PRIVATE PILOT

I. AREA OF OPERATION: PREFLIGHT PREPARATION

G. TASK: OPERATION OF SYSTEMS

OBJECTIVE

To determine that the applicant exhibits knowledge of the elements related to the operation of systems on the airplane provided for the flight test by explaining at least three (3) of the following systems:

1. Primary flight controls and trim.
2. Flaps, leading edge devices, and spoilers.
3. Water rudders (ASES).
4. Engine and propeller.
5. Landing gear.
6. Fuel, oil and hydraulic.
7. Electrical.
8. Avionics.
9. Pitot-static vacuum / pressure and associated flight instruments.
10. Environmental.
11. Deicing and anti-icing.

ELEMENTS

1. Primary flight controls:
    a. Ailerons: Mounted on outboard trailing edges of wings and connected to the control column via mechanical linkages to control roll about the longitudinal axis.
    b. Elevator or stabilator: Mounted on the tail horizontally and connected to the control column via mechanical linkages to control pitch about the lateral axis.
    c. Rudder: Mounted on the tail vertically and connected to rudder pedals via mechanical linkages to control yaw about the vertical axis.
2. Secondary flight controls:
    a. Flaps: Attached on inboard trailing edges of wings. The can be extended for high lift (landing) and retracted when not needed (cruise). Types include plain, split, slotted and Fowler flaps.
    b. Trim tabs: Elevator trim tabs relieve control column pressure in pitch.
3. Powerplant:
    a. The airplane engine and propeller work together to provide thrust and drive systems.
    b. Reciprocating engines' cylinder arrangement can be radial, in-line, v-type or opposed.
    c. Four-stroke operating cycle: Intake, compression, power and exhaust:
        i. Intake: Piston travels down and fuel/air mixture is drawn in the cylinder.
        ii. Compression: Intake valves close and piston is driven up.
        iii. Power: The pressurized fuel/air mixture is ignited and piston is driven down.
        iv. Exhaust: Intake valves open and cylinder moves up, purging the cylinder.
    d. Each cylinder operates on a different stroke, causing continuous crankshaft rotation.
4. Propeller:
    a. A rotating airfoil, subject to induced drag, stalls and other aerodynamic principles.
    b. Propeller is twisted to produce uniform lift from the hub (high twist) to tip (low twist).
    c. Fixed-pitch propeller: Pitch set by the manufacturer. Usually a compromise of:
        i. Climb propeller: Low pitch, high RPM, high HP, best takeoff performance.
        ii. Cruise propeller: High pitch, low RPM, low HP, best cruise performance.
    d. Adjustable-pitch propeller (modern version is the constant-speed propeller):
        i. Converts high % of brake HP into thrust HP over a wide range of RPM.
        ii. Allows selection of most efficient RPM (high for takeoff, low for cruise).
        iii. Throttle controls manifold pressure (MP), propeller control regulates RPM.
        iv. For power ↑: RPM ↑, then MP ↑. For power ↓: MP ↓, then RPM ↓.
5. Landing gear system:
    a. Principle support of the airplane on the surface (may be wheels, floats or skis).
    b. Conventional landing gear: Two main wheels and a rear-mounted wheel. Provides better propeller ground clearance – desirable on unimproved fields.
    c. Tricycle landing gear: Two main wheels and a nose-mounted wheel. Allows more forceful application of brakes, permits better forward visibility and tends to prevent ground-looping.

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6. Fuel system:
    a. Provides an uninterrupted flow of clean fuel from the tanks to the engine.
    b. Flows through a fuel selector valve and strainer to either a carburetor or fuel injector.
    c. May be a gravity-feed or fuel-pump system.
7. Oil system:
    a. Includes an oil sump, oil pump and oil filter.
    b. Lubricates the engine's moving parts and provides cylinder-piston seal, cools the engine by reducing friction and removing heat and carries away contaminants.
    c. Dry sump: Separate oil tank. Wet sump: Oil sump is integral part of engine.
    d. Oil pressure and oil temperature gauge readings indicate health of oil system.
8. Hydraulic system:
    a. Operates wheel brakes, retractable landing gear, and constant-speed propellers.
    b. Includes a fluid reservoir, pump, filter and relief valve.
9. Carburetor system:
    a. Brings in air (through filter), mixes with fuel, and delivers fuel/air mixture to cylinders.
    b. Usually float-type (but could be pressure-type with a fuel pump).
    c. Air flows through a venturi, creating a partial vacuum and pulling in fuel.
    d. Mixture control decreases fuel flow, compensating for low air density at altitude and maintains the correct fuel/air mixture.
    e. Carburetor ice occurs due to fuel vaporization and venturi air pressure decrease.
    f. Carburetor heat uses preheated air to prevent formation of carburetor ice.
10. Fuel injection system:
    a. Fuel is injected directly into cylinders (or just ahead of the intake value).
    b. Usually incorporates both an engine driven fuel pump and auxiliary pump.
    c. Advantages of fuel injection: Reduction in evaporative icing, better fuel flow and distribution, faster throttle response, precise mixture control, and easier cold starts.
    d. Disadvantages of fuel injection: Difficult hot starts (vapor locks) and problems starting after fuel starvation.
11. Ignition system:
    a. Made up of starter, magnetos, spark plugs, high-tension leads and ignition switch.
    b. Starter provides initial sparks ("START"), then magnetos take over ("BOTH").
    c. A magneto uses a permanent magnet to generate an electric current from the crankshaft rotation by electromagnetic induction.
    d. Detonation is an uncontrolled, explosive ignition of the fuel/air mixture.
    e. Preignition occurs when the fuel/air mixture ignites prior to the normal time.
12. Electrical system:
    a. Includes alternator, battery, alternator/battery switch, alternator switch, bus bar, circuit breakers, voltage regulator, ammeter or loadmeter and electrical wiring.
    b. Engine driven alternators supply electric current and maintain battery charge.
    c. A voltage regulator controls the rate of charge to the battery.
    d. An ammeter shows if the alternator is producing adequate electrical power.
        i. A negative amp value indicates current is being drawn from the battery.
        ii. A positive amp value indicates the battery is being charged by the alternator.
        iii. A full-scale negative deflection indicates an alternator malfunction.
        iv. A full-scale positive deflection indicates a voltage regulator malfunction.

Note: For all systems, the airplane's POH / AFM should be consulted for specifics.

REFERENCES

1. AC 61-23 / FAA-H-8083-25, Pilot's Handbook of Aeronautical Knowledge, Chapters 4 and 5.
2. POH / AFM, Pilot Operating Handbook / FAA-Approved Airplane Flight Manual.