 lb (23 kg)
Minimum solo pilot weight	130 lb (135 lb with full auxiliary fuel), or compute weight and balance. Ballast may be required
Solo flight	From the right seat only

Flight and maneuver limitations

- Aerobatic flight prohibited.

- **Low-G cyclic pushovers prohibited.** A forward cyclic pushover unloads the rotor and can cause a right roll and mast bumping. Recover with an immediate, gentle aft cyclic to reload the rotor. Only then can lateral cyclic stop the right roll (SN-11).
- Flight with the governor selected off is prohibited, except for an in-flight system malfunction or emergency procedures training.
- Flight in known icing conditions prohibited. Maximum operating density altitude 14,000 ft.
- The alternator, RPM governor, low-rotor-RPM warning system and OAT gauge must be operational for dispatch.
- Day and night VFR only.
- Wind limits (FAA AD 95-26-04 / SFAR 73): no flight with surface winds above 25 kt including gusts, gust spread above 15 kt, or continued flight in moderate or worse turbulence. These apply unless the pilot has logged 200 or more helicopter hours, at least 50 of them in the R22, and has completed the SFAR 73 awareness training. On encountering such turbulence, fly between 60 KIAS and 0.7 Vne, but no lower than 57 KIAS.

The simulated HeliSAS (Chapter 6) changes none of these limitations. The R22 stays a day and night VFR helicopter.

Placards

The cockpit carries the real aircraft's placards. **LOW-G PUSHOVERS PROHIBITED** runs along the cyclic T-bar and **SOLO FROM RIGHT SEAT ONLY** is on the cyclic. The console carries **THIS ROTORCRAFT APPROVED FOR DAY AND NIGHT VFR OPERATIONS** and **ADS-B OUT INSTALLED**. **NO STOWAGE — KEEP AREA CLEAR** is beside the collective and **FUEL CONTROL GUARD — INSTALL BEFORE TAKEOFF** is on the mixture guard. The panel at the front of the pilot's seat carries the minimum solo pilot weight placard (**135 LB WITH FULL AUX FUEL**), **LOCK AFTER PRIMING** and **IN CASE OF ENGINE FIRE PUSH HEATER CONTROL TO OFF**. The carb temperature gauge carries **KEEP NEEDLE OUT OF YELLOW ARC DURING POSSIBLE CARBURETOR ICING CONDITIONS**. There are also **NO SMOKING**, a compass correction card, the **FUEL OFF / ON** valve label, **NO STEP** and **DANGER** markings outside, and **REMOVE BEFORE FLIGHT** on the pitot cover. The **Limit Manifold Pressure** placard (maximum continuous power; add 0.9 in Hg for the 5-minute takeoff power) and the **Never Exceed Speed** placard are on the frame above the pilot's head (Figure 2-3).



LIMIT MANIFOLD PRESSURE - IN. HG

MAXIMUM CONTINUOUS POWER

PRESS ALT-FT	OAT - °C -20	-10	0	10	20	30	40
SL	21.5	21.8	22.1	22.3	22.6	22.9	23.2
2000	21.1	21.4	21.6	21.9	22.2	22.5	22.8
4000	20.7	21.0	21.2	21.5	21.8	22.0	22.3
6000	20.3	20.6	20.8	21.1	21.3	21.6	21.9
8000	19.9	20.2	20.4	20.7	20.9	FULL THROTTLE	

FOR MAX TAKEOFF POWER (5 MIN), ADD 0.9 IN. HG

NEVER EXCEED SPEED - KIAS

PRESS ALT-FT	OAT - °C -20	-10	0	10	20	30	40
SL	102					99	96
2000					98	94	91	87
4000				98	94	90	87	82	77
6000			98	94	90	87	82	77	64
8000	94	90	86	80	75	69	64	
10000	86	80	74	68	62	57		
12000	74	67	61	NO FLIGHT				
14000	61	NO FLIGHT						

Figure 2-3 The Limit Manifold Pressure and Never Exceed Speed placards on the frame above the pilot's head (top), and the same placards straightened for reading (bottom).

2.4 Instrument markings at a glance

Instrument	Markings
Airspeed	Green 50–102 KIAS; red line 102
Rotor tachometer	Yellow 60–70%; red line 90%; yellow 90–101%; green 101–104%; yellow 104–110%; red line 110%
Engine tachometer	Yellow 60–70%; red 90–101%; green 101–104%; red 104–110%
Manifold pressure	Yellow 19.6–24.1 in Hg (variable limit, see the placard, Figure 2-3); red line 24.1
Cylinder head temperature	Green 200–500 °F; red line 500 °F
Oil temperature	Green 75–245 °F; red line 245 °F
Oil pressure	Red 25 psi; yellow 25–55; green 55–95; yellow 95–115; red 115 psi
Carburetor air temperature	Yellow −15 °C to +5 °C
Fuel quantity	No arcs. F is full. At E the tank is empty except for a small quantity of unusable fuel. The faces are marked 18.3 US GAL (main) and AUX 9.7 US GAL, the total capacity of each bladder tank (16.9 and 9.4 gal usable)



Figure 2-4 The instrument panel and its markings (analog layout).

2.5 What the R22 teaches — Robinson's safety notices in one page

Robinson has published Safety Notices for four decades. They are the distilled accident record of the R22, and every one of them applies in the simulator too. These are the ones every R22 pilot should know:

Notice	Lesson
SN-10 / SN-24 Low RPM rotor stall	The primary cause of fatal accidents in light helicopters is failure to maintain rotor RPM. Rotor stall can occur at any airspeed. Once the rotor stalls, drag acts like a huge rotor brake and recovery is impossible below a few hundred feet. React to the horn immediately: roll throttle on and lower collective, together.
SN-11 Low-G pushovers	Pushing the cyclic forward after a pull-up or a rapid climb unloads the rotor. The helicopter rolls right and the rotor can strike the mast. Apply gentle aft cyclic to reload the rotor before any lateral input. Never demonstrate or experiment with low-G.
SN-25 / SN-31 Carburetor ice	Carb ice can form at outside temperatures up to 30 °C (86 °F). With the governor on, ice will not show as an RPM or manifold-pressure drop. The governor masks it until the engine quits. Keep the carb temperature gauge out of the yellow arc. When in doubt, apply carb heat.
SN-29 Airplane pilots	Fixed-wing reflexes kill in the R22. Pushing the stick forward and adding power when the low-RPM horn sounds drives the rotor RPM even lower and can stall the rotor in under a second. Lower the collective instead, and never push the cyclic forward abruptly.
SN-32 High winds and turbulence	Reduce power and fly 60–70 KIAS in turbulence. Do not over-control. The helicopter is more susceptible to turbulence at light weight.
SN-36 Overspeeds during lift-off	Always confirm the governor is on before increasing RPM above 80%. Keep a relaxed grip on the throttle and let the governor control RPM.

Notice	Lesson
SN-37 Exceeding limitations	Every second above a limit accumulates fatigue damage. Operate well below Vne, especially in turbulence.
SN-38 Practice autorotations	By 100 ft: RPM near 100%, 60–70 KIAS, rate of descent under 1500 ft/min, turns complete. Otherwise recover immediately. Limit practice to three or four consecutive autorotations.
SN-42 Unanticipated yaw	What pilots call LTE in the R22 is usually low RPM combined with high torque (over-pitching). Keep the RPM up and the yaw stays controllable.
Safety tips	Never push the cyclic forward to descend. Lower the collective instead. Reduce rate of descent before reducing airspeed to avoid vortex ring state. Never take off or land downwind. Do not use collective to slow the rotor during shutdown. Turn the strobe on before start and leave it on until the rotor stops.

3 Setting Up Microsoft Flight Simulator 2024

Ten minutes in the Options menus decide whether the R22 flies like a helicopter or fights you all the way. This chapter lists the settings to use and the names to search for in the 2024 Controls Options.

3.1 Simulator settings

Flight model

General Options → Flight Model → MODERN. Helicopter aerodynamics exist only in the Modern flight model. Never use Legacy with this aircraft.

Assistance options

Open **Assistance Options** and set the piloting assists as follows. The arrows under the menu bar switch between the *Default Assists* and *All Assists* presets. Pick Default, then change the individual items.

Assistance option	Setting	Why
Assisted Tail Rotor	OFF	With it on, the simulator holds your heading for you and fights your pedals. The R22 needs real pedal work.
Assisted Cyclic	OFF	With it on, the simulator keeps pushing the helicopter toward a hover attitude and makes force trim and SAS behave strangely.
Vortex Ring State Protection	OFF (recommended)	An optional 2024 assist that moves the collective for you to avoid settling with power. Turn it on only if you want the help. It will override your collective.
Auto-rudder	OFF	Airplane assist; interferes with the tail rotor.
Assisted yoke / AI auto-trim / assisted takeoff and landing	OFF	Not applicable to a helicopter and can inject control inputs.
Crash damage, engine stress damage	As you prefer	With them on, hard landings count, and running the engine above about 25 in Hg or 500 °F CHT wears it out.

The assistance labels may be worded a little differently between simulator updates. Look for the words *tail rotor*, *cyclic* and *vortex ring* in the Piloting group.

3.2 How control presets work in MSFS 2024

Open **Options → Controls**. The 2024 Controls page is organized per device. Select your stick, collective or pedals in the list on the left and you will see **three presets** for that device:

- **General Controls** holds cameras, menus, the player character and the EFB.
- **Helicopter Controls** holds everything for flying and operating the R22: cyclic, collective, tail rotor, throttle, trim, governor, clutch, rotor brake. Airplanes use a separate *Airplane Controls* preset, so your fixed-wing bindings are untouched.
- **Specific <aircraft> Controls** holds bindings that apply to the selected aircraft only.

Load or select the R22 first, so the Helicopter Controls preset is the one you are editing. Use the cog (gear) icon on a preset row to **Duplicate** the default preset and give it a name such as *R22 – Collective*. The simulator remembers which preset you selected for each aircraft. Leave the page with **Save and Back**.

- To find a binding, click the **magnifying glass** (search by name) and type part of the name shown in the tables below. Or use **Search by input** and press the button or move the axis you want to assign.
- The **filter** button at the bottom cycles *None* → *Assigned* → *Essential*. Use *None* to see everything.
- Click an action's input box → **Start Scanning** → press the button or move the axis → **Validate**.
- Click the **cog** next to an assignment to open **Actions Settings**. For a button you will find **Input Repetition** and **Set Control On Release**. For an axis, **Invert axis** and **Tweak action curve**.
- A number next to an assignment means the same input is used by more than one action. The force trim (3.4) needs that. Everywhere else, resolve it.

3.3 Flight-control axes

> **WARNING** Map the **collective** and the **throttle** to *different* axes. In a helicopter you control power and height with the collective. The governor handles the throttle (twist grip). If you have only one lever, use it for the collective and leave the throttle unbound. Roll the twist grip with the mouse when you need it.

Function	Search for (2024 label)	Category	Notes
Collective	`COLLECTIVE AXIS`	POWER MANAGEMENT › COLLECTIVE	Invert if needed so that raising your lever raises the collective. Verify with the tooltip on the cockpit collective: 0% fully down, 100% fully up.
Throttle (twist grip)	`SET HELICOPTER THROTTLE AXIS`	POWER MANAGEMENT › THROTTLE	Dedicated axis only. Full forward/open for flight; the governor trims it.
Cyclic fore/aft	`SET CYCLIC LONGITUDINAL AXIS`	FLIGHT CONTROL SURFACES › PRIMARY CONTROL SURFACES	Forward = nose down. If the cockpit stick moves the wrong way, invert.
Cyclic left/right	`SET CYCLIC LATERAL AXIS`	as above	
Anti-torque pedals	`TAIL ROTOR AXIS`	as above	Left pedal = nose left. Invert if the cockpit pedals move the wrong way.
Pedals on buttons	`INCREMENT TAIL ROTOR` / `DECREMENT TAIL ROTOR`	as above	For sticks without a twist (yaw) axis; coarse.
Collective on buttons	`INCREMENT COLLECTIVE` / `DECREMENT COLLECTIVE`	POWER MANAGEMENT › COLLECTIVE	Small steps; usable but not recommended.

Real Tail Rotor Feel Simulation in the R22 Settings app (9.1) is ON by default. The tail rotor then needs more pedal input, for the feel of the real one. We meant it for anti-torque or rudder pedals. With a twist stick or pedals on buttons, switch it OFF and your input goes straight through.

The airplane axes (`AILERONS AXIS`, `ELEVATOR AXIS`, `RUDDER AXIS`, `THROTTLE AXIS`) also drive this aircraft, so a fixed-wing profile will fly it. `THROTTLE AXIS` moves the **collective**, not the twist grip. Do not bind both the helicopter and the airplane version of the same axis, and never bind `THROTTLE AXIS` and `COLLECTIVE AXIS` to different levers.

> **CAUTION** If you bind a throttle axis, **park it fully open in flight**, and before you load a flight that starts with the engine running. If the lever sits below the governor's setting, the governor holds the twist grip above it. But any movement of the axis of half a percent or more then counts as a deliberate roll-down and hands the throttle back to your lever (5.2). A lever left half-way and nudged by accident will chop the power.

Sensitivity

There is no single "realistic" curve. Hardware, desk height and stick length differ for everyone. The cyclic and collective pass straight through. Only the tail rotor is shaped, by the Real Tail Rotor Feel Simulation option above. Set the curves per action with **Tweak action curve**. They are saved with the profile, so your airplanes keep theirs. A good starting point for a short desktop stick is sensitivity −30% on both cyclic axes and the tail rotor, dead zone 0–2%, neutral 0, extremity dead zone 0–2%. Long-throw cyclics and pedals usually want a linear curve. Keep the collective linear.

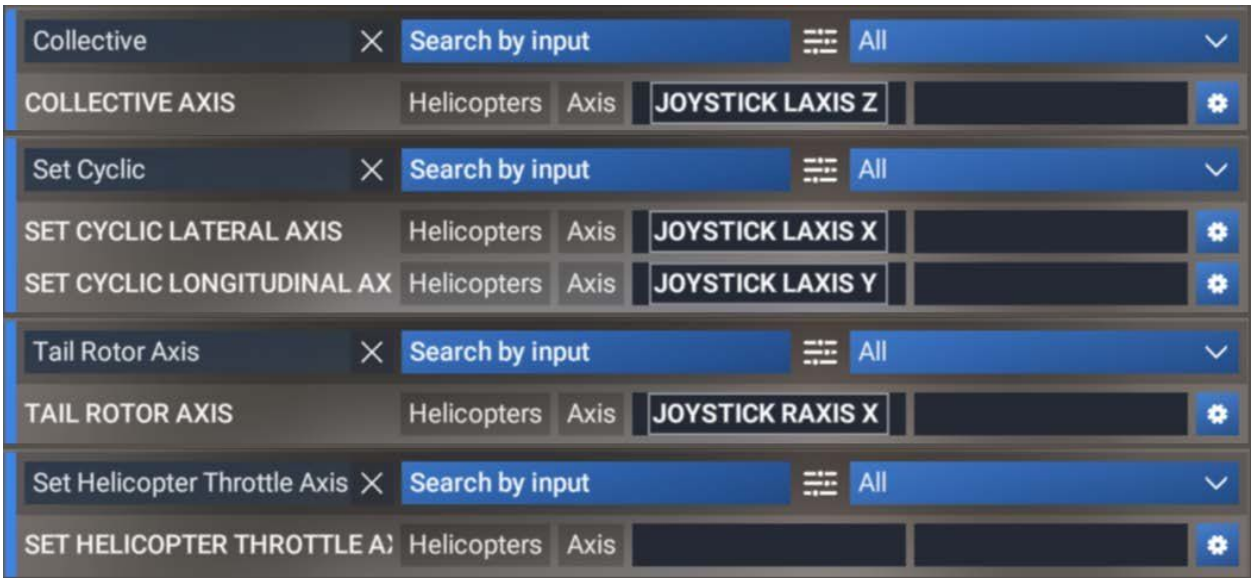


Figure 3-1 The four axes in the 2024 Controls Options: collective, cyclic (both axes) and tail rotor, with the helicopter throttle axis left unassigned when there is no separate lever for it.



Figure 3-2 What the axes drive: the collective with its twist grip, between the seats (left), and the T-bar cyclic (right).

3.4 Force trim release — read this twice

We built the force trim in the R22 to work like a real HeliSAS force trim (Chapter 6). So that the button responds instantly on every type of hardware, it uses **two** simulator bindings **on the same physical button**:

1. Search for **force trim** and assign your FTR button to `SET HELICOPTER FORCE TRIM RELEASE BUTTON` (FLIGHT CONTROL SURFACES › CONTROL TRIMMING SURFACES). Open its cog → Actions Settings and make sure **Input Repetition** is **ON** (it is on by default). Leave *Set Control On Release* unticked here.
2. Search for **quick trim** and assign the **same button** to `QUICK TRIM` (TOOLS › SIMULATION SHORTCUTS). Open its cog and **tick Set Control On Release**.
3. Save and Back. A conflict marker appears because one button has two actions. Leave it.

Binding	Options	What it does in the R22
`SET HELICOPTER FORCE TRIM RELEASE BUTTON`	Input Repetition ON	Tells the aircraft the button is held. The repeat keeps the release "alive" while your finger is on it.
`QUICK TRIM` (same button)	Set Control On Release ✓	Fires the instant you let go, so the trim locks where you released. No half-second lag on a quick tap.
`ROTOR TRIM RESET`	optional, separate momentary button	Not a force trim. Zeroes both trims and returns the cyclic reference to neutral. Useful after an odd trim state. Never on a latching switch.
`INCREASE` / `DECREASE ROTOR LONGITUDINAL TRIM`, `INCREASE` / `DECREASE ROTOR LATERAL TRIM`	optional, four-way hat, Input Repetition ON	Beep trim: nudges the trim nose-up/down, left/right while held. With the SAS engaged the same hat nudges the attitude the SAS is holding, 0.1° per click (6.2).

CAUTION Do **not** assign `SET ROTOR LONGITUDINAL TRIM` or `SET ROTOR LATERAL TRIM` (the trim *axes*) to anything. An axis at rest keeps sending its value. It will silently force the trim back to zero, and the force trim will appear broken.

IN THE SIM Why two bindings? The simulator repeats the force-trim event while the button is held. The aircraft keeps the release active for a short safety interval after the last repeat. Without the second binding, a release in the first half-second of a press would register only when that interval ran out. `QUICK TRIM` on release closes that gap. The aircraft intercepts the simulator's own "quick trim" function, so it does nothing else here.

3.5 Buttons and switches

Apart from the force trim release (3.4), none of these are mandatory. Every control fitted in the cockpit can be clicked. The governor, clutch and HeliSAS buttons are worth having on hardware, and AP DISC exists only as a binding.

Engine, drive and rotor

Function	Search for (2024 label)	Category	Notes
Governor switch	`TOGGLE ENGINE GOV SWITCH`	INSTRUMENTS AND SYSTEMS › FLIGHT INSTRUMENTS	Also `ROTOR GOVERNOR SWITCH ON` / `OFF` for a two-position switch. The bindings move the cockpit GOV switch; ON also hands the throttle back to the governor after a twist-grip override (5.2).
Clutch switch	`TOGGLE ROTOR CLUTCH SWITCH`	POWER MANAGEMENT › ROTOR CLUTCH	`SET ROTOR CLUTCH SWITCH` for a latching switch.
Rotor brake	use the cockpit handle (4.6)	—	The handle applies the rotor brake, lights BRAKE and is released by the starter. The simulator's own `TOGGLE ROTOR BRAKE` (Ctrl+/) also brakes the rotor. The handle and the BRAKE light do not show it, and the starter does not release it. If you use it, release it with the same key.
Key switch — start	`MAGNETOS START`	INSTRUMENTS AND SYSTEMS › ENGINE INSTRUMENTS	Each press runs the starter for about three seconds and the key returns to BOTH. Press again if the engine has not caught.
Key switch — positions	`MAGNETOS OFF` / `MAGNETOS RIGHT` / `MAGNETOS LEFT` / `MAGNETOS BOTH`	as above	`INCREASE MAGNETO` / `DECREASE MAGNETO` step through OFF-R-L-BOTH.
Mixture	`MIXTURE AXIS (0 TO 100%)`, or `SET MIXTURE RICH` / `SET MIXTURE LEAN`	POWER MANAGEMENT › MIXTURE	Full lean = idle cut-off (engine stop). The guard does not lock it. The mixture moves with the guard open or closed (4.3).
Carburetor heat	`TOGGLE ANTI ICE`	INSTRUMENTS AND SYSTEMS › ANTI ICE	The knob is gradual in the cockpit. `SET ENGINE 1 GRADUAL ANTI ICE` accepts an axis.

Function	Search for (2024 label)	Category	Notes
Primer	`TOGGLE PRIMERS`	INSTRUMENTS AND SYSTEMS › FUEL	
Fuel shut-off valve	`TOGGLE ENGINE 1 FUEL VALVE`	INSTRUMENTS AND SYSTEMS › FUEL	
Throttle on buttons	`INCREASE` / `DECREASE HELICOPTER THROTTLE`, `CUT` / `FULL HELICOPTER THROTTLE`	POWER MANAGEMENT › THROTTLE	DECREASE and CUT override the governor like a hand rolling the grip down (5.2). INCREASE and FULL are ignored while the governor is governing.

Electrical, lights and other systems

Function	Search for (2024 label)	Category	Notes
Battery	`TOGGLE MASTER BATTERY`	INSTRUMENTS AND SYSTEMS › ELECTRICS	
Alternator	`TOGGLE MASTER ALTERNATOR`	as above	
Avionics master	`TOGGLE AVIONICS MASTER`	INSTRUMENTS AND SYSTEMS › FLIGHT INSTRUMENTS	Optional. There is no avionics switch in the cockpit, and the avionics come on with the battery. The binding switches them all off and on (HeliSAS included, not the electric attitude indicator). Nothing in the cockpit shows its position.
Strobe / anti-collision	`TOGGLE STROBES`	LIGHTS › EXTERIOR LIGHTS	The STROBE switch drives the red anti-collision light on the tailcone. Use this binding, not `TOGGLE BEACON LIGHTS`, which the aircraft overrides.
Navigation (position) lights	`TOGGLE NAV LIGHTS`	as above	
Landing lights	`TOGGLE LANDING LIGHTS`	as above	Switch is on the cyclic center post.
Night-vision goggles	`TOGGLE NIGHT VISION`	—	Z on the PC keyboard by default. On Xbox, assign a button (5.8).
ELT	`TOGGLE ELT`	INSTRUMENTS AND SYSTEMS › FLIGHT INSTRUMENTS	Starts and stops a transmission directly. The cockpit remote switch does not move, and nothing transmits with the ELT unit at OFF (5.10).
Spray kit	`SPRAY ON` / `SPRAY OFF` / `TOGGLE SPRAY`	—	Agricultural variants. Spray on also starts the pump. Spray off leaves it running (9.7).

HeliSAS (stability augmentation and autopilot)

HCP button / cyclic switch	Search for (2024 label)	Category	Notes
SAS (engage / disengage)	`TOGGLE AUTOPILOT MASTER`	AUTOPILOT › GENERAL	Same as the SAS button on the control panel.
HDG	`TOGGLE AUTOPILOT HEADING HOLD`	AUTOPILOT › HEADING	
NAV	`AUTOPILOT NAV1 HOLD`	AUTOPILOT › NAV	Note: no "TOGGLE" prefix in the 2024 list.
SPD	`AUTOPILOT AIRSPEED HOLD`	AUTOPILOT › AIRSPEED	
ALT	`TOGGLE AUTOPILOT ALTITUDE HOLD`	AUTOPILOT › ALTITUDE	
VRT	`TOGGLE AUTOPILOT VS HOLD`	AUTOPILOT › VERTICAL SPEED	VRT couples the glideslope/glidepath. It is not a vertical-speed mode. It re-uses that binding.
AP DISC (cyclic)	`AUTOPILOT OFF`	AUTOPILOT › GENERAL	First press drops every autopilot mode and leaves the SAS engaged. Pressed with no mode armed or active, it disengages the SAS (6.3). The cockpit grip has no AP DISC button, so bind it.
Heading bug	`INCREASE HEADING BUG` / `DECREASE HEADING BUG`	INSTRUMENTS AND SYSTEMS › FLIGHT INSTRUMENTS › HEADING BUG	Moves the heading bug on the directional gyro, the HDG target.
Altimeter setting	`INCREASE ALTIMETER` / `DECREASE ALTIMETER`	KOLLSMAN	The quick-set `SET ALTIMETER` (TOOLS › SIMULATION SHORTCUTS) sets local pressure in one press.

> **FROM COWANSIM** The simulator's own autopilot does nothing in a helicopter, so we wired the HeliSAS to listen to these bindings directly. They work only once its five-second self-test after power-up has finished (6.3).

The "on" versions (`AUTOPILOT HEADING HOLD ON`, `AUTOPILOT ALTITUDE HOLD ON`, `AUTOPILOT AIRSPEED HOLD ON`) engage a mode without toggling it. Use them for a button that should only ever switch the mode on. You drop the mode with the HCP button or AP DISC. `AUTOPILOT ON` engages the SAS without toggling it.

3.6 Cameras, walkaround and click spots

Cockpit camera

The R22 cockpit is small and the panel is low, so a good camera setup matters. The useful General Controls bindings sit under TOOLS › CAMERA › COCKPIT CAMERA: `TRANSLATE COCKPIT VIEW`

`FORWARD / BACKWARD / LEFT / RIGHT`, `INCREASE / DECREASE COCKPIT VIEW HEIGHT`, `ZOOM / UNZOOM COCKPIT VIEW`, `RESET COCKPIT VIEW`, and `SAVE CUSTOM CAMERA 0–9 / LOAD CUSTOM CAMERA 0–9`. Save one camera on the instrument panel, one on the console switches, one on the HeliSAS panel and one looking at the collective. The 2024 keyboard ships with two presets. Check which one you use before relying on the default keys.

Walkaround

When you start a flight from a **parking spot**, the R22 is cold and dark and you normally begin outside the helicopter as the pilot character. Walk around it, remove covers and tie-downs, open the cowl panels, check the oil and fuel (Chapter 9), then open the pilot's door with its handle. Opening the door does not put you in the seat. Click the **enter** spot that appears in the open doorway to climb in. With the pilot's door removed, the enter spot is always there. The door stays open until you close it, so you can leave it open while you work through the test buttons and switches.

From a **runway or helipad** the simulator starts you in the cockpit with the engine running. Helipads currently do not offer a cold-and-dark start. To get out, open the pilot's door from inside and click the **exit** spot in the doorway. Or use the `TAKE CONTROL OF CHARACTER` binding (default Shift+C on PC). While outside, the pilot character's keys apply: `W A S D` to move, `E` to interact.

Click spots and tooltips

Every switch, lever, knob and handle in the cockpit is clickable, and most have tooltips. Hover to see the name and current state. Click, drag or scroll to operate. Turn **instrument tooltips** on in the accessibility options if you do not see them. The enter and exit spots in the pilot's doorway are invisible until you hover over them, when they light up. The force trim release and AP DISC are the exceptions. They are hardware buttons, not click spots.

VR

The R22 flies in VR. With motion controllers you can take hold of the cyclic and the collective and fly with them. The click spots work with the controllers as they do with the mouse.

Tablet (EFB)

Press **TAB** or click the tablet in the cockpit to open the EFB. Use it for fuel and payload (the Mass and balance page), the R22's own interactive **checklist** in the simulator's Checklist app (Figure 3-3) and flight planning. The **R22 Settings** app holds the panel layout, slip ball, doors, tablet mount and bugs, the stick, **Auto Trim** and tail-rotor settings, the covers and the ground-handling wheels (9.1). The **R22 Manual** app has this manual (9.1). The tablet sits on a mount at the top of the panel. See 4.7 for moving it.

The **Checklist** app carries the R22's own checklist, 17 pages from the preflight inspection to securing the helicopter. There is a page for the coupled HeliSAS approach and extra items on the Mariner and the Agricultural variant. Pick the level at the top. **Standard** has the items that set up the simulated helicopter. **Advanced** adds the interactive walkaround and cockpit items. **Expert** adds the real-world checks that have no simulated effect. Each item names the control, shows the state it expects and, where it helps, gives a line of advice. The eye button highlights the control in the cockpit, and many items swing the camera to it.



Figure 3-3 The tablet: the app page, with R22 Manual and R22 Settings beside the simulator's own apps (left; CIVA INS is a separate add-on), and the R22 checklist in the Checklist app, with its hint text and highlight buttons (right).

4 Cockpit Tour

The R22 cockpit is tiny and logical. The warning-light strip and the flight instruments sit in the panel at the top. The engine instruments and four more lights are on the console below, the switches around the pilot's left hand, the avionics stack in the center. Everything that matters in flight is on the two sticks. This chapter walks through it panel by panel.



Figure 4-1 The cockpit from the pilot's (right) seat in the DIGITAL ×1 layout: instrument panel, console, the T-bar cyclic with the pilot's grip (right), and the tablet on its mount, open at R22 Settings.

4.1 Instrument panel

The upper panel carries the flight instruments, the console below it the engine instruments. The numbers refer to Figure 4-2.



Figure 4-2 Instrument panel and upper console (digital layout shown; the analog layout has a conventional attitude indicator and an analog clock at position 10).

#	Instrument	What it shows / how to use it
1	Warning and caution lights	CLUTCH, MR TEMP, MR CHIP, CARBON MONOXIDE (not used), STARTER ON, TR CHIP, LOW FUEL, LOW RPM. See 4.2.
2	Vertical speed indicator	±2000 ft/min.
3	Attitude indicator	Analog layout: conventional attitude gyro with a horizon-bar adjustment knob. Digital layouts: RCA 2610 electric attitude indicator with two brightness buttons (DIM) and its own power-up sequence. It needs the GAUGES breaker and panel power. Optional slip ball (9.1).
4	Airspeed indicator	Knots (outer scale) and mph (inner scale). Green 50–102, red line 102 KIAS. In the real aircraft the indication is unreliable below about 20 kt.
5	Dual tachometer	Two needles on one dial: Engine (left) and Rotor (right) in percent. In powered flight the needles are joined ("married") at 102–104%. They split when the sprag clutch frees the rotor (autorotation, throttle chop). Each needle has its own breaker (TACHS E, TACHS R, 4.8). With the battery and alternator off they keep reading through a bypass as long as the clutch switch is at ENGAGE (8.6).
6	Altimeter	Three-pointer altimeter. Kollsman window 28.9–31.1 in Hg; turn the knob (or scroll) to set pressure.
7	Directional gyro	Heading card with a heading bug, the target for the HeliSAS HDG mode. The left knob (PUSH) aligns the gyro to the compass. The right knob (HDG) moves the bug.
8	Manifold pressure	5–35 in Hg. Yellow arc 19.6–24.1 is the variable-limit band, red line 24.1. This is your power gauge. Raise the collective and MAP rises.

#	Instrument	What it shows / how to use it
9	Carburetor air temperature	−30 to +30 °C with the yellow icing arc −15 to +5 °C. Placard: keep the needle out of the yellow arc during possible icing conditions. Below 18 in Hg MAP ignore it and use full carb heat.
10	Clock / voltmeter	Digital layouts: a digital clock that also shows bus voltage, UT, local time, flight and elapsed time (SELECT / CONTROL buttons). Analog layout: an analog clock.
11	Ammeter	−70 to +70 A battery charge / discharge meter. Positive means the alternator is charging the battery, negative means the battery is being drained. With the alternator off or failed it swings negative and the ALT light comes on.
12	Oil pressure	psi. Red line 25, green 55–95, red line 115. Must show 25 psi within 30 seconds of start.
13	Auxiliary fuel	E to F. No arcs. The LOW FUEL light is the final warning. The real aux tank empties first; in the simulation both tanks feed together (5.6).
14	Main fuel	E to F. At E only the unusable fuel is left. Treat a needle near E as an empty tank.
15	Oil temperature	°F. Green 75–245, red line 245.
16	Cylinder head temperature	°F. Green 200–500, red line 500.
17–19	ALT, OIL, GOV OFF lights	See 4.2. OIL is red; the others amber.
20	BRAKE light	Rotor brake applied.
21	PANEL LTS DIM knob	Instrument-lighting brightness. Drag or scroll. In the real aircraft the instrument lights come on with the NAV LTS switch. In the simulation they are on whenever the panel has power, so turn the knob down to dim them.
22	Switch cluster	NAV LTS, STROBE, CLUTCH, ALT, MASTER BATTERY and the key switch. See 4.3.

Three items are not numbered. The **Davtron air-temperature gauge** is on the console face, with its °F/°C switch. The **magnetic compass** above the panel swings with rotor vibration. The **yaw string** on the bubble is the R22's slip indicator. Keep it centered.

4.2 Warning and caution lights

The light strip sits at the top of the panel, directly in the pilot's view. ALT, OIL, GOV OFF and BRAKE are on the console. The four gearbox and fuel lights (MR TEMP, MR CHIP, TR CHIP, LOW FUEL) have push-to-test buttons in the engine bay (9.2). The others are checked functionally: OIL and ALT are on before start, STARTER ON while cranking, CLUTCH while the belts tension, GOV OFF with the switch off, BRAKE with the brake on, LOW RPM at the run-up horn check. All of them need the WARN LTS breaker in. Meanings and the POH actions:

Light	Means	Action
LOW FUEL (amber)	About 1.5 gallons of usable fuel left, roughly ten minutes at cruise power. The test button also lights it.	Land as soon as practical. Never use it as a fuel gauge.
MR CHIP	Metal particles on the main gearbox chip detector.	Land as soon as practical, or immediately if accompanied by noise, vibration or temperature rise.
TR CHIP	Metal particles on the tail gearbox chip detector.	As above.

Light	Means	Action
LOW RPM (with horn)	Rotor RPM below 97%. Silent with the collective full down.	Immediately lower collective, roll throttle on, and in forward flight apply aft cyclic.
MR TEMP	Main gearbox over-temperature (test only in the simulation).	Land as soon as practical, or immediately with other symptoms.
OIL (red)	Engine oil pressure below 25 psi. The engine has stopped, or oil pressure is lost.	Check the tach for power loss and the oil pressure gauge. If pressure is gone, land immediately.
STARTER ON	Starter motor engaged.	If it stays on after releasing the key: mixture off, battery off.
CLUTCH	The clutch actuator is running, tensioning the belts after ENGAGE or releasing them after DISENGAGE.	Normal after engaging and after disengaging. Wait for it to go out before takeoff, and at shutdown before you switch the battery off. If it comes on in flight and stays on more than 10 seconds, pull the CLUTCH START breaker and land as soon as practical. Land immediately, ready to autorotate, if there are other signs of a drive-system failure.
GOV OFF	Governor switch is off. It does not light when the governor is inactive below 80% RPM, overridden by the twist grip, or stopped by a pulled GOV breaker.	Switch it on before increasing RPM above 80%. Flight with the governor selected off is prohibited, except for an in-flight system malfunction or emergency procedures training.
BRAKE	Rotor brake handle is applied.	Release before starting. Release immediately if seen in flight.
ALT	Low voltage. The alternator is off line: switch off, ALT breaker pulled, alternator failed, or the engine not running.	Reduce load. Alternator switch off, then on after one second. If it stays on, land as soon as practical, since the tachometers depend on electrical power.
CARBON MONOXIDE	On the real aircraft the carbon-monoxide detector comes with the heater. It is not modeled and never lights.	



Figure 4-3 Battery on at night before start: caution lights on the console, and the instrument lighting on with panel power.

4.3 Console and switch panel

The switch cluster sits on the console face, under the instruments. The numbers refer to Figure 4-4.



Figure 4-4 The console switch panel, with the Davtron air-temperature display below it.

#	Control	Positions / function
1	Carburetor air temperature gauge	See 4.1.
2	Clock / voltmeter	Digital clock with bus voltage (analog clock in the analog layout).
3	PANEL LTS DIM knob	Instrument-lighting brightness.
4	BRAKE light	Rotor brake applied.
5	NAV LTS, STROBE	Position lights, and the red anti-collision light on the tailcone. STROBE on before start, off after the rotor stops.
6	CLUTCH (red guard)	DISENGAGE / ENGAGE. Engaging at low RPM tensions the belts while the CLUTCH light is on, up to about 40 seconds. Disengage during shutdown.
7	ALT	Alternator field ON / OFF. ON after start. With the engine stopped the ALT light stays on.
8	MASTER BATTERY	Battery master (red). ON before start. It powers the main bus.
9	Key switch	OFF – R – L – BOTH – START. Hold START to crank. The key springs back to BOTH. In the real aircraft the starter is inhibited while the rotor brake is applied. In the simulation, cranking releases the brake.

#	Control	Positions / function
10	CABIN AIR pull knob	Opens the nose vent. It animates and sounds, but there is no cabin temperature model. The CABIN HEAT knob is on the panel at the front of the pilot's seat (Figure 4-6).
11	Davtron air temperature	Outside air temperature. The switch beside it selects °F or °C.

Elsewhere on the console and around the cyclic post (Figure 4-5):

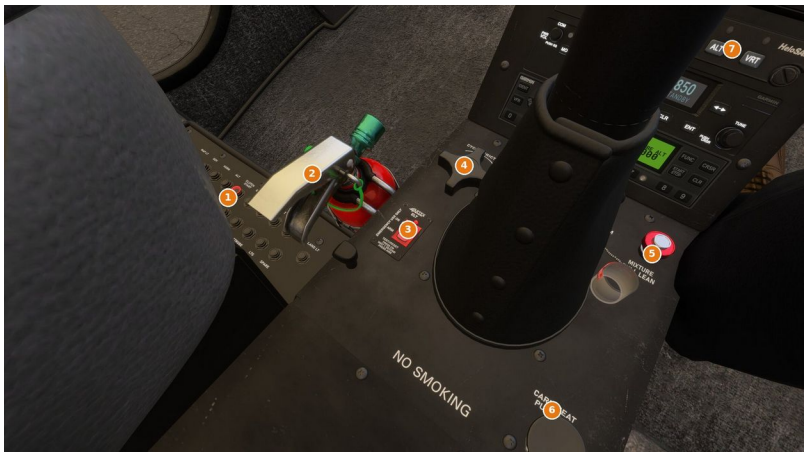


Figure 4-5 Around the cyclic post: breaker panel (1), fire extinguisher (2), ELT remote switch (3), cyclic friction (4), mixture with its guard open (5), carb heat (6) and the edge of the HeliSAS panel (7).

Control	Function
MIXTURE PULL LEAN (with guard)	Red knob right of the cyclic post, under a flip-up guard. Pulled = idle cut-off. The guard is a cover, not a lock. The knob, a mixture axis and the mixture keys all move the mixture with the guard open or closed, engine running or not. Leave it full rich in flight. In-flight leaning is not recommended (7.5).
CARB HEAT PULL	Push-pull knob, gradual. Pull as much as you need to keep the carb temperature out of the yellow arc.
Cyclic friction knob	Forward of the cyclic post. Drag to set. Neither friction affects your hardware. The cyclic friction is a position only. The collective friction scales how fast the mouse drags the collective (100% = locked). Frictions OFF for flight.
PULL RT TRIM	Pull knob beside the avionics stack. It engages the real R22's lateral trim spring, which offsets the left stick force at cruise speed. Pulling it adds a fixed right trim (about 1.8%) to whatever trim you have. Pushing it in takes the same amount away again. Pull it in cruise, push it in for hover and approach.
ELT remote switch	Artex-style remote, ARM / ON, with a flashing light and a warning tone when the ELT transmits. The unit itself is in the engine bay (9.2).
Primer	Plunger forward of the pilot's seat. Click to pump. The real aircraft takes two or three strokes for a cold engine. The simulation starts without priming.
FUEL valve	Red toggle on the frame behind the left seat, OFF / ON (the tooltip says *Closed / Open*). OFF stops the engine in about a minute.
Heater blower	Switch on the panel at the front of the pilot's seat, beside the hour meter, the primer and the CABIN HEAT knob. The blower is audible when running and has its own breaker (HEATER).

Control	Function
Map light	Overhead, with its own HIGH – LOW – OFF switch beside it. Clicking the light toggles it at the brightness the switch last set, so after a cold-and-dark start set the switch first. Click-and-drag to aim it. The console floods follow the PANEL LTS DIM knob.
SOLO pin	Removes / installs the left-seat (dual) controls (9.4).
Seat	Click the seat to shift your seating position (9.4).
Headset	Click it to put it on or hang it back on its hook (tooltip *Headset — Put on / hang up headset*, showing *Worn* or *On hook*). Worn, it turns the engine, rotor and wind noise down (5.10).



Figure 4-6 The fuel shut-off valve behind the left seat (left), and the panel at the front of the pilot's seat (right): cabin heat knob (1), heater blower switch (2), primer (3) and hour meter (4).

4.4 Cyclic (T-bar)

The R22's cyclic is a T-bar pivoting on a center post between the seats, with a grip for each seat. In the CowanSim R22 the pilot's grip carries the COM buttons. The force trim and autopilot-disconnect buttons of a HeliSAS grip are buttons on your own hardware.

The force trim release (**FTR**) is the hardware button you bound in 3.4. There is no click spot for it. Hold it to re-trim (Chapter 6). **AP DISC** is the HeliSAS disconnect, also a hardware binding (`AUTOPILOT OFF`, 3.5). The first press drops every autopilot mode and leaves the SAS engaged. Pressed again, or with no mode armed or active, it disengages the SAS (6.3).

The four trim bindings of 3.4 act as a four-way trim hat (nose up/down, roll left/right) for small attitude changes without touching the FTR. The real R22 has no trim hat. This one models the HeliSAS beep-trim switch.

On the cyclic itself:

- **CH SEL** flips the active and standby COM frequencies. **FREQ −/+** step the **active** frequency down and up in 25 kHz steps and repeat while held.
- **Landing light switch** on the cyclic center post.
- **Spray control box** (Agricultural variants) rides on the cyclic in front of the pilot (9.7).

A hidden click spot on the pilot's side of the T-bar **hides the cyclic** for a clear view of the panel. Hover to find it, click again to bring it back. The stick animation follows your hardware plus the trim, with the slight once-per-revolution wobble of a real R22 during run-up.



Figure 4-7 The pilot's cyclic grip: FREQ –/+ and CH SEL for the COM radio.

4.5 Collective and throttle

The collective lever on the pilot's left carries the **twist-grip throttle** (THROTTLE OPEN arrow), the **GOV OFF/ON** switch on its tip and the **FRICTION INCREASE** lever at its base. Both frictions start half on at the first flight and are remembered afterwards (9.1). With the collective friction on, the lever is slower to drag with the mouse.

Twist the grip with the mouse (drag or scroll) to roll the throttle on and off. The tooltip shows the throttle percentage. With the governor on, the grip turns on its own as the governor trims the engine, as the real grip does under your hand. Rolling the grip *down* yourself overrides the governor (5.2). The copilot's collective and grip move with the pilot's and disappear when the dual controls are removed.



Figure 4-8 The collective: twist grip with its THROTTLE OPEN arrow, GOV switch on the tip, friction lever at the base.

4.6 Pedals, rotor brake and doors

The **anti-torque pedals** are fully animated. The copilot's pedals are removed with the dual controls.

The **rotor brake** is a pull handle overhead, above and behind the pilot's left shoulder, marked BRAKE. It works like the real one and brakes the rotor. **Pull sideways and hold** to brake; it springs back when you let go. **While holding it, pull down** to latch it on. On a fresh press, **push up** to release the latch. A plain click does nothing. The **BRAKE** light shows whenever the brake is applied. Cranking the starter releases it (the real aircraft inhibits the starter instead).

Doors open and close with a click on the handle, inside or out. Opening the pilot's door does not move you. A separate **enter** spot appears in the open doorway when you are outside, and an **exit** spot when you are inside. With the pilot's door removed, both are always there. Doors can be removed and refitted (9.3). An open or removed door lets the outside sound in.

Seats and the headset are covered in 4.3 and 9.4.



Figure 4-9 The rotor brake handle overhead: pull and hold, pull down to lock, push up to release.



Figure 4-10 Anti-torque pedals seen from the pilot's seat, with the blue R22 Pilot's Handbook folder (the tablet pocket) beside them.

4.7 Tablet (EFB) mount

The simulator tablet either sits on a suction mount at the top of the panel or is stowed in its pocket, the blue **R22 Pilot's Handbook** folder on the floor beside the pilot's pedals (Figure 4-10). Click the folder (tooltip *Tablet pocket*) to move the tablet between the pocket and the mount. On the mount, drag the **upper jaw** (*Adjust tablet*) to slide the tablet up/down and left/right. Drag the **second jaw** (*Rotate tablet*) sideways to turn it. Put it where it does not block the instruments. If you hide the tablet with its own side button, clicking the suction mount brings it back. The R22 Settings app can also stow the tablet and hide the mount (9.1). The tablet still opens with TAB.



Figure 4-11 The tablet on its suction mount, seen through the open pilot's door, with its pocket, the folder, in the footwell below.

4.8 Circuit breakers

The breaker panel is on the ledge forward of the left seat, as in the real aircraft. Click a breaker to pull or push it. The tooltip names each one and shows *Pushed in / Pulled out*. In flight, resetting breakers is not recommended.

Main bus	Avionics bus
MAP LT • GOV • HORN (low-RPM horn and light) • ALT (alternator field) • CLUTCH START (starter and clutch actuator) • GAUGES • WARN LTS • TACHS E (engine tach) • TACHS R (rotor tach) • HEATER (blower) • STROBE • NAV LTS (position and instrument lights) • SPARE • LAND LT • 28V CONV (not fitted)	AUDIO PANEL • 28V CONV (not fitted) • GPS • XPDR • R/ALT (radar altimeter, not fitted) • COM NAV (the COM radio)

> **FROM COWANSIM** We wired every breaker to cut what its label says, so pulling one is the way to practice a failure.

HORN silences the low-RPM horn and the LOW RPM light. **WARN LTS** darkens every warning light. **GAUGES** takes the instrument lighting, the air-temperature display, the electric attitude indicator, the HeliSAS lights and the low-RPM warning with it. **TACHS E** and **TACHS R** drop the engine or the rotor tach needle to zero. **GOV** stops the governor and leaves the throttle where it is (GOV OFF stays dark, because it shows only the switch). **ALT** takes the alternator off line and lights ALT.

CLUTCH START disables the starter and the clutch actuator. The CLUTCH light goes out, and the actuator starts no new movement until the breaker is back in, whatever you do with the switch. A movement already under way finishes (5.3). **STROBE** puts out the red anti-collision light. **NAV LTS** cuts the position lights and the instrument lighting, not the warning lights. **LAND LT**, **MAP LT** and **HEATER** cut their lights and the blower.

GPS switches off both navigators (GNS 530 and 430, GTN 750 and 650, or GTNXi 750 and 650), **COM NAV** the GTR 225 COM radio, **XPDR** the transponder, and **AUDIO PANEL** the audio panel. SPARE, 28V CONV and R/ALT have nothing fitted behind them. The tooltips name each breaker by its function (*Starter/clutch circuit breaker*, *Rotor tachometer circuit breaker* and so on). Push the breakers back in before you decide the helicopter is broken.



Figure 4-12 The circuit-breaker panel forward of the left seat.

4.9 Avionics stack and HeliSAS control panel

The center console carries the avionics (Figure 4-13): the Davtron air-temperature gauge (1), the navigator of the chosen variant and panel layout (2), here a GNS 430 (see 5.10), the **HeliSAS control**

panel (3), the Garmin GTR 225-style COM radio (4), the GTX 330-style transponder (5) and the RT TRIM knob (6).

The HeliSAS control panel (HCP) has six lit push-buttons, **SAS**, **HDG**, **NAV**, **SPD**, **ALT** and **VRT**, each with a two-color LED. **White** means armed (for SAS: standby), **green** engaged, dark off. The mode LEDs blink white during the five-second self-test after power-up. Operation is described in Chapter 6.



Figure 4-13 The avionics stack (digital layout, GNS variant): air temperature (1), GNS 430 (2), HeliSAS control panel (3), GTR 225 COM (4), GTX 330 transponder (5), RT TRIM (6).



Figure 4-14 The HeliSAS control panel with SAS, HDG and ALT engaged.

5 Systems

How each system works in the real R22 Beta II, and how the CowanSim R22 reproduces it. Read this chapter once and the checklists in Chapter 7 will make sense, rather than reading as a list of switch positions.

5.1 Engine, throttle and manifold pressure

The Lycoming O-360-J2A is rated at 145 hp. In the R22 it is derated to 131 hp for five minutes at takeoff and 124 hp continuous, both at 104% (2652 RPM). Derating means the engine never runs at full throttle at sea level. The pilot limits power with **manifold pressure** instead, using the Limit Manifold Pressure placard (by pressure altitude and outside air temperature). In return, full power stays available up to several thousand feet on a standard day. Above the "critical altitude" the throttle is wide open and power falls off with height.

A mechanical **throttle correlator** links the collective to the throttle. Raise the collective and the throttle opens. Lower it and the throttle closes. The electronic **governor** (5.2) makes the fine corrections on top of that. The twist grip also has an **overtravel spring** beyond the idle stop. Rolling the throttle fully off into the spring guarantees the correlator cannot add power when you raise the collective. That is used for run-on autorotation landings and in the tail-rotor-failure procedure.

Power management works as in the aircraft. The collective sets manifold pressure and the governor holds RPM. Keep MAP out of the red and respect the yellow band (19.6–24.1 in Hg). The higher you are and the colder the day, the lower the day's limit. The Limit Manifold Pressure placard above your head gives the numbers (Figure 2-3). Read the day's maximum continuous MAP off the placard. For takeoff you may add 0.9 in Hg for up to five minutes. The 24.1 in Hg red line is an absolute ceiling, not a target.

> **IN THE SIM** The throttle correlator is modeled, so raising the collective opens the throttle. The overtravel spring is not. With the grip fully closed, the correlator still adds throttle as you raise the collective.

Mixture

The red **MIXTURE** knob under its guard is a true carburetor mixture control, not a power knob. Full rich gives rated power at sea level. Pulling the knob fully out is idle cut-off and stops the engine.

> **FROM COWANSIM** We modeled the float carburetor. The mixture the engine gets depends on the knob, the air density and the carburetor temperature, as on the real engine. As you climb the mixture richens and power falls off faster than altitude alone would explain, and **leaning gains it back**. Robinson does not recommend leaning in flight (7.5), so fly full rich. Fuel flow follows the mixture too. Full rich burns more than a best-power mixture, about 15% more at sea level and over 40% more at 14,000 ft density altitude. Carb heat richens the mixture further, which is part of why it costs power.



Figure 5-1 Engine controls around the cyclic post: mixture under its guard, carb heat, cyclic friction, and the COM radio and transponder above.

Carburetor heat and carb ice

The R22 carburetor ices readily. Robinson warns of ice at outside temperatures up to 30 °C whenever humidity is high. The **carburetor air temperature (CAT) gauge** shows the temperature at the carburetor venturi. Keep the needle **out of the yellow arc (−15 to +5 °C)** by pulling the **CARB HEAT** knob as far as needed. Below 18 in Hg of manifold pressure the gauge reads wrongly, so in descents and autorotations apply **full** carb heat regardless. Use full heat during the warm-up to preheat the induction system. Carb heat costs power (up to 2000 ft of hover ceiling), so push it in (off) for takeoff if the CAT gauge allows.

> **WARNING** With the governor on, carb ice does not announce itself. The governor keeps opening the throttle to hold RPM and manifold pressure until it runs out of travel. Then the engine quits. If the CAT needle is in the yellow, or you merely suspect ice, apply carb heat. (Robinson Safety Notices SN-25 and SN-31.)

Carburetor icing is modeled. Watch the CAT gauge in cool, damp weather and in every descent. The knob is gradual, so you can set as much heat as the gauge needs. On the ground you can see the needle move as you pull the knob during the run-up check.

5.2 Governor

The electronic RPM governor senses engine RPM and makes small throttle corrections through a friction clutch on the twist grip. The pilot can override it by gripping the throttle. With the switch on, it is **active only above 80% RPM** (rotor RPM in the simulation, which with the clutch engaged is also engine RPM). That is why the start and shutdown are flown on manual throttle below that speed. Its switch is on the tip of the pilot's collective, and the **GOV OFF** light shows whenever the switch is off. Flight with the

governor selected off is prohibited, except for an in-flight system malfunction or emergency procedures training.

After start, set 50–60% RPM on the grip, engage the clutch, warm up at 70–75%, confirm the governor switch is **ON**, then roll the throttle slowly up. As RPM passes 80% the governor takes over, brings the needles to 102–104% and holds them there through every collective movement. Keep a relaxed hand on the grip and let it work.

IN THE SIM The CowanSim governor behaves like the real friction-clutch unit:

- With the switch on and engine RPM above 80%, the governor owns the throttle. Tiny axis noise (under half a percent) is ignored. Keep a throttle axis parked fully open, because a definite movement while the lever sits below the governor's setting is treated as your hand rolling the grip down.
- **Rolling the grip down** (a definite move on your throttle axis, `DECREASE` / `CUT HELICOPTER THROTTLE`, or the cockpit grip) overrides the governor. The throttle follows your hand, and the GOV OFF light stays dark because the switch is still on. This is how you split the needles for a practice autorotation. Rolling *up* while the governor is governing does nothing — it already has the grip.
- The governor **takes the throttle back** when you roll the grip up past the position it was holding. It also takes it back if you switch it off and on (or press a governor-ON binding), or if engine RPM runs away above 108%.
- The governor needs electrical power. Pull the **GOV** breaker, or switch the battery and alternator both off, and it stops where it is. The throttle is yours to roll. With only the breaker pulled the GOV OFF light stays dark, because it shows the switch position and the switch is still on. The governor takes over again when power returns, if the switch is on.
- If you have no throttle axis, the grip sits where the governor puts it. Roll it with the mouse when you need manual throttle.

WARNING Always confirm the governor is ON before increasing RPM above 80% (SN-36). Increasing RPM with the governor off and then switching it on at the wrong moment is a classic cause of overspeeds during lift-off.

5.3 Clutch and drive system

Engine power reaches the rotors through two double V-belts from the engine sheave to the upper sheave. An **electric clutch actuator** between the sheaves tensions the belts when the **CLUTCH** switch is moved to ENGAGE. The actuator measures belt tension and switches itself off when the belts are right. The **CLUTCH light** is on while the actuator is running, engaging or disengaging, and goes out when the belts are tensioned. The upper sheave contains the **sprag (overrunning) clutch**, which lets the rotor turn faster than the engine. In an engine failure or a throttle chop the rotor freewheels and the tachometer needles **split**. A long drive shaft runs aft to the tail-rotor gearbox.

- Engage the clutch at 50–60% engine RPM. The blades must begin turning within five seconds. Belt tensioning then takes a while longer with the light on.
- Wait for the CLUTCH light to go out before the magneto check, and **never take off with it on**.
- If the light comes on in flight and does not go out within 10 seconds, pull the CLUTCH START breaker and land as soon as practical.
- On shutdown, disengage the clutch at idle. The light stays on while the actuator releases the belts and goes out when it has finished. Leave the battery on until it does — the actuator needs electrical power to finish disengaging.

In the simulator, the belts visibly tension after engagement and begin to run, the upper sheave spins up and the rotor accelerates. Open the rear cowl and watch. The sprag clutch is modeled. Lower the collective and roll the throttle off and the needles split, with the rotor RPM carrying on while engine RPM drops. The clutch switch does not touch the throttle, so set the RPM yourself with the grip before you engage.

The actuator runs for up to about 40 seconds each way and does not fail by itself. It needs electrical power, as in the aircraft. With the CLUTCH START breaker pulled, or the battery and alternator off, the switch still moves but the clutch stays put and the CLUTCH light is dark. When power returns the actuator runs to wherever the switch is set, so if you selected ENGAGE in the meantime it engages at once. Unlike the real actuator, a movement already under way finishes when the power goes.



Figure 5-2 The Lycoming O-360 from the left: cylinders and exhaust, the yellow oil filler cap, and the NO STEP and EXTERNAL POWER placards below.

5.4 Rotor brake

The rotor brake acts on the aft end of the main gearbox. It is applied with the pull handle overhead, above and behind the pilot's left shoulder. **Wait at least 30 seconds after the engine stops**, then pull the handle smoothly, and do not stop the rotor in less than 20 seconds. Braking earlier or stopping faster abuses the brake shoes. The **BRAKE** light shows while the handle is applied, and the brake must be released before start.

The handle works like the real one (4.6) and applies the simulator's rotor brake. Pull it sideways and hold to brake, pull down while holding to latch it on, and push up on a fresh press to release. Like the real brake it is gentle. It takes about 20 to 30 seconds to bring the rotor to a stop, as the POH requires, rather than snatching it. With the engine stopped and the clutch disengaged the rotor coasts down on its own, since the sprag clutch and gearbox drag are modeled. You can also let it run down without the brake.

IN THE SIM Use the handle rather than the simulator's own rotor-brake key, which brakes the rotor without moving the handle or lighting BRAKE (3.5). Cranking the starter releases an applied brake, where the real aircraft would inhibit the starter.

5.5 Rotor system and RPM

The R22 has a low-inertia rotor. It stores little energy, so RPM decays quickly if power is lost or the collective is pulled with too little throttle, and it recovers quickly when you act. **Rotor RPM is the one number you never stop monitoring.** The power-on operating range is the green arc, 101–104%. In autorotation 90–110% is permitted. The **low RPM warning**, a horn and the LOW RPM light, comes on below 97%. It is disabled with the collective full down, so it does not sound during start and shutdown. A high-RPM **warble** sounds in the headset as the rotor passes about 108%, warning you before the 110% limit.

WARNING Low-RPM rotor stall is the number-one killer in light helicopters (SN-10/SN-24). When the horn sounds, **lower collective and roll throttle on, together, immediately**. In forward flight add aft cyclic. Do not pause to analyze. In the simulation the rotor stalls as the real one does if you let the RPM decay — and it does not recover below a few hundred feet.

An overspeed in autorotation is prevented as in the aircraft, by raising the collective slightly. Watch the needles during the entry. At light weights the R22 builds rotor RPM fast when the collective goes down. The horn needs electrical power and the HORN and GAUGES breakers in. The light needs the WARN LTS breaker as well.

5.6 Fuel system

Fuel is **gravity fed** from a main tank on the left and an auxiliary tank on the right, both above and behind the cabin. There are no fuel pumps. The aux tank sits slightly higher and is interconnected with the main tank, so it empties first while fuel remains in the main. A single **shut-off valve** (red toggle on the frame behind the left seat) controls flow from both tanks. Float-type gauges show each tank. When they read **E** only unusable fuel remains. An independent sender in the main tank drives the **LOW FUEL** light at about 1.5 gallons of usable fuel — roughly ten minutes at cruise power. Sample fuel from the gascolator and both tank drains before the first flight of the day and after refueling.

Tank	Total	Usable	Note
Main (left)	18.3 US gal	16.9 US gal	bladder tank; LOW FUEL sender in this tank
Auxiliary (right)	9.7 US gal	9.4 US gal	empties first via the interconnect
Total	28.0 US gal	26.3 US gal	about 158 lb usable at 6 lb/gal

In the simulator, you refuel on the ground with the engine stopped. Open a **filler cap** (click it from outside) and the tank fills at about 24 gallons a minute while the cap is open. The tooltip shows *Main tank: x gal*, then *Filling main tank: x gal* and finally *Main tank full: x gal*. The aux tank's tooltips read the same way. Close the cap to stop. You can also set fuel on the tablet's Mass and balance page (Fuel tab,

9.9), or call the fuel truck. The **fuel shut-off valve** stops the engine within about a minute when closed. The mixture does it faster.

> **IN THE SIM** Both tanks feed the engine together in the simulation. The aux tank does not empty first, and the LOW FUEL light watches the total.

5.7 Electrical system

The R22 has a 14-volt DC system: a 12-volt battery, a 60-amp alternator with an alternator control unit, a main bus and an avionics bus. The ammeter is a battery charge/discharge meter. It reads positive when the alternator is charging and negative when the battery is carrying the load. The **ALT** light indicates the alternator is off line. Reduce electrical load and cycle the alternator switch off and on after one second. If the light stays on, land as soon as practical, because **the tachometers, governor and low-RPM warning all need electrical power** (each on its own breaker). Circuit breakers are on the ledge forward of the left seat (4.8).

The digital clock's voltmeter shows the bus voltage: about 12.8 volts on a charged battery and about 13.7 volts with the alternator charging. The ALT light is a low-voltage light. It is on with the alternator switch off, the ALT breaker pulled, the alternator failed or the engine not running. So it is normal before start, and it goes out once the alternator is switched on with the engine running.

There is no avionics master switch in this cockpit. The avionics bus comes on with the battery and feeds the HeliSAS, the radios and navigators, the transponder, the audio panel and the digital clock. A `TOGGLE AVIONICS MASTER` binding switches all of them off and on together (3.5). The electric attitude indicator stays on. The GAUGES breaker feeds the instrument lighting, the air-temperature display, the electric attitude indicator, the HeliSAS panel lights and the low-RPM warning. What each breaker does is listed in 4.8.

5.8 Lighting

The red **anti-collision** light on the tailcone is on the STROBE switch. Switch it on before start and off after the rotor stops. The **position (nav) lights** are on the cabin sides and tail. The two **landing lights** are in the nose, with their switch on the cyclic center post. Robinson recommends continuous use of landing and position lights for conspicuity.

In the real aircraft the **instrument and flood lights** come on with the NAV LTS switch. In the simulation they are on whenever the panel has power (GAUGES and NAV LTS breakers in, 4.8). Set the brightness with the PANEL LTS DIM knob on the console. The **map light** overhead is switched HIGH / LOW / OFF with the switch beside it. Clicking the light toggles it at the brightness the switch last set, and you can drag the light to aim it.

For **night-vision goggles**, press **Z** (the simulator's `TOGGLE NIGHT VISION`) for an intensified low-light view at night, and again to take them off. On Xbox, give `TOGGLE NIGHT VISION` a controller button in the Controls Options.

> **FROM COWANSIM** MSFS 2024's camera exposure can wash out lights in bright daylight. We compensate for it automatically, so the annunciators and panel lighting stay visible by day and keep their correct brightness at night.

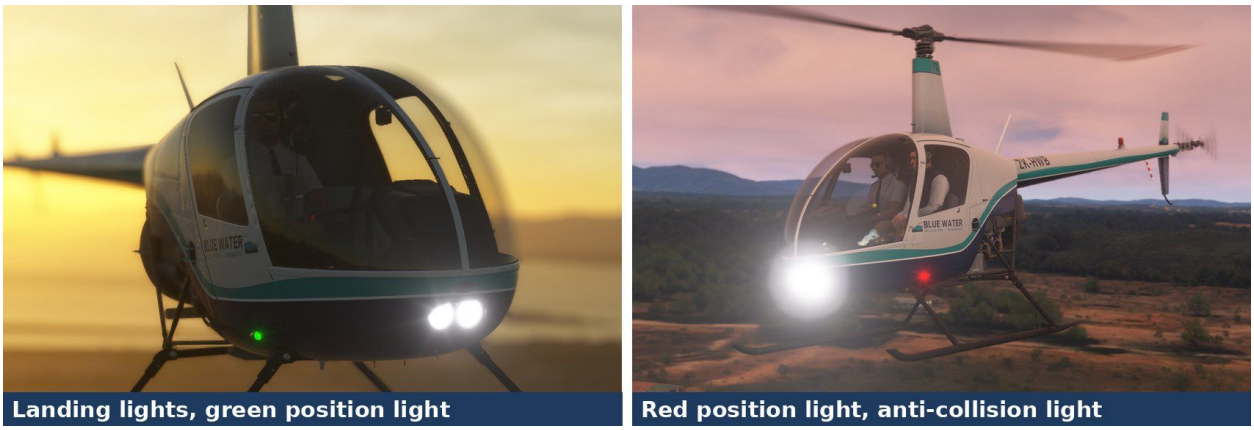


Figure 5-3 The exterior lights: both landing lights in the nose and the green position light on the right side (left); the red position light on the left side and the anti-collision light on the tailcone (right).



Figure 5-4 Night over Aspen: the instrument and console lighting, with the tablet open at R22 Settings.

5.9 Cabin heat and ventilation

Fresh air comes through a nose vent (CABIN AIR knob) and the sliding vents in each door. The optional heater takes air from the engine cooling shroud. It is controlled by the CABIN HEAT knob on the front of the pilot's seat, beside the blower switch. In the simulation the knobs animate and the blower runs and sounds, but there is no cabin temperature to manage.

5.10 Avionics

Figure 4-13 shows the stack in a digital layout, from the air-temperature display at the top to the RT TRIM knob at the bottom.

COM radio

A Garmin GTR 225-style COM transceiver sits below the HeliSAS panel. It has a PWR/VOL knob (push for the squelch test), outer MHz and inner kHz knobs that tune the **standby** frequency, and a **swap** key. A short press of the swap key swaps active and standby. A press of one to three seconds, and a press of more than three seconds, call the radio's long-press functions. The MON, FUNC, CLR, ENT, COM, MEM and ICS keys cover monitoring the standby frequency, memory channels and intercom. On the cyclic, **CH SEL** swaps the frequencies and **FREQ −/+** step the *active* frequency in 25 kHz steps.

Transponder and audio panel

The GTX 330-style transponder below the COM radio is operated with its own keys (STBY, ALT, ON, VFR, IDENT and the digit keys). The analog panel layout carries a GMA 350-style audio panel just below the air-temperature display. The digital layouts put the navigator there.

Navigation units

The navigator depends on the variant you selected: Garmin **GNS 530/430**, **PMS50 GTN 650/750** or, on PC with the TDS patch, **TDS GTNXi 650/750** (1.3). Which units are shown also depends on the instrument-panel layout set on the tablet (9.1). The smaller unit (GNS 430, GTN 650 or GTNXi 650) sits in the console in the DIGITAL ×1 and ×2 layouts. The larger unit (GNS 530, GTN 750 or GTNXi 750) sits in a side pod on the right of the panel in DIGITAL ×2. The ANALOG layout has no navigator.

The HeliSAS NAV and VRT modes follow the navigation source selected on the unit (GPS or VLOC). A GPS flight plan or direct-to needs nothing else. Tracking a VOR radial or localizer needs the course set as well. On the GTN units you set it with the on-screen CDI/OBS. On the GNS units you use the simulator's VOR 1 and VOR 2 OBS increase/decrease bindings (search for OBS in the Controls Options). VOR 1 serves the GNS 530 and VOR 2 the GNS 430. The HeliSAS follows NAV 1 only, so a VOR or localizer for the NAV and VRT modes must be tuned on the GNS 530 (DIGITAL ×2). The GNS 430 can be used for your own navigation, but the HeliSAS will not track it. Each GNS unit is switched on and off with its own COM power/volume knob at the top left. If a GNS screen is dark, use that knob. Refer to Garmin's, PMS50's or TDS's own documentation for operating the units.



Figure 5-5 The three panel layouts on the same GNS variant: ANALOG (no navigator), DIGITAL ×1 (GNS 430 in the console) and DIGITAL ×2 (GNS 530 in the side pod as well).



Figure 5-6 GNS variant, DIGITAL ×2: GNS 530 in the side pod, GNS 430 in the console.



Figure 5-7 PMS50 variant, DIGITAL ×2: GTN 750 in the side pod, GTN 650 in the console.



Figure 5-8 TDS variant, DIGITAL ×2: GTNXi 750 in the side pod, GTNXi 650 in the console.

Attitude indicator (RCA 2610)

The digital layouts fit an RCA 2610 electric attitude indicator. A slip ball for it is optional (9.1, Figure 5-9). The two buttons on its bezel set the display brightness. It returns to full brightness after a power cycle and needs the GAUGES breaker.



Figure 5-9 The RCA 2610 in flight with the optional slip ball switched on: the white ball between the two marks at the bottom of the display.

ELT

A 406 MHz ELT is installed in the engine bay with a three-position switch **ARM – OFF – ON** (9.2). Moving it from OFF to ARM runs a self-test, shown by the unit's lamp a few seconds later. The cockpit remote switch (ARM / ON) and the unit are linked, as in the real installation. ON on either switch starts a transmission. The cockpit light flashes and a warning tone sounds. OFF on the unit stops any transmission, including one triggered by a crash, and ARM on the remote resets it. A `TOGGLE ELT` binding starts or stops a transmission directly, without moving either switch. Leave the unit and the remote in ARM for flight.

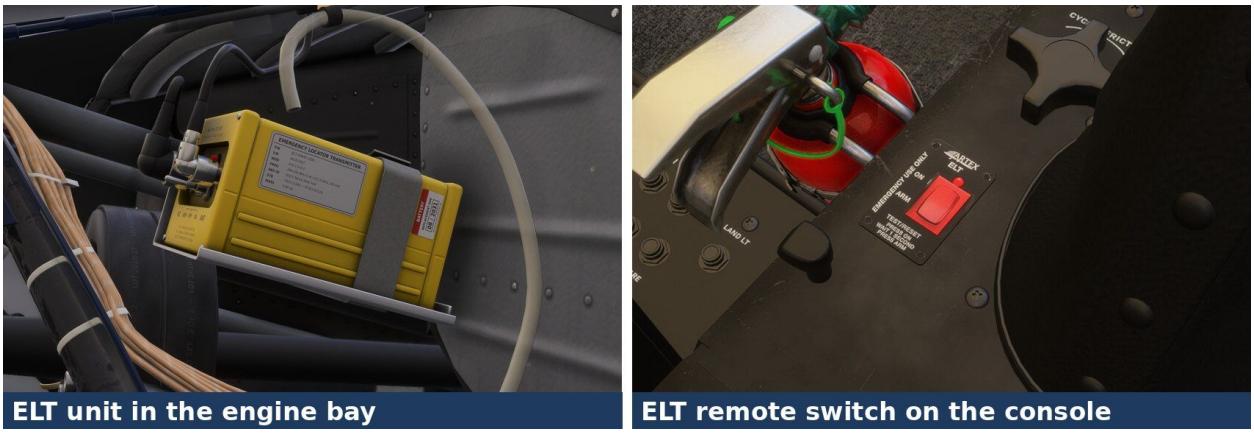


Figure 5-10 The ELT unit on the frame in the engine bay (left) and the Artex-style remote switch on the console (right).

Headset

Click the headset to put it on. It leaves its hook and you hear it plug in. Click the same spot again to hang it back up. The tooltip shows *Worn* or *On hook*. Worn, it turns down the engine, rotor, wind, rain,

downwash and skid noise, as a real headset does. The low- and high-RPM warnings, the ELT tone and the clicks of the controls stay at full volume. In the real aircraft a functioning headset is required for each pilot, because the low-RPM horn plays through the audio system on later machines.

5.11 Pitot-static, OAT and covers

The pitot tube is on the front of the mast fairing, and the static source is inside the aft cowling. The pitot feeds the airspeed indicator. The static source feeds it, the altimeter and the VSI. With the **pitot cover** on, the airspeed indicator stays dead. Remove the cover on the walkaround. The air-temperature gauge gives the outside air temperature you need for the MAP and Vne placards. Its switch selects °F or °C.

5.12 Effects

The engine exhaust shows heat haze while running and a puff of smoke while the starter cranks. The rotor wash raises dust, grass, snow or spray according to the surface, and spray off the water when you hover low over it (floats or skids). The skids kick up dust on touchdown.

The bubble. The windshield and door windows are modeled as worn Plexiglas, like a real R22's. There are fine micro-scratches and swirl marks that light up when the sun is on them, and deeper scratches and fingerprints. Rain runs across the glass, ice creeps over it in icing conditions, and bugs build up on the front, top and door windows over time. You see them from the cockpit as well as from outside (Figure 5-11). **Clean Windshield** in the R22 Settings app wipes them off, and **Hide Bug Splatter** keeps them off (9.1). How much rain and ice you see depends on the simulator's **Windshield Effects** graphics setting.



Figure 5-11 The Plexiglas in the sun: micro-scratches and swirl marks on the pilot's door window (left); bugs and scratches on the bubble, with the simulator's passenger in the left seat (right).

Animation and vibration. The engine shakes on its mounts while it runs. The cyclic shakes with the rotor, circling once per revolution as the rotor spools up. In the engine bay the drive belts and the alternator belt run, the clutch actuator tensions the belts and the upper sheave spins. Overhead, the main rotor is fully animated. The swashplate tilts with the cyclic and rises with the collective, and the blades change pitch, teeter and cone up as they take the load. At the tail, the blade pitch follows the pedals and the hub teeters with it.

Sound. The sound set follows the rotor and engine through every phase: start, clutch engagement, governed flight and the long coast-down after shutdown, with the engine's cooling ticks afterwards. On

top of that come the rotor brake, wind, downwash and rain, the extra noise with a door open or removed, the skids creaking and scraping, the controls moving, gyros and fans running with the battery, and headset hiss. There are also the low- and high-RPM warnings, the ELT tone, the walkaround (covers, cowl panels, fuel caps and sample, ground-handling wheels), the floats on the water and the spray pump. Put the headset on (5.10) and the engine, rotor and wind noise drops, as through a real headset.



Figure 5-12 Exhaust heat haze behind the engine bay.

5.13 Simplifications

We simplified or left out a few things from the real aircraft in this version. They are listed here so that you do not go looking for them:

- **Not fitted or not modeled:** the FULL THROTTLE light, the carbon-monoxide detector and the Engine Monitoring Unit; a trigger for **MR TEMP** (the gearbox does not overheat, but the light works with its test button); **carb heat assist** (manage carb heat with the knob); the landing-lights-with-clutch interlock; the throttle's overtravel spring (5.1); strobe lights (the anti-collision light is the red tailcone light); the rotor-brake starter interlock (cranking releases the brake instead, 5.4); the need to prime a cold engine (the primer works, but starts succeed without it, 4.3); a cabin temperature.
- **Electrical:** no avionics master switch in the cockpit (3.5); the instrument lights come on with panel power rather than with the NAV LTS switch (5.8); a clutch movement already under way finishes when the actuator loses power (5.3).
- **Drag and fuel:** the extra drag of open or removed doors and of the Mariner's floats is not modeled; both fuel tanks feed together (5.6).
- **Limits:** the simulator enforces neither the weight limits nor the exact CG envelope (9.9), and its overspeed limit is a fixed 102 KIAS (95 for the Mariner) at every altitude (2.3).
- **Cosmetic:** the cabin heat and vent knobs; the heater blower only sounds.

6 Force Trim and HeliSAS

The CowanSim R22 carries a force-trim system and a HeliSAS two-axis stability augmentation system with autopilot modes. We modeled it on the Genesys Aerosystems HeliSAS fitted to the Robinson R44 and R66. This chapter explains the real system first, then how to use it in the simulator, including what your hardware does and does not let you feel.

6.1 What HeliSAS is

HeliSAS is an attitude-based flight control system. Two electric servo-actuators, connected to the cyclic through electromagnetic clutches, apply small corrections in pitch and roll so the helicopter holds the attitude the pilot has trimmed. A flight control computer (FCC) runs the control laws and the safety monitors. A small **HeliSAS control panel (HCP)** in the avionics stack carries the mode buttons. Two buttons on the cyclic, **FTR** (force trim release) and **AP DISC**, give the pilot direct control. In the simulator these two are buttons you bind on your own hardware (3.4 and 3.5). The system is *parallel*. The basic push-pull control runs are untouched, and the servos push on the cyclic with light forces that the pilot can always overpower. It weighs under 12 lb. It is designed to be engaged from before lift-off to after touchdown, and Genesys describes it as making it possible to fly with the hand off the cyclic. It controls pitch and roll only. The collective and pedals remain the pilot's.

Three behaviors define it:

- **Attitude retention.** With SAS engaged the helicopter holds its trimmed pitch and roll attitude. Relax your hand on the cyclic and it stays put. Disturb it and it comes back. Below 200 ft AGL keep your hand on the grip anyway (6.5).
- **Force trim.** The servos give the cyclic an artificial centering force toward the trimmed position. Hold FTR and the clutches let go, so the stick moves freely with almost no force. Let go of FTR and whatever attitude you are holding becomes the new trim reference.
- **Fly-through.** You can override the SAS at any time by moving the cyclic against the light spring force, without disengaging anything. Release and it returns to the trimmed attitude. With **Auto Trim** on (6.2) the trim follows you during the fly-through, so on release the helicopter settles near the attitude you were holding, within the SAS limits (10° of bank, 11° nose-up, 10° nose-down). With Auto Trim off it goes back to the attitude you trimmed before.

HeliSAS does not relieve the pilot of monitoring attitude and rotor RPM at all times. A SAS disconnect due to a failure requires the pilot to assume immediate control. It is a VFR system. It does not make the R22 an instrument helicopter.

6.2 Force trim release (FTR) in the CowanSim R22

In the real helicopter, force trim is tactile. The stick is held by the servo springs, FTR frees it, and wherever you leave it is where it stays. A desktop joystick has no servo to hold it, so the simulator does the equivalent in software. The **trim** is the stick position the helicopter treats as neutral. The CowanSim R22's FTR works like this.

Press and hold FTR and the stick load "bleeds off". Whatever deflection you are holding is progressively transferred into the trim, about two-thirds of it in the first two seconds and nearly all of it in five. That

lets you ease the stick back to its center **without the helicopter changing attitude**. A quick tap transfers only a small part of the deflection. The button has to be held while the stick is centered.

Release FTR and the trim locks where it is. The helicopter keeps the attitude. Your stick is centered and free again.

If the SAS is engaged, releasing FTR also makes the current attitude the SAS reference, as in the real system. The SPD and ALT modes likewise take the current speed or altitude as their new target.

Tell the helicopter what kind of stick you have. The **Stick Has a Centering Spring** switch is in the Flight Model section of the R22 Settings app (9.1). Set it to SPRUNG for an ordinary spring-centered joystick and to NOT SPRUNG for a cyclic that stays where you leave it. With a spring-centered stick, **Auto Trim** in the same section (ON by default) applies too. ON, an attitude you hold slowly becomes the new target. OFF, the helicopter goes back to the trimmed attitude when you let go. A short FTR press sets a new target.

With a spring-centered joystick (most hardware)

1. Fly the helicopter to the attitude you want (level cruise, climb, descent or hover).
2. Press and **hold** FTR while you keep that attitude with the stick.
3. Over the next few seconds the trim takes the load. Ease the stick back toward its spring center at the rate that keeps the nose and the wings where they are. You cannot feel the load fading on an ordinary stick, so the attitude indicator and the horizon are your cue. If the nose starts to move in the direction you are holding, you are holding too much. Ease off a little faster.
4. When the stick is centered and the helicopter is still holding the attitude, **release** FTR.
5. Hands off. The helicopter stays where you trimmed it. Small corrections are now made from the center position, with full stick travel available in both directions.

With a non-centering cyclic (no springs)

The sequence is the same, but you move the stick back to its center yourself while holding FTR. The trim takes up the difference over the same few seconds. Release when the stick is at center and the attitude is right. If you release with the stick still displaced, the displacement remains an input on top of the new trim, and the helicopter will keep moving. Force-feedback bases that follow the simulator's rotor trim give the real experience: hold FTR, move the stick, release.

Technique notes

- Re-trim whenever the stick load builds up: after every speed change, at the top of the climb, on entering the approach. Genesys's advice for the real system is to *fly through the SAS and activate the FTR when the desired attitude is achieved*. In the simulator that means fly to the attitude first, then hold FTR for the few seconds it takes to center the stick. Do not hold the button while hunting for an attitude.
- **Releases are instant with the on-release binding.** On its own, a force-trim release registers a moment after you let go, because the simulator keeps the release active for a short safety interval (3.4). With `QUICK TRIM` bound to the button's release it registers the instant you let go, so you can stop the transfer the moment the stick is centered.
- The **trim hat** (if you bound it) nudges the trim without touching FTR: aft = nose up, forward = nose down, left/right = bank. Hold it for a steady change. With the SAS engaged it nudges the attitude the SAS holds, a tenth of a degree per click.

- `ROTOR TRIM RESET` returns both trims to zero in one go. Use it if you ever lose track of where the trim is, or on the ground before start. It is **not** an FTR.
- The cockpit stick shows your hardware input *plus* the trim. After you trim, it sits off-center while your joystick is centered. That is normal, the same as the real cyclic.

CAUTION Do not hold FTR with the stick hard over "to see what happens". Every second you hold it with a large deflection pushes more of that deflection into the trim, and the helicopter will roll or pitch steadily. Trim with the attitude you want, not with the stick you have.



Figure 6-1 Trimmed and hands-off in cruise: the cyclic sits forward of neutral after trimming while the joystick is centered.

6.3 SAS — stability augmentation

Standby and self-test

HeliSAS is wired to the avionics bus without a switch of its own. In the real installation it powers up with the avionics master. This cockpit has no avionics switch, so it powers up with the **battery**. A `TOGGLE AVIONICS MASTER` binding switches it off and on with the rest of the avionics (3.5). Its lights also need the GAUGES breaker. For the first **five seconds** the five mode lights blink white while the FCC initializes, and the buttons are ignored. The real unit also sounds four beeps in the headset while it initializes. When the blinking stops and the **SAS** light is steady **white**, the system is in **standby** and ready to engage. If the avionics bus loses power, everything switches off at once and the self-test runs again when power returns.

Engaging

Press the **SAS** button on the HCP (or the `TOGGLE AUTOPILOT MASTER` binding). The light turns **green**. The SAS may be engaged on the ground, during the takeoff, or at any time in flight. On the ground it holds the trim where it is and begins stabilizing once the skids are light. On engagement in flight it takes the current pitch and roll attitude as its reference. If the bank is beyond 10°, or the pitch beyond 15° nose-up or 10° nose-down, it assumes an unusual attitude and gently levels the helicopter instead. The reference attitude is limited to 10° of bank, 11° nose-up and 10° nose-down.

> **FROM COWANSIM** The real HeliSAS can also be engaged from standby by holding the cyclic trim button. We left that out. In the CowanSim R22 the FTR button is used for trimming, so only the SAS button or its binding engages the system.

Flying with SAS engaged

Once trimmed, the helicopter holds attitude in a hover and in cruise with your hand resting light on the grip. Changes in wind or power will still push it off heading or altitude. SAS holds *attitude*, not track or height. Use the autopilot modes for those.

To maneuver, fly through. The cyclic deflection commands an attitude *change* away from the reference. Full deflection asks for about 45°. When you release the stick the helicopter returns to the trimmed attitude. To make a new attitude the reference, fly to it and trim with FTR, or nudge the reference with the trim hat.

Collective and pedals are always yours. Power changes with SAS engaged are normal. The system holds pitch attitude, so airspeed will drift with power until you re-trim. Cyclic friction must be **fully off**. In the real aircraft friction defeats the servos. In the simulation, keep it off out of habit.

> **IN THE SIM** Your hardware decides how "hands off" feels.
>
> • With a **spring-centered stick**, the stick returns to center when you let go and the SAS then holds the trimmed attitude. Trim properly (6.2) and it flies hands-off. If you let go without trimming, the SAS recovers toward the reference attitude, unless **Auto Trim** (6.2) has already made the attitude you were holding the new target.
>
> • With a **non-centering cyclic**, the SAS holds the attitude your stick is positioned to. Center the stick when you trim and it behaves like the real aircraft.

Disengaging

Press the **SAS** button again. The SAS switches off (light white, standby) and takes every autopilot mode with it. Or use the cyclic **AP DISC** button, as in the real system. The **first press drops every autopilot mode and leaves the SAS engaged**. Pressed when no mode is armed or active, it disengages the SAS. The real system sounds four beeps in the headset whenever the SAS disengages. **Have your hand on the cyclic when you disengage.** The R22 is unstable without the SAS. The SAS may be left engaged on the ground, but after landing the Genesys handbook says to disengage it and set the cyclic friction.

6.4 Autopilot modes

The outer-loop modes layer on top of SAS. **SAS must be engaged first**, and the modes can be selected only **at or above 44 KIAS** (and below Vne). If airspeed falls below 44 KIAS all modes switch off automatically and the SAS stays. The real unit gives a single beep. Each HCP light reads: **dark** = off, **white**

= armed, **green** = engaged. A mode is engaged or disengaged by pressing its button. **AP DISC** on the cyclic drops all of them at once and leaves the SAS engaged. A second press disengages the SAS. The pitch modes (SPD, ALT, VRT) share the pitch axis and the roll modes (HDG, NAV) the roll axis. When a new mode engages, or an armed one captures, the mode that was flying that axis goes dark.

Mode	Button / binding	What it does	Requirements and notes
HDG (heading select)	HDG / `TOGGLE AUTOPILOT HEADING HOLD`	Turns to and holds the heading bug on the directional gyro, maximum bank 20°. Move the bug to steer.	At or above 44 KIAS. You may fly through for a larger or smaller bank. Pressing NAV arms NAV. HDG keeps flying until NAV captures, then goes dark.
NAV (navigation)	NAV / `AUTOPILOT NAV1 HOLD`	Tracks the active course: the GPS flight plan or direct-to when the navigator's CDI source is GPS, or the VOR radial or localizer when it is VLOC. White while armed (intercepting), green on capture.	A GPS course is captured as soon as the navigator has one. A VOR or localizer is intercepted at 30–45° and captured as the needle comes alive near the center. If the signal is lost (the simulation treats a needle at full scale for 30 seconds as lost) NAV drops back to armed and the SAS holds wings level. The TDS GTNXi steers NAV with its own roll commands when it is the active source.
SPD (airspeed hold)	SPD / `AUTOPILOT AIRSPEED HOLD`	Holds the indicated airspeed present when selected, using pitch attitude (up to 12° of pitch). Press and release FTR to make the current speed the new reference.	Pressing ALT replaces SPD with ALT.
ALT (altitude hold)	ALT / `TOGGLE AUTOPILOT ALTITUDE HOLD`	Holds the barometric altitude at which it was engaged. If climbing or descending it first arrests the rate, then returns to the engagement altitude. FTR re-references it to the current altitude.	Genesys limits ALT to 200 ft AGL and above, a limitation the pilot observes. Uses pitch only, so airspeed follows power. Change speed by moving the collective *slowly*. A quick power change will cause an altitude excursion that it then corrects.
VRT (vertical path)	VRT / `TOGGLE AUTOPILOT VS HOLD`	Couples the ILS glideslope or a GPS glidepath (LPV, LNAV/VNAV or LNAV+V). Arms white while the glidepath is above you. Turns green at intercept, and ALT goes dark as VRT takes the pitch axis.	NAV must be armed or active, or VRT will not arm. Until capture, ALT keeps flying. Pressing VRT while SPD is active switches the pitch axis to ALT, because SPD cannot stay active with VRT armed. With no pitch mode engaged VRT holds the current pitch attitude until capture. Press VRT again to disarm it. If the glideslope signal is lost VRT drops out and the SAS holds pitch. Disengages below 44 KIAS. Take over by hand by 50 ft AGL at the latest.
AP DISC (cyclic)	`AUTOPILOT OFF`	First press: every autopilot mode off, SAS stays engaged. Pressed with no mode armed or active: SAS off (standby).	Press once to drop all the modes, twice to disengage the SAS as well and fly by hand. To drop a single mode, press that mode's button.

The real R44/R66 installation also switches the modes off above 130/140 KIAS. The R22's Vne of 102 KIAS makes that limit moot. Respect Vne and the question never arises.

Flying coupled: the collective is the throttle of the autopilot

Every pitch mode (SPD, ALT, VRT) works with pitch attitude alone, so **you** manage airspeed or rate of descent with the collective. In ALT, more collective means more airspeed at the same altitude. In VRT, the collective sets the airspeed at which the glideslope is tracked. Make power changes slowly and the modes stay smooth. Snatch the collective and ALT will balloon or sag before it recovers. Near the bottom of the power curve (slow speeds, steep descents) glideslope tracking becomes less accurate, so keep the approach at a sensible speed.

6.5 Procedures

HeliSAS check (during the run-up)

Power-up (battery ON)	Mode lights blink white for five seconds, then SAS steady white
Cyclic friction	OFF
SAS button	Press; SAS green
Cyclic, small displacement in pitch and roll	Resistance; returns to trim when released *(real aircraft; not felt on an ordinary stick and nothing moves on the ground)*
FTR	Press and release with the stick centered; nothing moves and the trim stays at zero *(real aircraft: free cyclic while held)*
AP DISC	Press; SAS white (standby), four beeps *(real aircraft)*

> ***Note:*** *Do not hold FTR while waggling the stick on the ground. With the button held, any stick displacement is wound into the trim (6.2). If the trim is disturbed, press* `ROTOR TRIM RESET`.

Lift-off and hover with SAS

SAS	Engage before lift-off; SAS green
Lift-off	Raise the collective; position the cyclic for a level lift and lift into the hover with the stick where it needs to be (do not hold FTR while you are still searching for the position)
Hover trim	Once the hover is steady, hold FTR and ease the stick to center over a few seconds while keeping the hover attitude; release
Hover	Hands light on the grip; small corrections from center

> ***Note:*** *In light winds a HeliSAS-equipped helicopter hovers with no cyclic input once trimmed. Keep your feet busy, because SAS does nothing for the pedals. The real-aircraft technique of holding the trim button through the lift-off does not suit the simulator's bleed-off trim. Hold FTR only while you are centering the stick.*

Climb and cruise

Transition	Accelerate normally; re-trim with FTR as the stick load changes

At or above 44 KIAS	Select HDG (bug set) and, above 200 ft AGL, ALT (or SPD for the climb)
Power	Set cruise MAP with the collective slowly; watch airspeed settle
Navigation	Set the CDI source (GPS or VLOC), select NAV; verify white → green on capture

Coupled approach (ILS or LPV)

Navigator	Approach loaded and activated; CDI source VLOC for an ILS, GPS for an LPV, LNAV/VNAV or LNAV+V
Lateral	NAV armed or active (HDG for vectors until established)
Vertical	ALT engaged at the intercept altitude, below the glidepath
VRT	Press; white (armed). If it will not arm, NAV is not armed/active
Before glidepath intercept	Reduce collective *slowly* to the power that gives the desired approach speed
At intercept	VRT green, ALT dark; lower the collective smoothly to descent power for your approach speed, and make any speed change very slowly
Minimums / 44 KIAS	Hand on the cyclic. The modes drop by themselves below 44 KIAS and the SAS stays. Fly the landing with SAS, or press AP DISC (with no mode left it disengages the SAS)

> ***Note:*** *Changing the CDI source from VLOC to GPS, or losing the glideslope, drops VRT to SAS pitch. Re-arm if you need it again.*

Missed approach

ILS	Add power, switch the CDI to GPS. VRT drops to SAS pitch, NAV stays and turns onto the missed-approach course. Set the climb attitude and press and release FTR
GPS approach	Add power, press VRT to disengage it. NAV remains. Climb in SAS pitch and re-trim with FTR, or fly it manually in SAS

Before landing

Autopilot modes	Press each lit mode button to drop it, or let them drop below 44 KIAS. SAS stays
Below 44 KIAS	Any remaining mode drops automatically; hand on the cyclic
After landing	SAS off as desired (SAS button or AP DISC); frictions on

Failures and disengagement

The real HeliSAS is fail-passive. Its monitors disengage the system before any significant cyclic motion can occur, with four beeps and the SAS light returning to white. Erratic or abrupt cyclic motion, or a

large resisting force, means a fault. Fly through it, disengage with AP DISC (twice if a mode is engaged) or the SAS button, and re-engage only if the SAS light is steady white. In the real system the loss of a valid NAV signal disconnects the NAV mode with a single beep. In the simulation NAV drops back to armed with the SAS holding wings level (6.4). Here a disengagement most often has a simple cause: the HeliSAS lost power, either with battery and alternator off or with an avionics-master binding pressed (3.5). If only the modes dropped, check the airspeed. Below 44 KIAS they switch off and the SAS stays.

> **WARNING** Due to the unstable nature of helicopters, autopilot disengagement requires immediate pilot attention. Never fly the R22 hands-off below 200 ft AGL or anywhere near terrain.

6.6 Quick reference

I want to...	Do this
Trim the stick load away	Hold FTR for a few seconds, easing the stick to center while holding the attitude; release.
Make SAS hold a new attitude	Fly to it (fly-through), then trim it with FTR as above, or nudge it with the trim hat.
Engage / disengage SAS	SAS button (or `TOGGLE AUTOPILOT MASTER`). Green = engaged, white = standby.
Hold heading	Set the bug, press HDG (≥ 44 KIAS).
Follow the GPS or a VOR/ILS	Set the CDI source, press NAV; white = armed, green = captured.
Hold altitude	ALT (keep it above 200 ft AGL); manage speed with the collective, slowly.
Hold speed in a climb or descent	SPD; re-reference with FTR.
Fly the glideslope	NAV armed/active, then VRT (white → green at intercept).
Drop one mode	Press its lit button.
Drop all modes, keep the SAS	AP DISC once (`AUTOPILOT OFF`).
Switch everything off	AP DISC twice, or the SAS button.
Zero the trims	`ROTOR TRIM RESET` (not an FTR).

7 Normal Procedures

These checklists follow Robinson's R22 POH Section 4 closely, with notes on how each item is done in the simulator. Fly them in this order and the helicopter will behave. Skip the warm-up or the governor check and it will teach you why they exist.

Recommended airspeeds	KIAS
Takeoff and climb	60
Maximum rate of climb (Vy)	53
Maximum range	83
Significant turbulence	60 to 70
Landing approach	60
Autorotation	60 to 70 (approx. 65 after an engine failure; 75 at 90% RPM for maximum glide above 500 ft AGL)

7.1 Preflight walkaround

Start from a parking spot and the R22 is cold and dark, with you standing beside it. Walk the circuit a real R22 pilot walks, the POH daily inspection, using the interactive items described in Chapter 9. The table lists the POH areas and what you can do in the simulation at each one.

Two things set the order. The doors stay locked while the bubble cover is on, and the battery switch can only be reached from the seat. So take the covers off first (Figure 7-1), then follow the routine in 9.3. Climb in and switch the battery on. Climb out for the engine-bay checks with the pilot's door open, and climb back in when you are done.

POH area	POH items (abridged)	In the simulator
Cowl panels (right side)	Battery ON, OIL and ALT lights on. Push the warning-light test switches. Check fuel quantity. Battery OFF. Aux tank cap tight. Fuel lines, no leaks. Sample the sump drains. Gearbox oil full. Rotor brake, couplings and frame, check.	Switch the battery on from the seat first (the POH's "Battery ON"), then open the rear cowl panel, then the front one. Push each test button (MR TEMP, MR CHIP, TR CHIP, and hold LOW FUEL for a second) and watch the lights in the cockpit. With the pilot's door open you can see them from outside. Click the fuel sample tube to draw a sample, and stow it again or the panel will not close. Click the main gearbox sight glass to check the oil. Check the ELT switch is ARM.
Engine right side	Belts, condition and slack 1.5 in max. Sheaves, sprag clutch, couplings and exhaust, check.	Look at the belts, sheaves and actuator through the open cowl panels.
Empennage and tail rotor	Tail surfaces, gearbox oil visible, blades, pitch links and teeter bearings, check.	Click the tail gearbox sight glass. Grab the tail rotor (click and drag) and work the blades through their pitch travel. That is the pitch-link check.
Tailcone	Skins, strobe and antenna, check.	Visual.

POH area	POH items (abridged)	In the simulator
Engine left side	Engine oil 4 to 6 qt. Filter, lines, throttle linkage, battery and alternator belt, check.	Click the oil filler cap (yellow, on the engine) to pull the dipstick and check the oil. Click again to put it back.
Main fuel tank	Quantity, filler cap tight, no leaks.	Click the filler cap. The tooltip shows the quantity, and with the cap open the tank fills (5.6).
Main rotor	Blades clean, no cracks. Hub, rod ends and swashplate, check. Do not pull down on a blade to teeter the rotor.	Remove the rotor covers and tie-downs. One click takes both off. They go back on from the tablet (9.1), with the rotor stopped.
Fuselage left side	Baggage, removable controls secure, collective clear, seat belt, door latched, landing gear, position light.	Left door handle. Ground-handling wheels: helicopter set down on its skids and the wheels removed (9.5). They drop off by themselves if you forget.
Nose	Pitot tube clear, windshield, landing lights, yaw string.	Remove the pitot cover (on the front of the mast fairing) and the bubble cover.
Fuselage right side and cabin	Landing gear, door pins, baggage. Loose articles stowed. Seat belts. Instruments and controls, check.	Open the right door with its handle (or remove it) and click the enter spot in the doorway to climb in.

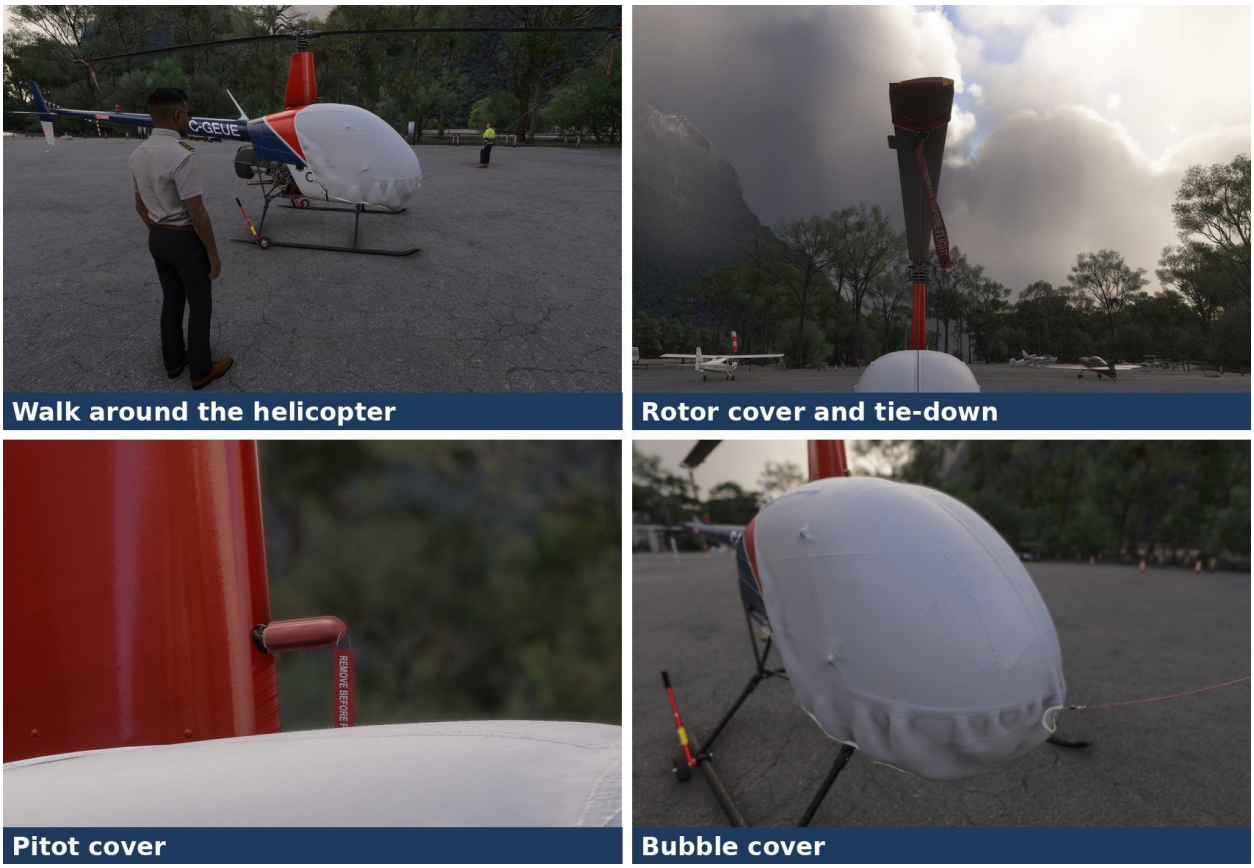


Figure 7-1 Starting the walkaround: the covers and tie-downs come off first.



Figure 7-2 Engine oil, fuel sample and tail rotor checks.

7.2 Before starting engine

IN THE SIM A cold-and-dark start on a parking spot begins with the battery, strobe, clutch and governor switches off and the mixture at idle cut-off with its guard open. The fuel valve is on and about 18 gallons are aboard. A running start has the governor and clutch on, the guard closed and about 14 gallons.

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 (closed)**
Primer..... **Down and locked**
Landing lights..... **OFF**
Avionics switch..... **OFF**
Clutch..... **Disengaged**
Altimeter..... **Set**
Governor switch..... **ON**

For the full-travel checks, move your hardware through its range and watch the cockpit controls follow. This is the moment to notice an axis that is reversed or an assist that is still on. Press `ROTOR TRIM RESET` once if you bound it, so you start with zero trim.

There is no avionics switch in this cockpit. The avionics come on with the battery. Use a `TOGGLE AVIONICS MASTER` binding for the avionics items here and in 7.3 and 7.8, or skip them.

7.3 Starting engine and run-up

Throttle twists for priming..... **As required (or primer, two to three strokes)**
Throttle..... **Closed**
Battery, strobe switches..... **ON**
Area..... **Clear**
Ignition switch..... **START, then BOTH**
STARTER ON light..... **Out**
Set engine RPM..... **50 to 60%**
Clutch switch..... **ENGAGE**
Blades turning..... **Less than 5 seconds**
Alternator switch..... **ON**
Oil pressure within 30 seconds..... **25 psi minimum**
Avionics, headsets..... **ON**
Wait for CLUTCH light out..... **Circuit breakers in**
Warm-up RPM..... **70 to 75%**
Engine gauges..... **Green**
Mag drop at 75% RPM..... **7% max in 2 seconds**
Carb heat..... **CAT rise/drop, set as required**
Sprag clutch check..... **Needles split**
Doors..... **Closed and latched**
Limit MAP placard..... **Check**
Cyclic / collective friction..... **OFF**
HeliSAS..... **Test (6.5)**
Governor ON, increase throttle..... **RPM 102 to 104%**
Warning lights..... **Out**
Lift collective slightly, reduce RPM..... **Horn and light at 97%**

CAUTION Avoid continuous operation between 60 and 70% rotor RPM (tail resonance). On a slippery surface be ready to counter nose-right rotation with left pedal as the governor brings the RPM up.

To start, hold the key in START with the mouse (click and hold), or press `MAGNETOS START`, which runs the starter for about three seconds per press. With the throttle closed and the mixture rich, the engine catches within a few seconds. Priming is not needed in the simulation. Release, and the key springs to BOTH.

Set 50 to 60% RPM with your throttle axis or the mouse (scroll on the grip) before you engage the clutch. The clutch switch does not touch the throttle.

For the mag check, turn the key to L, then R, watching the engine needle. The drop is modeled. Return to BOTH. For the sprag check, with the governor off or below 80%, roll the throttle back briefly. The engine needle drops away from the rotor needle and rejoins it when you roll the throttle back on.

For the governor check, leave the switch ON and roll the throttle up. As the needles pass 80% the governor takes over, and they settle at 102 to 104% on their own. For the horn check, raise the collective a little, since on the ground the horn needs it more than 5% up, and roll the throttle off slightly. The horn and the LOW RPM light come on below 97%. Restore.

The tablet's Checklist app carries the whole of this chapter, from preflight inspection through every flight phase to shutdown and securing, at three levels of detail (3.6). Each item highlights its control, and most swing the camera to it. It is the easiest way to learn where everything is.

7.4 Takeoff

1. Verify doors latched, governor ON, and RPM stabilized at 102 to 104%.
2. Clear the area. Slowly raise the collective until the aircraft is light on the skids. Reposition the cyclic as required for equilibrium, then gently lift into a hover.
3. Check gauges in the green and adjust carb heat if required.
4. Lower the nose and accelerate to climb speed, following the height-velocity profile: stay low and gain speed first, then climb at 60 KIAS. The POH height-velocity diagram shades two areas to avoid, because an engine failure in either leaves no recovery. One is slow and high: hovering or creeping forward at heights from which a successful autorotation is impossible, up to several hundred feet. The other is fast and very low. If RPM drops below 102%, lower the collective.

As the skids get light the nose tries to yaw right, and tail-rotor thrust makes the helicopter drift to the right and settle left-skid-low. A little left pedal and a touch of left cyclic are normal. Lift straight up to 3–5 ft, stabilize, then transition. With the SAS engaged (6.5) the hover is far steadier.

7.5 Cruise

1. Adjust carb heat if required.
2. Verify RPM near the top of the green arc.
3. Set manifold pressure as desired with the collective. Observe MAP and airspeed limits.
4. Pull the RT TRIM knob.
5. Verify gauges in the green, warning lights out.

> **CAUTION** In turbulence reduce power and fly 60 to 70 KIAS. Exercise extreme care never to pull the mixture control in flight. Engine stoppage will result. In-flight leaning is not recommended: with no propeller to keep the engine turning, an over-lean engine stops.

Pull RT TRIM, then trim with FTR, and re-trim after every power change. Engage the SAS and use HDG/ALT at or above 44 KIAS and above 200 ft AGL. The R22 then cruises with your hands free for the collective and the chart.

7.6 Doors-off operation

Flight with either or both doors removed is approved with no airspeed penalty. Avoid removing the left door if possible, to protect the tail rotor from loose objects. Secure everything in the cabin. Remove and refit the doors as described in 9.3.

7.7 Descent, approach and landing

1. Reduce power with the collective as desired. Adjust carb heat as required. Observe airspeed limits. **Never start a descent by pushing the cyclic forward.** Lower the collective.
2. Make the final approach into wind at the lowest practical rate of descent with an initial airspeed of 60 knots.
3. Reduce airspeed and altitude smoothly to a hover. **Be sure the rate of descent is less than 300 ft/min before airspeed is reduced below 30 KIAS** (vortex ring state avoidance).
4. From the hover, lower the collective gradually until ground contact.
5. After initial ground contact, lower the collective to the full-down position.

> **CAUTION** On a slope, return the cyclic to neutral before reducing rotor RPM. Never leave the flight controls unattended with the engine running.

Push the RT TRIM knob in before the approach (4.3) and re-trim with FTR.

7.8 Shutdown

Collective down, RPM 70 to 75%..... **Friction ON**
HeliSAS..... **SAS disengaged**
Cyclic and pedals neutral..... **Friction ON**
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, alternator, battery and ignition switches..... **OFF**

CAUTION Do not slow the rotor by raising the collective during shutdown. The blades may flap and strike the tailcone. If the ambient temperature is above 38 °C (100 °F), cool down at 70–75% RPM for at least a minute before reducing to idle.

IN THE SIM Roll the throttle fully closed before disengaging the clutch, so the governor is out of the picture (it is inactive below 80% anyway). The mixture guard is only a cover: the mixture pulls whether the guard is open or closed. The CLUTCH light stays on while the actuator releases the belts and goes out when it has finished. Only then switch the battery off. For the rotor brake, pull the handle sideways and hold, then pull down to latch (4.6). The rotor takes 20 to 30 seconds to stop, as the POH requires. The HeliSAS may stay engaged on the ground, but disengage it before you set the cyclic friction, as the Genesys handbook says. It powers down with the battery. After the rotor stops: strobe off, doors as you like, covers and tie-downs back on from the tablet (9.1).

7.9 Practice autorotation — power recovery

1. Carb heat as required (full heat below 18 in Hg).
2. Lower the collective to the down stop and reduce the throttle smoothly for needle separation. Do not chop the throttle. Recover immediately if the engine runs rough or RPM keeps dropping.
3. Adjust collective to keep rotor RPM within limits (90–110%). Adjust throttle for needle separation.
4. Keep airspeed at 60 to 70 KIAS.
5. At about 40 ft AGL begin the cyclic flare.
6. At about 8 ft AGL apply forward cyclic to level the ship. Raise the collective to control the descent and add throttle as needed to keep RPM in the green.

WARNING The governor is inactive below 80% engine RPM regardless of the switch. Catastrophic rotor stall can occur if rotor RPM ever drops below 80% plus 1% per 1000 ft of altitude. By 100 ft AGL: RPM near 100%, 60–70 KIAS, descent below 1500 ft/min, turns complete. Otherwise go around (SN-38). Limit practice to three or four consecutive autorotations.

Rolling the grip down overrides the governor (5.2). Rolling it back up past its hold point hands control back to it. That is the hand-on-the-grip feel of the real aircraft.

IN THE SIM We did not model the real aircraft's throttle overtravel spring. For a full-down (run-on) autorotation, roll the throttle fully closed and keep it there until the skids stop sliding. The correlator still adds some throttle as you raise the collective for the cushion (5.1).

8 Emergency Procedures

Robinson's R22 emergency procedures (POH Section 3), as they apply to the CowanSim R22. We modeled the failures that matter: engine failure, governor failure, electrical loss, fuel exhaustion and carb ice. The aircraft reacts to these procedures the way the real one does.

Definition	Meaning
Land immediately	Land on the nearest clear area where a safe normal landing can be performed. Be prepared to enter autorotation during the approach if required.
Land as soon as practical	Landing site at the pilot's discretion based on the nature of the problem and available areas. Flight beyond the nearest airport is not recommended.

8.1 Power failure — general

A power failure may be caused by an engine or a drive-system failure and is usually announced by the **low RPM horn**. An engine failure shows as a change in noise, a nose-left yaw, an OIL light or decreasing engine RPM. A drive-system failure shows as unusual noise or vibration, yaw either way, or decreasing rotor RPM while engine RPM increases. **In either case, immediately lower the collective to enter autorotation.**

> **CAUTION** Aft cyclic is required when the collective is lowered at high airspeed. Do not apply aft cyclic during touchdown or the ground slide, to prevent a blade strike on the tailcone.

Power failure above 500 ft AGL

1. Lower collective immediately to maintain rotor RPM.
2. Establish a steady glide at approximately 65 KIAS (75 KIAS at 90% RPM for maximum glide distance, about 4:1 or one nautical mile per 1500 ft).
3. Adjust collective to keep RPM between 97 and 110%, or apply full-down collective if light weight prevents attaining above 97%.
4. Select a landing spot and, if altitude permits, maneuver so the landing will be into wind.
5. A restart may be attempted at the pilot's discretion if time allows (8.2).
6. If unable to restart, turn unnecessary switches and the fuel valve off.
7. At about 40 ft AGL begin the cyclic flare to reduce rate of descent and forward speed.
8. At about 8 ft AGL apply forward cyclic to level the ship and raise the collective just before touchdown to cushion the landing. Touch down level with the nose straight ahead.

> **CAUTION** Increase rotor RPM to 97% minimum when autorotating below 500 ft AGL.

Power failure between 8 ft and 500 ft AGL

1. Lower collective immediately to maintain rotor RPM.

2. Adjust collective to keep RPM between 97 and 110% (full down if light).
3. Maintain airspeed until the ground is approached, then begin the cyclic flare.
4. At about 8 ft AGL apply forward cyclic to level the ship and raise the collective just before touchdown. Touch down level, nose straight ahead.

Power failure below 8 ft AGL

1. Apply right pedal as required to prevent yawing.
2. Allow the aircraft to settle.
3. Raise collective just before touchdown to cushion the landing.

The rotor loses RPM within a second or two of a power loss. Practice the reaction until it is reflex: collective **down** the instant the horn sounds, then look for the field. To set up a surprise in the simulator, use its failure options, or close the fuel valve in cruise and wait.

8.2 Air restart

Mixture..... **Full rich**
Primer..... **Down and locked**
Throttle..... **Closed, then cracked slightly**
Starter..... **Actuate with the left hand**

> **CAUTION** Do not attempt a restart if an engine malfunction is suspected, or before a safe autorotation is established.

8.3 Emergency water landing

Power off

1. Follow the same procedure as a power failure over land until contacting the water. If time permits, unlatch the doors before water contact.
2. Apply lateral cyclic when the aircraft contacts the water to stop the rotors.
3. Release the seat belt and quickly clear the aircraft when the rotors stop.

Power on

1. Descend to a hover above the water.
2. Unlatch the doors.
3. Passenger exits the aircraft.
4. Fly to a safe distance from the passenger to avoid injury by the rotors.
5. Switch battery and alternator OFF.
6. Roll the throttle off into the overtravel spring.
7. Keep the aircraft level and apply full collective as the aircraft contacts the water.
8. Apply lateral cyclic to stop the rotors.
9. Release the seat belt and quickly clear the aircraft when the rotors stop.

The Mariner (float) variant lands on water normally (9.6).

8.4 Loss of tail rotor thrust

In forward flight

Usually indicated by a nose-right yaw which cannot be corrected with left pedal.

1. Immediately enter autorotation.
2. Maintain at least 70 KIAS if practical.
3. Select a landing site, roll the throttle off into the overtravel spring, and perform an autorotation landing.

> **NOTE** When no landing site is available, the vertical stabilizers may permit limited controlled flight at low power settings above 70 KIAS. Before reducing airspeed, enter full autorotation.

In a hover

1. Immediately roll the throttle off into the overtravel spring and allow the aircraft to settle.
2. Raise collective just before touchdown to cushion the landing.

> **IN THE SIM** A tail-rotor failure cannot be triggered in the simulation, so this procedure is here for reference. The overtravel spring is not modeled either (5.1). With the grip rolled fully off, the correlator still adds some throttle as you raise the collective. That matters for the throttle-off steps here and in 8.3.

8.5 Fires

Engine fire during start on the ground

1. Continue cranking and attempt to start, which would suck flames and excess fuel into the engine.
2. If the engine starts, run at 50–60% RPM for a short time.
3. Fuel mixture OFF.
4. Fuel valve OFF.
5. Battery switch OFF.
6. If time permits, apply the rotor brake to stop the rotors.
7. Exit the helicopter.

Engine fire in flight

1. Enter autorotation.
2. Cabin heat OFF, cabin vent ON (if time permits).
3. If the engine is running, perform a normal landing, then mixture OFF and fuel valve OFF. If the engine stops, fuel valve OFF and complete the autorotation landing.
4. Battery switch OFF.

5. If time permits, apply the rotor brake.
6. Exit the helicopter.

Electrical fire in flight

1. Battery and alternator switches OFF.
2. Open the cabin vents.
3. Land immediately.
4. Mixture OFF and fuel valve OFF.
5. If time permits, apply the rotor brake.
6. Exit the helicopter.

> **CAUTION** The low-RPM warning system and the governor are inoperative with the battery and alternator switches both off. Keep a very close eye on the tachometer.

8.6 Tachometer failure

If the rotor or engine tach fails in flight, use the remaining needle to monitor RPM. If it is not clear which one has failed, or both fail, let the governor control RPM and land as soon as practical. Each tach, the governor and the low-RPM horn are on separate circuits. A bypass keeps the tachs on battery power with the battery and alternator switches off, as long as the clutch switch is engaged.

> **IN THE SIM** Pull the **TACHS E** or **TACHS R** breaker to practice. That needle drops to zero until you push the breaker back in. The bypass is modeled. With the battery and alternator both off, the tachs keep reading as long as the clutch switch is at ENGAGE. The governor and the low-RPM warning stop (caution in 8.5).

8.7 Governor failure

If the governor malfunctions, **grip the throttle firmly to override it, then switch the governor off**. Complete the flight on manual throttle. Roll the grip to hold 102–104% as you move the collective. Up collective needs more throttle, down collective less. Adjust the throttle constantly.

> **IN THE SIM** Manual throttle needs a throttle axis to be enjoyable. With the mouse it is possible but busy. To practice, switch the governor off at cruise, or pull the **GOV** breaker. With the breaker out the throttle stays where the governor left it, and the GOV OFF light stays dark because it shows only the switch position. Watch the tach. The RPM is now yours to hold with the twist grip.

8.8 Low rotor RPM

Horn and LOW RPM light at 97%: **lower collective and roll throttle on, immediately and together**. In forward flight apply aft cyclic to help the rotor. Do not wait to see whether it recovers on its own. Once the rotor stalls, recovery is impossible below a few hundred feet (2.5). With the collective on the down

stop the horn and light are inhibited, in the air as on the ground. In an autorotation, watch the needle, not the horn.

8.9 Warning and caution lights

See 4.2 for the full table. In summary: if **OIL** comes on, confirm on the gauge and land immediately if pressure is lost. For **MR TEMP**, **MR CHIP** or **TR CHIP**, land immediately with any other symptom, otherwise as soon as practical. **LOW FUEL** means about 1.5 gallons, about ten minutes. Land as soon as practical. If **CLUTCH** stays on in flight for more than 10 seconds, pull the CLUTCH START breaker and land as soon as practical. Land immediately if there are other signs of a drive-system failure. For **ALT**, reset once, and if it stays on land as soon as practical. For **STARTER ON** after start, mixture off and battery off. For **GOV OFF**, switch the governor on, unless you switched it off for a governor failure (8.7). For **BRAKE**, release immediately.

8.10 Low-G and turbulence (FAA AD 95-26-04)

In a low-G condition the helicopter rolls right. Gradually apply aft cyclic to restore positive G and rotor thrust, and do not apply lateral cyclic until positive G is established. For uncommanded pitch, roll or yaw in turbulence, gradually apply the controls to maintain rotor RPM and positive G and to eliminate sideslip. Minimize cyclic inputs and do not over-control.

In moderate or greater turbulence, depart the area if it is isolated, otherwise land as soon as practical. Fly 60 KIAS to 0.7 Vne, never below 57 KIAS.

8.11 HeliSAS disengagement or failure

1. Continue flight on manual control. If the autopilot has not disengaged itself, disengage it with your AP DISC button or the SAS button on the control panel. Press AP DISC twice to drop the SAS as well.
2. If the SAS annunciator is steady white, re-engagement may be attempted at the pilot's discretion.

> **WARNING** Due to the unstable nature of helicopters, autopilot disengagement requires immediate pilot attention. Modes other than SAS also switch off by design below 44 KIAS, and the whole system drops out if the avionics bus loses power.

9 Tablet Settings, Walkaround Items, Variants and Options

Everything that is not a flight control: the R22 Settings and R22 Manual apps on the tablet, the things you can touch on the walkaround, the ground-handling wheels, the Mariner and Agricultural airframes, the liveries, and how to load fuel and payload.

9.1 The R22 Settings and R22 Manual apps

Press **TAB** or click the tablet to open the EFB, then open the **R22 Settings** app (CowanSim logo). It has three sections: **Cockpit**, **Flight Model** and **Preflight**. Tap a switch or selector to change it. **Clean Windshield** is a button. The page re-reads the helicopter every half second, so a cover removed or a door taken off in the 3D cockpit shows up here too.

Section	Setting	States	What it does
Cockpit	Instrument Panel	ANALOG · DIGITAL ×1 · DIGITAL ×2	Analog instruments and no navigator; digital attitude indicator and clock with one navigator in the console; or the same plus a larger navigator in a side pod. Which navigators appear depends on the variant (1.2, 5.10). ANALOG on the first flight. The choice is remembered afterwards. There is no switch for it in the cockpit.
Cockpit	RCA2610 Digital Attitude Indicator Slip Ball	OFF · ON	Adds a slip ball to the digital attitude indicator (5.10). OFF by default: most R22s are flown with the yaw string.
Cockpit	Hide Pilot Door	VISIBLE · HIDDEN	Removes or refits the right (pilot) door, the same as the door-removal click spot in the cockpit (9.3).
Cockpit	Hide Copilot Door	VISIBLE · HIDDEN	Removes or refits the left door.
Cockpit	Hide Tablet Mount	VISIBLE · HIDDEN	Stows the tablet and hides its mount, or brings them back, like clicking the folder (4.7). TAB still opens it.
Cockpit	Hide Bug Splatter	VISIBLE · HIDDEN	HIDDEN keeps the windshield and door windows free of bugs. VISIBLE lets them build up as you fly (5.12).
Cockpit	Clean Windshield	CLEAN button	Wipes the bugs off. They build up again as you fly.
Flight Model	Stick Has a Centering Spring	NOT SPRUNG · SPRUNG	SPRUNG (the default) for a stick that centers itself (most joysticks), NOT SPRUNG for one that stays where you leave it. The force trim and HeliSAS depend on it (Chapter 6).
Flight Model	Auto Trim	OFF · ON	Spring-centered sticks only. ON (the default): an attitude you hold slowly becomes the new target. OFF: the stick returns to the trimmed attitude. A short FTR press sets a new target (6.2).
Flight Model	Real Tail Rotor Feel Simulation	OFF · ON	ON (the default): the tail rotor needs more pedal input. Only recommended with anti-torque or rudder pedals. OFF passes your pedal input straight through (3.3).
Preflight	Pitot Cover	REMOVED · ON	Removes or refits the pitot cover. Refitting is only possible from here. On the walkaround you can only take it off.

Section	Setting	States	What it does
Preflight	Rotor Cover	REMOVED · ON	Removes or refits the blade covers and tie-downs. ON parks the blades first.
Preflight	Windshield Cover	REMOVED · ON	Removes or refits the bubble cover. ON closes both doors first, and they stay shut until it comes off.
Preflight	Ground Handling Wheels	REMOVED · ON	Fits or removes the wheels (9.5) with the engine stopped and the rotor stationary. Grayed out on the Mariner.

The R22 remembers your settings from one flight to the next: the instrument-panel layout, the slip ball, the bug setting, the three Flight Model settings, whether the left-seat controls are fitted (SOLO pin, 9.4), the cyclic and collective friction, where you aimed the map light, and the °F/°C setting of the air-temperature gauge. The Preflight items follow the state the flight starts in. A cold-and-dark start on a parking spot has all three covers on and the wheels fitted. The Mariner has no wheels, and neither does a parking start that the simulator loads without the covers. A runway or in-flight start has nothing fitted.

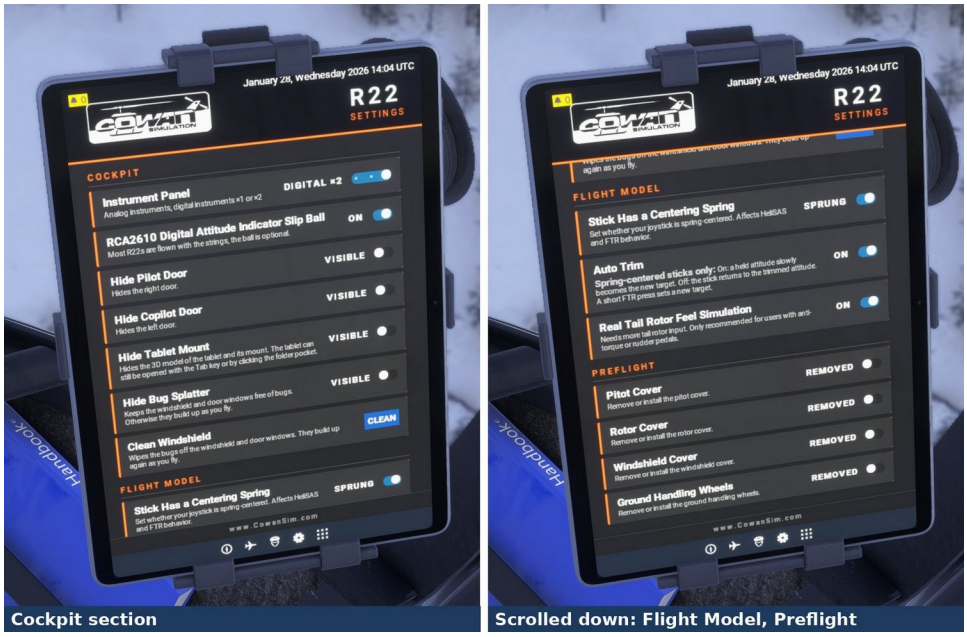


Figure 9-1 The R22 Settings app on the tablet: the Cockpit section (left) and, scrolled down, the Flight Model section and the Preflight section with the covers and ground-handling wheels (right).

R22 Manual

The **R22 Manual** app (the other CowanSim icon) carries this manual, page by page, so you can read it without leaving the cockpit. The pages scroll in one long column like a PDF reader. Drag them with the mouse, use the mouse wheel, or drag the bar on the right to move quickly. The buttons along the top open the **Contents** list, which shows the chapters and sections with the one you are reading highlighted. The arrows step back or forward a page, with the page counter between them. Further buttons zoom out, fit the page to the width or zoom in. The entries on the Contents pages are links: click one to jump there. With a gamepad, the stick scrolls, LB and RB turn the page, LT and RT zoom, X fits the width and Y opens the Contents. The app remembers your page and zoom for the next flight.



Figure 9-2 The R22 Manual app: this manual on the tablet, with the Contents button, page arrows and zoom along the top.

9.2 Engine bay and preflight items

The engine compartment opens on the right-hand side of the fuselage through two hinged cowl panels, one behind the other. Everything the real preflight inspection asks for in the engine compartment is modeled behind them. The one exception is the oil dipstick, which is on the left side of the engine. Click each item with the mouse. Most can also be used with the pilot character's interact action on the walkaround; the sight glasses, the ELT and the ground-handling wheels are mouse-only. When you use the interact action, the fuel sample tube and the oil cap are put back for you as the interaction ends.

Item	Where	What it does
Rear cowl panel	Right side, aft of the mast fairing	Click to open or close. Its lip holds the front panel shut, so it has to be open before the front panel will move. It cannot be closed again until the front panel is closed and the fuel sample tube is stowed. Until then the tooltip reads *Close the front panel first*.
Front cowl panel	Right side, forward of the rear panel	Click to open or close. Opens only with the rear panel open (tooltip *Open the rear panel first*).
Warning-light test buttons	Inside the bay, on the frame	Push-to-test buttons MR TEMP, MR CHIP and TR CHIP light their annunciator on the panel while pressed. LOW FUEL has to be held for about a second before the LOW FUEL annunciator answers. The lights need the battery on and the WARN LTS breaker in. Open the pilot's door first and you can watch the panel from outside while you press them.
Fuel sample tube	Behind the front panel	Click the glass tube to draw a sample from the drain. The tube props the front panel open while it is out. Click again to stow it.
Main gearbox sight glass	On the main gearbox	Click to check the oil level. The tooltip confirms the check.

Item	Where	What it does
Tail gearbox sight glass	Tail rotor gearbox	Click to check.
Engine oil dipstick	Left side of the engine: the yellow oil filler cap	Click the cap to pull the dipstick and check the oil level (tooltip *Check Oil Level*). Click again to put it back.
ELT	Yellow unit on the frame in the bay	Three-position switch ARM – OFF – ON. Each click moves it one position along ARM → OFF → ON and back again, so going from ON to ARM passes through OFF. OFF → ARM runs the self-test, and the unit's lamp lights a few seconds later. In ON the unit transmits and the lamp flashes. Leave it in ARM for flight. It is linked with the cockpit remote switch (5.10).
Tail rotor	Tail rotor blades, rotor stopped	Grab a blade and drag to work the blades through their pitch range, the pitch-link freedom check. Not available once the rotor is turning.
Fuel filler caps	Main tank (left) and aux tank (right), either side of the mast	Click to open. The tooltip names the tank and shows its contents (*Filling…* while fuel is going in). With the helicopter on the ground and the engine stopped, an open cap fills the tank until you close it or it is full (5.6).



Figure 9-3 The right-hand engine bay with the rear cowl panel open: the ELT, hoses and wiring (left) and, deeper in, the cooling duct, fuel lines and wiring (right).

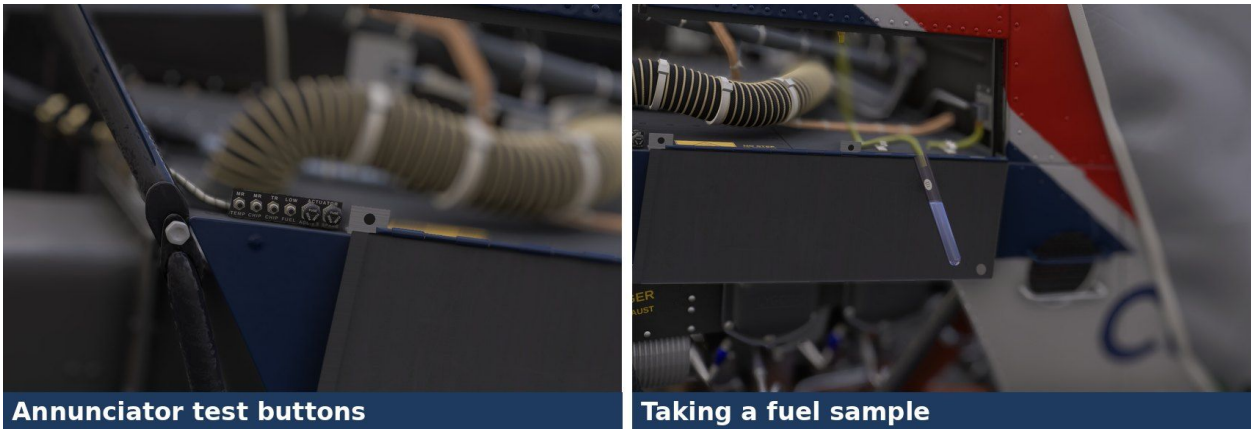


Figure 9-4 The warning-light test buttons on the frame (left), and a fuel sample being taken (right).



Figure 9-5 The tail rotor: with the rotor stopped, grab a blade and move it through its pitch range.

9.3 Covers, tie-downs and doors

A cold-and-dark start on a parking spot puts the R22 in front of you fully covered: rotor-blade covers with tie-down straps on both blades, a pitot cover and the bubble cover over the cabin. Remove them on the walkaround by clicking (tooltips *Rotor Cover / Tie Down — Remove covers & tie downs*, *Pitot Cover — Remove*, *Bubble Cover — Remove*). One click on either blade removes both rotor covers and their tie-downs. On the walkaround, clicking only removes them. To put any of them back, use the Preflight section of the R22 Settings app (9.1). Refitting the bubble cover closes both doors for you.

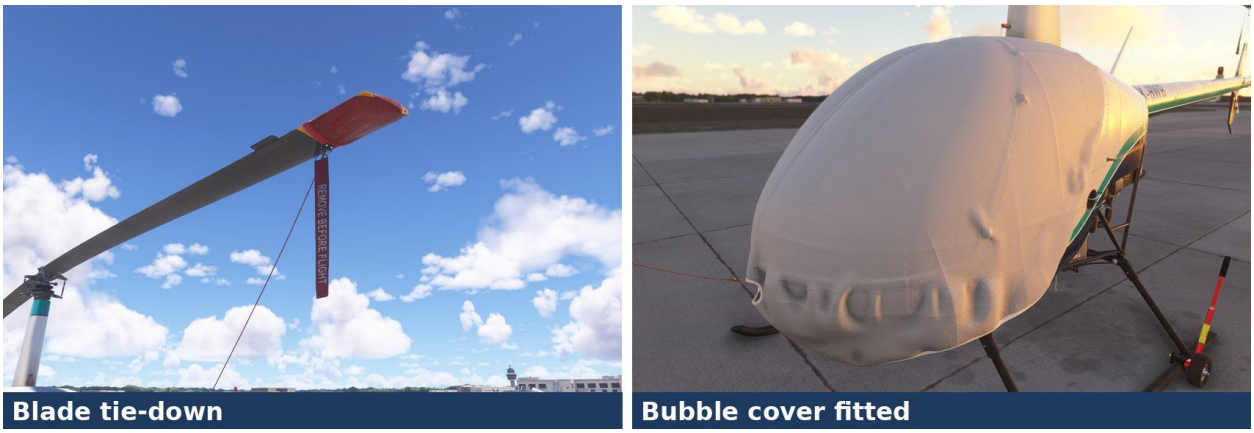


Figure 9-6 Blade cover and tie-down strap (left); the bubble cover fitted over the cabin (right).

Doors, getting in and getting out

The outside and inside handles of both doors open and close that door. Opening a door does nothing else. It does not put you in the seat. The door stays open until you close it, so you can leave it open while you work around the helicopter, or sit with it open on a hot day. With the bubble cover on, the handles are locked.

To get in, open the pilot's (right) door fully, or remove it. While you are outside on foot, an **enter** click spot appears in the doorway. Click it to take the seat. With the door closed there is no enter spot. To get

out, open the right door from the seat with its inside handle and click the **exit** spot that appears in the doorway. If the right door has been removed, the exit spot is always available.

Both doors can come off. From the cockpit, each door has its own *Show/hide door* click spot (the tooltip reads *Remove/install pilot door* or *copilot door*). One click takes the door off, another puts it back. From outside, use the two door switches in the R22 Settings app. The real R22 is approved for flight with either or both doors removed. Expect more noise and wind, though we did not model the extra drag. With a door open or removed, the rotor and engine are louder in the cabin and the wind noise rises with airspeed.



Figure 9-7 Pilot's door open on the ramp. The enter spot is an invisible volume in the doorway; the door stays open until you close it.

A cold-start routine that works: remove the covers and open the pilot's door. Climb in and switch the battery on. Climb out again and do the engine-bay checks with the door open, so you can watch the warning lights answer the test buttons. Then climb back in.

9.4 Dual controls, seat, headset and the cyclic

- **SOLO pin (dual controls).** The left-seat controls are removable, as in the real aircraft, where the left cyclic grip, collective and pedals come out for solo flight or a passenger. Click the **SOLO** pin on the cyclic T-bar (tooltip *Solo setup*) to remove or refit the left cyclic grip, the left collective with its twist grip and the left pedals.
- **Seat.** Click the seat (tooltip *Seat — Move the seat for a better view of the controls*) to shift your seating position between two settings.
- **Headset.** Click it to put it on or hang it back up. Worn, it turns the cockpit noise down (5.10).

- **Hide the cyclic.** A click spot on the pilot's side of the T-bar hides the whole cyclic for an unobstructed view of the panel (tooltip *Show/hide*). Click it again to bring it back. On the Agricultural variant the spray control box is hidden with it, but any spray bindings keep working.
- **Tablet.** The tablet sits on its suction mount at the top of the panel, or stowed in the blue R22 Pilot's Handbook folder beside the pilot's pedals. Click the folder to swap between the two. Drag the mount jaws to position and rotate it (4.7).

9.5 Ground-handling wheels

The R22's detachable ground-handling wheels clamp to the skid tubes just aft of the cabin. Lifting their handles lowers the wheels and raises the skids off the ground, so one person can roll the helicopter around the ramp. They are fitted when you start cold and dark on a parking spot (the Mariner has none). They must come off before flight. In the sim they take care of that themselves.

- **Lift / set down.** Click either wheel **handle** (tooltip *Ground Handling Wheels — Lift / Set Down*). The handle swings over, the wheels go down and the helicopter rises onto them (state *Up*). Click again to set it back on its skids (*Down*). Lifting is locked out once the engine is running or the rotor is turning.
- **Push and steer on foot.** Once the helicopter is fully up on its wheels, a **grip** appears on the tail (tooltip *Tail / Vertical Stabilizer — Move the helicopter*). Drag it forward or back to roll the helicopter, sideways to turn it. The tooltip shows the heading.
- **Push and steer from the external view.** While the helicopter is up on its wheels, switch to the external camera. It then rolls with your **cyclic** (forward or back) and turns with your **pedals** (or a stick's twist axis, whatever is bound to `TAIL ROTOR AXIS`). This only works in the external view.
- **Remove.** Set the helicopter down on its skids, then click a **tire** (*Remove*). Both wheel assemblies are taken off.
- **Refit.** Only with the engine stopped and the rotor stationary, from the Preflight section of the R22 Settings app (9.1).

> **FROM COWANSIM** We take the wheels off for you the moment the engine fires or the rotor begins to turn, so you cannot take off with them on.



Figure 9-8 Ground-handling wheels: handle down and the wheel clear of the ground (left); handle lifted, the wheel down and the skid raised (right).

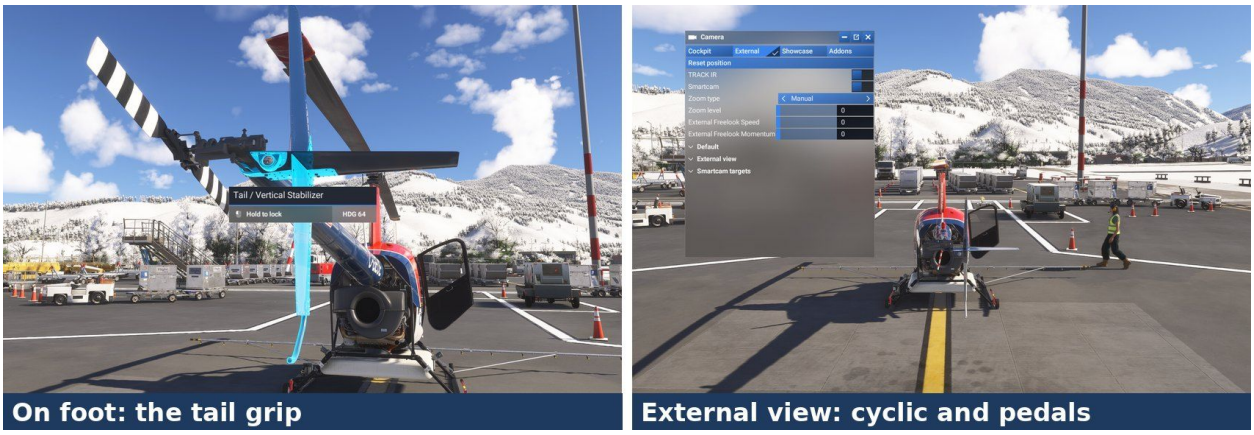


Figure 9-9 Moving the helicopter: the tail grip on foot (left), and rolling it with the cyclic and pedals from the external view (right).

9.6 The Mariner (fixed utility floats)

The Mariner variants carry Robinson's fixed utility floats on the skid gear. The helicopter operates from water or from land, and on land the floats sit on the ground like skids. On the water, the sim adds the bow spray, splash and wake you would expect.

The float gear is about 31 lb heavier than the skid gear: the simulator shows 900.6 lb empty against 869.8 lb for the Default (2.2). The aft center-of-gravity limit is half an inch more restrictive, as in the POH float supplement. **Vne with floats fitted is 95 KIAS** (power on, up to 3000 ft density altitude; 80 KIAS power off up to 7500 ft), not 102. In the real aircraft the floats also cost a few knots of cruise speed. We modeled their weight but not their extra drag.

For a water landing, approach into wind to a hover over the water, then lower the collective gently and let the floats settle. Touch down with little or no forward speed. Hold the cyclic neutral as the floats take the weight. The water does not hold the fuselage still the way the ground does.

On the water the helicopter weathercocks into wind and drifts with it. Taxi at low speed with the pedals for direction and a little forward cyclic. Avoid fast water taxiing, which pushes the bows under. Keep the rotor RPM in the green throughout.

To take off from the water, lift straight into a hover and transition as normal. The heavier airframe needs a little more power to hover. On land, take off and land on hard surfaces as you would on skids. Avoid sliding landings. The floats are not skids.

The Mariner is otherwise identical to the Default airframe: same engine, systems, avionics fits, liveries and panel layouts.



Figure 9-10 The Mariner on the ramp (left) and settling onto the water with the bow spray up (right).

9.7 The Agricultural variant (spray kit)

The Agricultural variants carry a Simplex-type spray kit: a 64 US gallon tank under the fuselage with a pump and filters, a 24 ft boom with eight nozzles each side, filler caps on both sides, an emergency dump door, and a spray control box on the cyclic. The kit weighs 92.2 lb empty. We built it on the simulator's liquid-dropping system. The liquid in the tank is real weight that moves the center of gravity, and what you spray is drawn from it.

The load



Figure 9-11 Loading the spray tank: the Liquid tab of the Mass and balance page, with the SPRAYTANK set to 20 of 64 gallons.

> **FROM COWANSIM** We start every flight with **20 gallons** (about 167 lb) in the tank. The tank holds 64 US gallons, but a full tank weighs around 530 lb, more than an R22 can lift with a pilot and fuel. The kit is meant to be run part-full.

The Agricultural R22 weighs 962 lb empty. With the default 170 lb pilot and 20 gallons in the tank, only about 70 lb of fuel (12 US gallons) fit before you reach the 1370 lb maximum gross weight. The fuel the

flights start with puts it 10 to 40 lb over. Take fuel or liquid off in the Mass and balance page before you start (9.9), or plan to spray part of the load before you need full hover performance.

The tank is loaded from the tablet. On the **Mass and balance** page, the **Liquid** tab has the SPRAYTANK. Set it anywhere from empty to 64 gallons with the − / + buttons or the Quick fill slider, in gallons or pounds (Figure 9-11). The page shows the resulting total mass against the 1370 lb limit. The filler caps on the tank open and show the contents, but filling is done here.

To check the load, click a **filler cap** on either side of the tank to open it. The tooltip reads *Spray tank: x gal*. The tank level is also shown in the simulator's HUD liquid-tank indicator, with a spray indicator while spraying.

The spray control box

The control box rides on the cyclic in front of the pilot. The pump starts switched **off** at the beginning of every flight.



Figure 9-12 The spray control box on the cyclic.

#	Control	What it does
1	PUMP ON lamp	Lit while the pump circuit is powered, with the pump switch on and electrical power available.
2	35 A circuit breaker	The pump's breaker. It is part of the model but not a click spot. The PUMP switch is how you isolate the pump.
3	PUMP ON/OFF	Runs the spray pump. Nothing comes out of the boom with the pump off.
4	SPRAY ON/OFF	Opens the boom valves. With the pump running, the selected boom sprays. The spray sheet is visible behind the helicopter and reacts to the rotor downwash.
5	BOOM L / BOTH / R	Selects the left boom, both booms or the right boom. Each click steps to the next position. Every flight starts with BOTH.
6	JETTISON guard and JETT switch	Lift the red guard, then flip JETT to open the dump door and empty the tank in a few seconds. This is the emergency jettison for a power loss or a low-RPM situation. Closing the guard switches the jettison off again. The dump needs no pump.

Bindings. The simulator's `SPRAY ON`, `SPRAY OFF` and `TOGGLE SPRAY` controls work the SPRAY switch. Switching the spray on from a binding also switches the pump on, so one button on your cyclic runs the whole kit. Spray off leaves the pump running. If you hide the cyclic (9.4) the box disappears with it, but the bindings keep working.

Flying the spray run

- Plan each pass into or across the wind at 3–10 ft above the crop and 40–60 KIAS. Switch the spray on at the start of the swath and off at the end, and turn around outside the field. The boom is wide, so keep the turns shallow near the ground.
- Spraying with one boom (BOOM L or R) covers the edge of a field without over-spraying the next one.
- Watch the power. Near maximum gross weight hover performance is reduced, and the helicopter settles if you slow down too far on the turn. If you lose power over the field, lower the collective, then jettison.

The spray kit is not fitted to the other airframes. The Agricultural variant is otherwise the same R22, with the same avionics fits, panel layouts and liveries.



Figure 9-13 The Agricultural variant: boom, tank, pump and filters.



Figure 9-14 Spraying with both booms: the spray sheet behind the boom, flattened by the rotor downwash.



Figure 9-15 From the pilot's seat during a spray run, control box on the cyclic.

9.8 Liveries

The package ships with **43 liveries**, 21 of them new for Microsoft Flight Simulator 2024. All of them share the same interior. Between them they carry registrations from the United States, Canada, the United Kingdom, Australia, New Zealand, Germany, Austria, Switzerland, France, Belgium, Spain, Italy, Norway, Japan, Brazil and South Africa. Every livery is available on every variant. Choose it on the livery tab of the aircraft selector.



Figure 9-16 Four of the 43 liveries.

9.9 Fuel and loading from the tablet

Fuel and payload are set in the simulator's own **Aircraft** app on the tablet (*Mass and balance*). The **Seats** tab takes the pilot and passenger weights, **Cargo** the baggage compartments under the seats, **Liquid** the spray tank on the Agricultural variant (9.7), **Fuel** the main and auxiliary tanks, and **Empty** the aircraft's empty weight. The diagram shows the resulting center of gravity against the envelope. Keep it inside. The real R22's loading rules apply (2.3): 240 lb maximum per seat including the compartment below it, 50 lb per compartment, no stowage in the footwell, and a 135 lb minimum solo pilot weight with full auxiliary fuel. The simulator does not enforce them for you, and its seats accept up to 300 lb. Its CG envelope is a simplified box drawn from the widest limits, so near an edge check against the POH envelope. The R22 is small. Two 200 lb people and full fuel is over gross weight.

Add a passenger on the Seats tab and the simulator's passenger sits in the left seat (Figure 5-11, right). Fuel can also be added on the ramp through the filler caps (5.6) or by calling the fuel truck from the ground-services menu.



Figure 9-17 The simulator's Mass and balance page on the tablet (Seats tab), with the navigator in the side pod beside it.

10 Troubleshooting and FAQ

Symptom	Likely cause and fix
The helicopter yaws and drifts on its own as soon as I lift; the pedals feel dead.	Assisted Tail Rotor and/or Assisted Cyclic are on (3.1). Turn both off.
Moving my throttle lever raises the collective instead of the twist grip.	The lever is bound to `COLLECTIVE AXIS` or to the airplane `THROTTLE AXIS` (which drives the collective here). Bind the grip to `SET HELICOPTER THROTTLE AXIS` and the collective to `COLLECTIVE AXIS` only.
Force trim does nothing / the stick snaps back after I release FTR.	Check both bindings in 3.4: `SET HELICOPTER FORCE TRIM RELEASE BUTTON` with Input Repetition ON and `QUICK TRIM` on the same button with Set Control On Release. Make sure neither `SET ROTOR LONGITUDINAL TRIM` nor `SET ROTOR LATERAL TRIM` is bound to an axis.
FTR lags half a second on a quick tap.	The `QUICK TRIM` on-release binding is missing or on a different button.
My "trim" button zeroes everything.	It is bound to `ROTOR TRIM RESET`: a reset, not a force trim release.
A quick tap of FTR hardly trims at all.	A tap re-references the SAS but moves little stick load into the trim. Hold FTR a few seconds while you ease the stick to center (6.2).
Pulling RT TRIM rolled the helicopter a little.	Normal. The knob adds a fixed right trim (about 1.8%) when pulled and takes it away when pushed in (4.3). Pull it in cruise before you trim with FTR. Push it in before the approach and re-trim.
The SAS switched off when I pressed AP DISC.	AP DISC drops the autopilot modes first and leaves the SAS engaged. It disengages the SAS when no mode is armed or active, on a second press or after the modes have already dropped below 44 KIAS (6.3). To drop a single mode, press its lit button on the HCP.
The helicopter rolls or pitches steadily while I hold FTR.	You are holding a large stick deflection with FTR pressed, and the deflection is flowing into the trim. Hold the attitude, let the stick center, release (6.2).
SAS will not engage; the SAS light is dark or the mode lights are flashing.	No power (battery off), the avionics switched off by an avionics-master binding (press it again, 3.5), or the GAUGES breaker pulled, which darkens the HeliSAS lights (4.8). For five seconds after power-up the mode lights blink white and every button is ignored. Wait, then press SAS.
HDG / NAV / SPD / ALT buttons do nothing.	SAS is not engaged, or airspeed is below 44 KIAS. If you are pressing a bound button rather than the HCP, make sure it is one of the controls listed in 3.5. Not every autopilot control in the simulator reaches the HeliSAS.
VRT will not arm, or will not capture.	VRT only arms while NAV is armed or active. It captures when a glideslope or glidepath needle comes alive near the center. So the navigator must be flying an approach with vertical guidance: an ILS on VLOC, or an LPV, LNAV/VNAV or LNAV+V approach on GPS.
All autopilot modes dropped off at once.	Airspeed fell below 44 KIAS. The SAS is still engaged. Re-select the modes at or above 44 KIAS. A lost NAV signal drops NAV back to armed, not the other modes.
RPM will not come up to 102–104%; GOV OFF is lit.	The governor switch on the collective tip is off. Switch it on before passing 80%. After spawning ready-to-fly, check the switch. If the simulator loaded the aircraft with the governor off, the light tells you.
RPM will not come up to 102–104%; GOV OFF is dark.	Below 80% the governor does nothing. Roll the throttle up past 80% and it takes over. Or you have overridden it with the twist grip, which leaves the light dark. Roll the grip back up past where the governor was holding, park a throttle axis fully open, or cycle the governor switch (a governor-ON binding also hands the throttle back). Or the GOV breaker is pulled (4.8).

Symptom	Likely cause and fix
The governor stopped holding RPM after I touched the throttle.	A deliberate roll-down of the grip overrides the governor (5.2). Roll the grip back up past where it was holding, or cycle the governor switch.
Engine quits in cruise with no warning.	Carburetor ice with the governor masking it (5.1), fuel exhaustion (LOW FUEL ignored), or the mixture pulled. Lower the collective at once (8.1). Then, if height allows, carb heat full on (knob out), fuel valve on, and an air restart (8.2).
The low-RPM horn sounds whenever I raise the collective on the ground.	Rotor RPM is below 97% because the governor is off or the throttle is not up. The horn is doing its job. The aircraft is not ready to fly.
CLUTCH light never goes out.	It stays on while the actuator tensions the belts after you engage, and again while it releases them after you disengage, up to about 40 seconds each time. Never take off with it on. At shutdown leave the battery on until it goes out. If it stays on much longer, check the CLUTCH START breaker (4.8). In flight, see 4.2.
A light, instrument or radio stopped working.	A breaker is pulled. Each one cuts what its label says. Check the panel forward of the left seat and push it back in (4.8).
ATC says the electrical systems must be turned on.	The battery is off, or an avionics-master binding has switched the avionics off (3.5).
No cold-and-dark start on a helipad.	A simulator limitation. Helicopters spawn running on helipads. Start from an airport parking spot for the full walkaround and cold start.
The navigator is missing, or the GTN shows a dead bezel.	The Instrument Panel setting is ANALOG, which has no navigator. It is the first-flight default; set DIGITAL ×1 or ×2 (9.1). Or a PMS50 or TDS variant was loaded without that package. Install it or pick the GNS variant. Both screens dark: the GPS breaker (4.8). One dark GNS screen: its COM power/volume knob (5.10).
The TDS variants are not in the selector.	They are hidden until the R22 TDS patch from CowanSim.com is installed, which is possible on PC only and needs the TDS GTNXi (1.3).
I cannot open the doors.	The bubble cover is still on. Remove it from outside (or from the tablet).
The windshield is covered in bugs.	Press CLEAN in the R22 Settings app to wipe them off, or set Hide Bug Splatter to HIDDEN to keep them off (9.1).
I opened the door but I am still standing outside.	The door only opens. Click the enter spot in the doorway to take the seat (9.3). To get out, open the pilot's door from inside and click the exit spot.
The ground-handling wheels disappeared.	They drop off automatically when the engine fires or the rotor turns, and runway and in-air starts never have them fitted. Refit them from the R22 Settings app with the engine off and the rotor stopped (9.5).
The rotor brake handle does nothing when I click it.	It is a pull-and-hold handle. Press and drag it sideways to brake, and while holding pull it down to lock. A fresh press and push up releases it (4.6).
The rotor stops or will not turn, but the BRAKE light is out.	The rotor brake was applied with the simulator's own rotor-brake key (Ctrl+/), which the handle and the BRAKE light do not show. Press the same key again to release it, and use the cockpit handle from then on (3.5).
It takes a lot of pedal to yaw.	That is Real Tail Rotor Feel Simulation (ON by default). Without real pedals, switch it OFF in the R22 Settings app (9.1).
Which stick setting do I pick?	SPRUNG for a self-centering stick (most joysticks), NOT SPRUNG otherwise (9.1).
Tooltips do not appear on the cockpit controls.	Enable instrument tooltips in the accessibility options and hover a moment longer. Some spots are invisible until hovered.
The cockpit stick sits off-center although my joystick is centered.	That is the trim. Press `ROTOR TRIM RESET` if you want it back to neutral.
Lights and annunciators are hard to see by day.	Both brighten automatically in daylight. If they stay dark, check the battery, the PANEL LTS DIM knob and the WARN LTS, GAUGES and NAV LTS breakers.

Appendix A Binding Quick Card

Names are the MSFS 2024 Controls Options labels — type part of the name in the search box. EFB: `TOGGLE EFB` (TAB).

Function	Search for	Option
Collective	`COLLECTIVE AXIS`	invert as needed
Throttle (twist grip)	`SET HELICOPTER THROTTLE AXIS`	separate axis, or leave unbound
Cyclic fore/aft	`SET CYCLIC LONGITUDINAL AXIS`	
Cyclic left/right	`SET CYCLIC LATERAL AXIS`	
Pedals	`TAIL ROTOR AXIS`	
Force trim release	`SET HELICOPTER FORCE TRIM RELEASE BUTTON`	Input Repetition ON
Force trim release (same button)	`QUICK TRIM`	Set Control On Release ✓
Trim reset (optional, not FTR)	`ROTOR TRIM RESET`	momentary button
Trim hat (optional)	`INCREASE` / `DECREASE ROTOR LONGITUDINAL TRIM`, `INCREASE` / `DECREASE ROTOR LATERAL TRIM`	Input Repetition ON
Governor	`TOGGLE ENGINE GOV SWITCH`	
Clutch	`TOGGLE ROTOR CLUTCH SWITCH`	
Start / key	`MAGNETOS START`, `MAGNETOS BOTH`, `MAGNETOS OFF`	START: about 3 s per press
Mixture	`MIXTURE AXIS (0 TO 100%)` or `SET MIXTURE RICH` / `LEAN`	guard does not lock it
Carb heat	`TOGGLE ANTI ICE`	
Battery / alternator / avionics	`TOGGLE MASTER BATTERY`, `TOGGLE MASTER ALTERNATOR`, `TOGGLE AVIONICS MASTER`	avionics: no cockpit switch (3.5)
Strobe / nav / landing lights	`TOGGLE STROBES`, `TOGGLE NAV LIGHTS`, `TOGGLE LANDING LIGHTS`	strobes, not beacon
Night-vision goggles	`TOGGLE NIGHT VISION`	PC default: Z
ELT	`TOGGLE ELT`	transmits directly; remote switch stays put
Spray kit (Agricultural)	`SPRAY ON` / `SPRAY OFF` / `TOGGLE SPRAY`	spray on also starts the pump; off leaves it running
SAS on/off	`TOGGLE AUTOPILOT MASTER`	also `AUTOPILOT ON` (engage only)
HDG / NAV	`TOGGLE AUTOPILOT HEADING HOLD`, `AUTOPILOT NAV1 HOLD`	`AUTOPILOT HEADING HOLD ON` engages HDG without toggling (3.5)
SPD / ALT / VRT	`AUTOPILOT AIRSPEED HOLD`, `TOGGLE AUTOPILOT ALTITUDE HOLD`, `TOGGLE AUTOPILOT VS HOLD`	SPD and ALT also have ON variants (3.5)
AP disconnect	`AUTOPILOT OFF`	1st press: modes off, SAS stays; again: SAS off
Heading bug / altimeter	`INCREASE` / `DECREASE HEADING BUG`, `INCREASE` / `DECREASE ALTIMETER`	

Appendix B Limitations and Speeds Quick Card

Item	Limit
Vne	102 KIAS to 3000 ft DA, less above (placard, 2.3); Mariner 95, power off 80 KIAS
Rotor RPM, power on	101–104% (green); horn and light below 97%; warble from 108%
Rotor RPM, power off	90–110%
Engine RPM	104% continuous (2652); 106% transient
Manifold pressure	Per placard (Figure 2-3); yellow 19.6–24.1 in Hg; red line 24.1
CHT / oil temperature	500 °F max / 245 °F max
Oil pressure	25 psi idle min; 55–95 psi in flight; 115 psi max start
Carb air temperature	Keep out of −15 to +5 °C; full heat below 18 in Hg
Weights	1370 lb gross; 240 lb per seat incl. baggage; 50 lb per compartment; solo 130 lb min (135 with full aux)
Fuel	Main 16.9 gal, aux 9.4 gal usable (26.3 total); LOW FUEL at 1.5 gal usable ≈ 10 min
Flight	No aerobatics; no low-G pushovers; governor ON; VFR day/night; 14,000 ft DA max
Wind (low-time pilots)	Max 25 kt incl. gusts; gust spread 15 kt; no moderate turbulence

Speeds (KIAS)

Takeoff & climb	Vy	Max range	Turbulence	Approach	Autorotation	Max glide (above 500 ft AGL)
60	53	83	60–70	60	60–70	75 @ 90% RPM

HeliSAS

Item	Value
Autopilot modes available	At or above 44 KIAS (drop automatically below)
ALT minimum	200 ft AGL
VRT	Arms only with NAV armed/active; captures on a live glideslope/glidepath
AP DISC	First press: all modes off, SAS stays engaged; with no mode armed or active: SAS off
Hand on cyclic	Below 200 ft AGL and during engagement/disengagement
Cyclic friction	Fully OFF with SAS/autopilot engaged
LEDs	White armed/standby • Green engaged • Dark off • Mode lights blinking white = 5-second self-test

Shutdown timing

Cool at 70–75% → throttle closed → clutch disengage → **30 s** → mixture off → **30 s** → rotor brake (do not stop the rotor in under 20 s) → clutch light out → switches off.

Appendix C Glossary

Term	Meaning
AGL	Above ground level
AP DISC	Autopilot disconnect button on the cyclic
ATC	Air traffic control
CAT	Carburetor air temperature
CDI	Course deviation indicator; also the GPS/VLOC source selection on the navigator
CG	Center of gravity
CHT	Cylinder head temperature
DA	Density altitude — pressure altitude corrected for temperature
EFB	Electronic flight bag — the simulator's tablet (TAB)
ELT	Emergency locator transmitter
FCC	Flight control computer (HeliSAS)
FTR	Force trim release
HCP	HeliSAS control panel
IGE / OGE	In / out of ground effect (hover performance)
ILS	Instrument landing system: localizer and glideslope
KIAS / KCAS / KTAS	Knots indicated / calibrated / true airspeed
LPV, LNAV/VNAV, LNAV+V	GPS approach types with vertical guidance (VRT can couple to them)
LTE	Loss of tail-rotor effectiveness
MAP	Manifold pressure, in Hg — the R22's power gauge
MR / TR	Main rotor / tail rotor
NR	Rotor RPM — the rotor tachometer needle (its breaker is TACHS R)
OAT	Outside air temperature
POH	Pilot's Operating Handbook
SAS	Stability augmentation system
SFAR	Special Federal Aviation Regulation (SFAR 73 covers R22 and R44 pilot training)
VFR	Visual flight rules
VLOC	VOR / localizer navigation source
Vne	Never-exceed speed
Vy	Best rate-of-climb speed

Appendix D Sources

Real-aircraft data in this manual was taken from the following publications. They are the authoritative references; where this manual and they disagree, they are right.

- Robinson Helicopter Company, *R22 Pilot's Operating Handbook and FAA Approved Rotorcraft Flight Manual*, Sections 1–10 (current revision February 22, 2024): www.robinsonheli.com/publications
- Robinson Helicopter Company, *R22 Beta II* specifications and brochure (2024); *Safety Notices* SN-10, SN-11, SN-24, SN-25, SN-29, SN-31, SN-32, SN-36, SN-37, SN-38, SN-42.
- EASA Type-Certificate Data Sheet EASA.IM.R.120 (Robinson R22), incorporating FAA TCDS H10WE data.
- Genesys Aerosystems, *HeliSAS Stability Augmentation System and Autopilot — Pilot's Operating Handbook*, 4th edition, 2016.
- Robinson Helicopter Company, *R44 / R66 Pilot's Operating Handbook Section 9 — HeliSAS Autopilot Supplement* (FAA approved 2022).
- Microsoft Flight Simulator 2024 SDK documentation — Key Events (helicopter, engine, electrical, autopilot), Helicopter SimVars, Control Preset Creation Guide; Microsoft Flight Simulator support articles on the 2024 Controls Options, controller profiles and the EFB.
- Vertical Magazine, "40 years of the Robinson R22" (2019); Australian Flying, "Robinson celebrates 50 years of the R22" (2025).

Thank you for flying CowanSim.

Appendix E Gallery

The CowanSim R22 Beta II in Microsoft Flight Simulator 2024.



Cruising beneath a towering cumulus.





Into the setting sun.



Winter in the mountains: flying over the peaks • on the ramp • ready for lift-off • over the valley with this manual on the tablet.



The engine bay from below, with the moon.



Night flight over the town, landing lights on.



Rainbow on the ramp • Under the mountains • Covered on the ramp • The Mariner on the water.



Spraying past the wind farm.



Evening light • Landing lights on at dusk • Flaring over the runway • Over the rooftops.



The Agricultural variant at work.



Low level in the evening light.



On the ramp: the Agricultural variant covered at sunset • ready to spray • the Default with its doors open • engine bay open.



Sunset over the hills and the bay.



The Mariner settling onto the water by the harbor.



Over the town at sunset.



The Mariner on a helipad before an aurora borealis helicopter tour.



The Mariner flying off into the mountains.



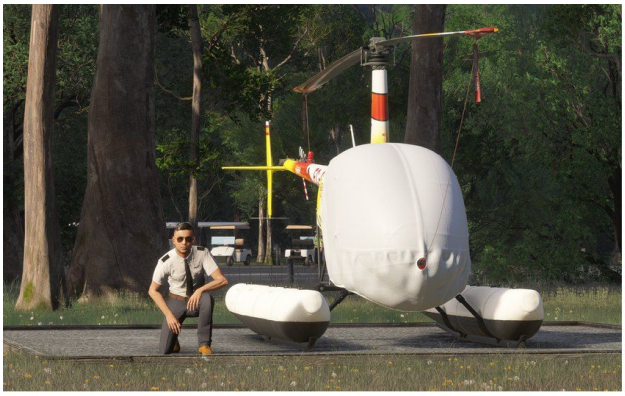
Head-on over the fjord, landing lights on.



On a snowy ramp • Beached on the sand • Water-taxiing in the shallows • Evening over the city lights.



Climbing out over the lake.









Covered for the night • Lifting off the water • Low over the water • The Canadian livery's engine bay.



Turning in the fjord.



Aurora Helicopter Charter, waiting on the pad.