Robinson R22 Sample (R-22 set includes 566 total pages)

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PRIVATE PILOT GROUND LESSON ONE

PURPOSE

The purpose of this lesson is for the student to learn and understand the specifics of Helicopter Components, Flight Controls, Electrical Systems, Fuel and Fuel System, Oil and Oil Systems and Helicopter Instruments

EMPHASIS

- ♦ Main Rotor
- ♦ Tail Rotor
- ♦ Engine
- ♦ Swash Plate Assembly
- ♦ Drive System
- ♦ Flight Controls
- ♦ Electrical Systems
- ♦ Ignition System
- ♦ Fuel & Fuel System
- ♦ Oil & Oil System
- ♦ Instruments
- ♦ Pitot Static System

SCHEDULE

♦ Introduction	:10
♦ Classroom Instruction	2:00
♦ Question Answer Session	:20
♦ Lesson Evaluation	:30

EQUIPMENT AND STUDY MATERIAL

- ♦ Rotorcraft Flying Handbook (RFH) & POH

INSTRUCTOR'S ACTIONS

- ♦ Introduction-Discuss lesson objective
- ♦ Lesson-Introduce and explain elements
- ♦ Conclusion- Question answer session
- ♦ Evaluation

STUDENT'S ACTIONS

- ♦ Introduction-Discuss lesson objective and resolve questions
- ♦ Lesson-Takes notes and resolve questions
- ♦ Conclusion-Ask pertinent questions
- ♦ Evaluation

COMPLETION STANDARDS

Student displays an understanding of the material presented by oral quizzing.

LESSON 1 3.0 Hours Ground Training

Objectives

This lesson will introduce the student to the basic R-22 helicopter components, systems, and instruments.

Recommended Study Material and Equipment for This Lesson

The Robinson R-22 Pilot Operating Handbook (POH)- sections 1 and 2, the Rotorcraft Flying Handbook- chapters 1,2, 3, and 4 and the Private Pilot Test Prep- Chapter 2 and 3. Other materials may be needed for class.

Lesson Content

1. Helicopter Components
    - a. Main rotor
    - b. Tail rotor
    - c. Power plant (Engine)
    - d. Swash plate assembly
    - e. Drive system diagram
        - 1) Gearboxes
        - 2) Bearings
        - 3) Drive train
        - 4) Tail cone (Empennage)
            - a) Vertical stabilizer
            - b) Horizontal stabilizer
    - f. Clutch (Actuator motor)
    - g. Landing gear
2. Flight Controls
    - a. Cyclic
    - b. Collective
    - c. Throttle
        - 1) Electronic governor
        - 2) Mechanical correlator
    - d. Pedals
3. Electrical System
    - a. Battery
    - b. Alternator
    - c. Circuit breakers
    - d. Magnetos
    - e. Fuses
    - f. Aircraft lights
        - 1) Navigation (Position) lights
        - 2) Anti-collision light
        - 3) Landing lights
        - 4) Instrument panel lights
        - 5) Map light
4. Fuel and Fuel Systems
    - a. Proper fuel
    - b. Supplemental fuel grades
    - c. Fuel system diagram and operation

- d. Fuel contamination
  - 1) Preventative measures
  - 2) Elimination measures
- e. Improper fuel
  - 1) detonation

5. Oil and Oil Systems
   - a. Type and quantity
   - b. Oil system operation
   - c. Differences between wet and dry sump oil systems
6. Instruments- Function and Limitations
   - a. Engine
     - 1) Tachometer
     - 2) Manifold pressure
   - b. Rotor
     - 1) Tachometer
     - 2) Low rotor RPM system
   - c. Flight- function and limitations
     - 1) Pitot-static system
       - a) Pilot source
       - b) Static source
       - c) Alternate pilot-static sources
       - d) Airspeed indicator
       - c) Pressure altimeter
       - d) Vertical speed indicator
     - 2) Magnetic compass
       - a)Acceleration, deceleration, and turning errors
       - b)Variation
       - c)Deviation

COMPLETION STANDARDS

This lesson will be complete when, the student displays an understanding of the material presented by oral quizzing.

Lesson 1 Helicopter Systems

Overview

This lesson will introduce the student to the components, systems and instruments of the R22 helicopter.

Objectives

After completion of this lesson you will know the specifics of:

Helicopter Components	Flight Controls
Electrical Systems	Fuel and Fuel System
Oil and Oil System	Instruments

Helicopter Systems

Flight Controls
Electrical Systems
Fuel and Fuel System
Oil and Oil System
Instruments

Helicopter Components

Main Rotor on an R22

- Two all-metal blades
- Honeycomb construction on the interior
- Stainless Steel leading edge
- Symmetrical airfoil
- Semi-rigid system
- Able to feather (pitch change)
- Both blades flap as a single unit (rigid in-plane)
- Under-slung on Teeter Hinge
- Coning Hinges at blade attachment to hub
- 25 ft 2 in diameter – 7.2 in chord - 8° washout (twist)
- Tip speed 672 fps at 100% rpm
- At 104%, Main Rotor RPM is 530

Tail Rotor

- Two all-metal blades
- Honeycomb construction on the interior, Aluminum skin
- Asymmetrical airfoil
- Semi-rigid system
- Able to feather (pitch change)
- Offset delta hinge to allow blade flapping
- Both blades flap as a single unit (rigid in-plane)
- Fixed Coning angle
- 3 ft 6 inch diameter – 4 inch chord
- Tip speed 599 fps at 100% rpm
- At 104%, Tail Rotor RPM is 3396

Engine

- Lycoming O-360-J2A (Beta II)
- 361 cubic inches displacement
- 180 BHP derated to 124 BHP @ 2652 rpm (104%rpm) maximum continuous
- 131 BHP @ 2652 rpm (104%rpm) five minute take off rating
- 4 –cylinder Horizontally-opposed
- Direct-drive
- Air-cooled
- Carbureted
- Normally-aspirated
- 2 Magnetos
- Direct-drive Squirrel Cage Cooling Fan
- Wet sump oil system
- Starter
- Alternator
- Shielded Ignition
- Oil Cooler
- Induction Air Filter
- 4-6 quart oil fill range
- 2200 hours between overhauls (TBO)

Swash Plate Assembly

Consists of a stationary plate and a rotating plate separated by a high-performance bearing.

- Three control rods come up from the Collective and Cyclic to move the Stationary plate.
- Two Pitch Links connect the two blades to the rotating swash plate assembly
- The Collective moves all three control rods at the same time (collectively).
- This causes equal pitch change to occur on both blades.
- The Cyclic moves each of the three control rods independently, causing both swash plates to tip at various angles (cycle).
- This causes each blade to change its pitch back and forth independently as the rotor system rotates.
- This periodic pitch change is called Cyclic Feathering.
- The rotor disc tilts accordingly, causing thrust in the direction of the tilt.

Drive System Gear Boxes

- The Main Rotor
  - Single-stage spiral-bevel gear set
  - 11 : 47 speed reducing ratio
  - Splash lubricated
  - Air cooled
- The Tail Rotor
  - Single-stage spiral-bevel gear set
  - 3 : 2 speed increasing ratio
  - Splash lubricated
  - Air cooled

Drive Train

- The Lower Sheave is bolted directly to Engine output shaft.

- Twin V-belts transfer power to the Upper Sheave.
- The Upper sheave has a larger diameter than the lower, resulting in a speed reduction of 0.8536 to 1.
- The Upper Sheave has a Freewheeling unit, or Sprague Clutch, contained in its hub.
- The Freewheeling unit allows the main and tail rotors to continue rotating (autorotate) if the engine stops.
- Power is transferred forward along the Clutch Shaft to the Main Rotor Gear Box and rearward along the Tail Rotor Shaft to the Tail Rotor Gear Box.
- Flexible couplings (Yoke flanges and flex plates) along the drive shafts allow for minor misalignments in the drive shafts.
- A damper placed midway along the length of the tail rotor drive shaft supports the shaft.

Clutch

- When starting the engine, the V-belts have slack between the upper and lower sheaves. The engine is turning, but the belts are not.
- After the clutch is engaged, an electric actuator slowly raises the upper sheave.
- As the actuator extends, the friction from the belts causes the rotor drive shafts to begin turning.
- The Clutch light, in the cockpit will go out when belts are fully tensioned.

Landing Gear

- Spring and yield skid type landing gear is used. This type of gear is designed to absorb the impact of most hard landings. In the case of an extremely hard landing, the struts will hinge up and outward and the center cross tube will yield to absorb the impact.
- There are three hardened steel wear shoes located on the bottom of each skid. When the thinnest point on a shoe is less than 1/16th of an inch, the shoe should be replaced.

Flight Controls

Cyclic

- The function of the cyclic is to tilt the main rotor disc in the direction of desired horizontal flight.
- While hovering, any forward, backward or sideways movement of the cyclic causes the helicopter to move accordingly.
- While in flight, turns are accomplished by right and left movement of the cyclic.
- Unlike an airplane, almost no pedal input is used for turns while in flight. Lots of pedal input is used during hover and low speed maneuvers.
- Airspeed is controlled primarily with the cyclic. Forward movement of the cyclic causes the helicopter to accelerate, and vice versa.
- There is a separate friction knob associated with the Cyclic that serves to hold the cyclic in position when not in flight.
- Dual Controls. (Left side controls removable)

Collective

- When the collective control is raised, pitch is increased correspondingly on both main rotor blades causing them to “bite” more air.
- This increase in pitch tends to slow the main rotor down because of the additional air being pushed downward, so the engine has to increase its output to maintain a constant RPM level.

- The R22 has an electronic governor that drives a mechanical correlator that automatically opens ands closes the throttle as required to maintain the RPM constant though all phases of powered flight.
- The governor switch is located at the very end of the right-side collective lever.
- There is an associated friction knob for the collective that serves to hold the lever in the down position when not in flight.
- The Collective lever is balanced so it holds its position in flight allowing the use of the left hand for other tasks. (Friction is off)
- Dual Controls. (Left side controls removable)

Throttle

- The Throttle is the twist-grip at the end of the collective lever.
- Twisting the throttle to the left (thumb up) causes the engine to increase RPM.
- Twisting the throttle to the right (thumb down) causes the engine to decrease RPM.
- If the Governor is turned off (or fails), the engine RPM is controlled manually with the throttle.

Pedals

- The Pedals control the pitch on the Tail Rotor thereby adding more or less thrust.
- If the left pedal is pressed, the nose of the helicopter will be caused to turn to the left.
- If the right pedal is pressed, the nose of the helicopter will be caused to turn to the right.
- The pedals behave in a "give-and-take" manner relative to each other. That is, if the left pedal is pushed towards the floor, the right pedal must be released and allowed to move away from the floor.
- Dual Controls. (Left side controls removable)

Electrical Systems

Battery

- 12 volt – 25 amp-hour
- Located on left side of engine compartment
- Primary purpose is to supply power for engine starting
- Secondary purpose is to supply nominal voltage to alternator. (Also to run electrical system in case of alternator failure)
- If the battery is dead (flat), the alternator will not work.
- Master Battery Switch on console disconnects the battery from all circuits except the tachometers and clock.

Alternator

- 14 volt – 60 amp
- Located on rear of engine compartment
- The Alternator is the primary source of power to electrical systems during normal operations.
- The Voltage Regulator protects the electrical system from over voltage conditions.
- If Alternator fails, the battery will drain and no longer supply current to tachometers.
- Alternator switch, Ammeter, and Alt light on console.
- Circuit Breakers
- All Circuit Breakers are of the push-to-reset type.
- If a breaker pops up, wait for a moment for it to cool before resetting.
- If a breaker pops again soon after being reset, it shouldn't be reset a second time.

- All breakers should be checked to be pushed down before each flight. (The landing lights breaker may be pulled up if it is clearly to be a day flight.)
- The circuit breakers are located on a ledge right in front of the passenger seat.

Ignition System

- Dual Ignition system with two Magnetos.
- A Magneto is a small AC generator driven by the engine to provide a very high voltage to a distributor (one distributor in each magneto), which directs it to the spark plugs.
- There are two spark plugs per cylinder for safety and efficiency.
- The ignition system is totally independent of the helicopter electrical system. Once the engine is running, it will operate regardless of the condition of the battery or alternator.
- The magnetos are tested with the ignition key as part of the pre-flight checklist.
- There is a warning light on the console for the starter. It should go out as soon as the key is released after the engine has started.

Aircraft Lights

- Red anti-collision strobe light installed on the tail boom.
- Three Navigation lights are installed:
    - Green below the pilot door (right side)
    - Red below the passenger door (left side)
    - White on the end of the tail boom facing backwards.

    Two Landing lights are installed in the nose of the helicopter at different vertical angles (one for steep approaches & autorotations, one for normal approaches) to increase the pilot's field of vision, and for redundancy.
- For nighttime illumination, the instrument panel is equipped with dimmable panel mount or integral instrument lights.
- A chart light is also provided at head level between the two seats.

Fuel and Fuel System

Proper Fuel
Available Fuel Grades

• 80/87 aviation fuel	Red
• 100LL aviation fuel	Blue
• 100/130 aviation fuel	Green
• Jet A fuel	Straw
• 100LL	Blue

When any two grades of aviation fuel are combined, the mixture turns clear.
This clear mixture can still be distinguished from Jet A fuel because Jet A is <u>oily</u> to the touch, while aviation fuel has the thin, evaporative feel.

- **<u>MAIN</u>** Tank
    - Total Capacity - 19.8 US gal
    - Useable Capacity - 19.2 US gal
- **<u>AUX</u>** Tank
    - Total Capacity - 10.9 US gal
    - Useable Capacity - 10.5 US gal
- Gravity-Flow system

- No Fuel Pumps
- Both tanks are interconnected allowing aux tank to drain into main tank.
- Fuel Gages operated by float-type sensors in each tank.
- Low Fuel warning light activates with approximately one gallon of fuel remaining.

Fuel Contamination

- Types of Contamination
  - Water
  - Debris - Solids
- Prevention
  - Fill Tanks at the end of the day
    This helps prevent condensation from forming inside the tanks.
- Elimination
  - Keep draining batches into fuel tester until contamination is eliminated.
- Improper Fuel

  The use of low-grade or an air/ fuel mixture which is too lean may cause **detonation**, which is the uncontrolled spontaneous explosion of the mixture in the cylinder. Detonation produces extreme heat. **Preignition** is the premature burning of air/ fuel mixture. It causes an incandescent area (such as a carbon or lead deposit heated to a red hot glow) which serves as an igniter in advance of normal ignition.

Oil and Oil System

- The Oil System lubricates, cools and cleans the engine.
- Wet sump, Oil Pump (pressure) feed, splash-lubricated crankshaft, air-cooled system.
- Oil Temperature and Pressure monitored by gages on the instrument panel.
- After checking the oil and replacing the Dipstick, be careful not to over tighten the cap. (Finger tight only.)
- Oil Type and Quantity
- Type
  - Ashless Dispersant Grade
  - 100W SAE50 for all average ambient air temperatures
- Quantity
  - 4 to 6 Quarts

  Wet vs. Dry Sump

  In a **dry-sump system**, the oil is contained in a separate tank and circulated through the engine by pumps. In a **wet-sump system**, the oil is carried in a sump which is an integral part of the engine.

Instruments

- Engine & Rotor
  - Dual Tachometer
- The Dual Tachometers display the RPM percentages of the Engine and the Main Rotor.
- The Tachometers will continue to register even if the engine is not running and the master battery switch is off. (Like in an autorotation)

  Rotor Tachometer Markings

- Upper red line 110%

- Upper yellow arc 104 to110%
- Green arc 101 to 104%
- Lower yellow arc 90 to 101%
- Lower red line 90%
- Bottom yellow arc 60 to 70%

  Engine Tachometer Markings
    - Upper red arc 104 to 110%
    - Green arc 101 to 104%
    - Lower red arc 90 to 101%
    - Bottom yellow arc 60 to 70%

    Low RPM System
- A warning light and horn indicate that rotor RPM has dropped to or below 97%. This system is disabled when the collective is in the full down position.
    - Manifold Pressure
- The Manifold Pressure gage displays the amount of power being produced by the engine to turn the main rotor and tail rotor.
- Changes in the position of the Collective are directly reflected on the Manifold Pressure gage.
- Manifold Pressure Markings
    - Upper red line 24.1 in. Hg
    - Yellow arc 19.6 to 24.1 in. Hg

Pitot static System

    Pitot-static source
    - The Pitot tube is located on the front of the mast faring above the cabin.
    - The Static Source is located inside the aft cowling.
    - Alternate Pitot-static source
    - The R-22 does not have an alternate static source.
- The Pitot tube supplies pressure only to the Air Speed Indicator
- The Static source supplies pressure to the Altimeter, the Vertical Speed Indicator, and the Air Speed Indicator

Air Speed Indicator

- Displays the speed of the helicopter relative to the air moving past the Pitot tube.
- The speed displayed here is the Indicated Air Speed. (KIAS)
- Flying into a headwind will show airspeed greater than the ground speed and flying with a tailwind will show less.
- Airspeed is controlled primarily with the Cyclic. Changes in the Collective position will have a secondary effect.
- Air Speed Indicator Markings
- Green arc 50 to 102 KIAS
- Upper red line 102 KIAS (VNE) (up to 3000ft D.A)
- Velocity to never exceed (VNE) will vary with pressure altitude and outside air temperature (OAT).

Altimeter

Displays the indicated altitude of the helicopter.

- Changes in altitude are determined by measuring changes in barometric pressure.
- The adjustment knob allows you to set the local altimeter setting in the small "Kollsman" window on the right.
- By keeping this setting current as you fly, your indicated altitude will match your true altitude.
- Changing the altimeter setting by 0.1 inch will change the altitude by 100 feet.

  Reading the Indicator
    - The long skinny hand is Hundreds
    - The short fat hand is Thousands
    - The outside triangle is Tens of Thousands

Vertical Speed Indicator

- Displays the rate of change of altitude of the helicopter, either up or down.
- Vertical speed is determined by measuring the rate of change of barometric pressure.
- Vertical speed is controlled primarily by changes in the Collective position and secondarily by changes in the Cyclic.

Magnetic Compass

- The Compass displays the heading of the helicopter relative to magnetic north.
- Magnetic North differs from True North.
    - This is due to Earth's molten iron core.
- This difference is referred to as Magnetic Variation (or magnetic declination).
- The location of Magnetic North moves slowly over time.
- Isogonic lines connect points of equal variation.
- The Agonic line is where the variation is zero.
- Magnetic Variation must be taken into account in order to follow a course relative to true north.
- Each aircraft has various characteristic elements that generate on-board magnetic fields that interfere with the compass.
    - Metal components
    - Engine
    - Radios
    - Electrical accessories
- The combined influence creates a compass error referred to as Magnetic Deviation
    - The magnitude and polarity of this influence varies with different headings.
- Every aircraft has a Compass Correction Card mounted near the compass.
    - The card shows the calibrated values that correct for the deviations of that aircraft.
- Magnetic Deviation must also be accounted for to navigate a course relative to true north.
- Another series of Compass Errors exist because of a phenomenon called Magnetic Dip.
- Any Magnetic object (like the bar in a compass) when suspended from a pivot above the Earth, will align itself with the magnetic field, AND the north end of the bar will tip down towards Magnetic north.
    - This phenomenon is undetectable at the equator because the Earth's magnetic lines are parallel to the surface and the effect increases as the magnet moves closer to the pole because the Earth's magnetic lines are "pulled" down towards the surface.

    - Near the magnetic pole the north end of the magnetic bar begins to tip downward so much that the compass becomes unusable.
- To compensate for this tilting and to make the compass sit level (and thus read accurately), a small weight is placed on the south arm of the compass (for aircraft in the northern hemisphere).
- This new weight keeps the compass level, but the unequal mass causes some corresponding compass behaviors whenever the aircraft accelerates, decelerates, or turns...
- Acceleration Error:
- While flying mostly east or west, if you accelerate, then the inertia of the compass weight causes it to "lag" slightly and turn the compass towards the north.
- During deceleration, inertia causes the weight to "throw" slightly ahead and turn the compass towards the south.
- In both cases, once the acceleration is over and steady flight is resumed, the compass will display the correct heading.
- **ANDS - A**ccelerate **N**orth **D**ecelerate **S**outh
- Turning Error:
- If you're headed North and you start a turn, the small balancing weight will initially get "thrown" to the outside of the turn, making it seem like you're actually turning the other way.
- As the turn progress, the magnetic forces will begin to overcome the inertia and the compass will start to correct itself, allowing the compass to settle in and display the correct heading.
- Thus, turns to the left while headed north will initially show a heading to towards the east...
- …and, turns to the right while headed north will initially show a heading to towards the west.
- In both cases, you should intentionally **undershoot** your desired heading because as you complete your turn the compass will be coming around more quickly than normal to "catch up" with the turn.
- If you're headed South and you start a turn, the small balancing weight will initially "lag" behind to the outside of the turn, making it seem like you've turned far more, far sooner than you actually have.
- As the turn progress, the magnetic forces will begin to overcome the inertia and the compass will start to correct itself, allowing the compass to settle in and display the correct heading.
- Thus, turns to the left while headed south will initially show a larger-than-normal heading to towards the east.
- Turns to the right while headed south will initially show a larger-than-normal heading to towards the west.
- In both cases, you should intentionally **overshoot** your desired heading because as you complete your turn the compass will be coming around more slowly than normal as it waits for the turn to catch up.
- **UNOS - U**ndershoot **N**orth **O**vershoot **S**outh

Conclusion

In this lesson you have been introduced to the components, systems and instruments of the R22 helicopter.

Objectives

You now know the specifics of:

- Helicopter Components
- Flight Controls
- Electrical Systems

Oil and Oil System
Instruments
Fuel and Fuel System