AIRCRAFT SYSTEMS

FULFILLS PA.I.G, CA.I.G, AI.II.E

Objective

The student shall understand the types of systems utilized on the training aircraft and the practices for safe operation of these systems. The student shall become familiar with managing failures of components of the aircraft's systems.

Instructor Actions	**Student Actions**
- Explain the systems utilized on the training aircraft - Present images and schematics of the systems - Present images of discrepancies and abnormal conditions typically found during preflight - Introduce the concept of 'flows' in checklists - Walk student around aircraft	- Take notes and participate in instructor's discussion - Take quiz on identifying discrepancies - Participate in aircraft walk around and discussion

Case Studies	**Equipment**
- Mitsubishi MU-2	- FAR/AIM - Pilots Operating Handbook - Training Aircraft

Completion Standards

The student shall explain the function and operation of all of the training aircraft's systems. The student shall demonstrate knowledge of discrepancies or failures in these systems and display proficiency in running emergency procedure checklists.

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ELEMENTS

RESOURCES

FAA-S-ACS-6C Private Pilot ACS - Area I Task G
FAA-S-ACS-7B Commercial Pilot ACS - Area I Task G
FAA-S-ACS-25 CFI ACS - Area II Task E

FAA-H-8083-2 Risk Management Handbook
FAA-H-8083-25C PHAK Chapter 7: Aircraft Systems

Aeronautical Decision Making for Instructor Pilots – Training Scenario 11

Piper Tomahawk POH

ERAU Airplane Components Video
ERAU Flight Control System Video
ERAU Engine System Video
ERAU Landing Gear System
ERAU Fuel System Video
ERAU Oil System Video
ERAU Hydraulic System Video
ERAU Electrical System Video
ERAU Environmental System Video

1. INTRODUCTION

Imagine you are the designer of a new airplane. It would make sense to group the design teams by their contribution to the airplane. There may be a wheels and brakes group, a powerplant group, etc. Our aircraft is divided into separate systems, categorized by contribution to the airplane as a whole.

Source, distribution, control, indication, safety

2. PROPELLORS

Fixed Pitch Simplest option found on trainers. Pitch is set by manufacturer to optimize for climb, cruise, or somewhere in between. Most propellors are solid wood or aluminum.

Variable Pitch Propellors whose blade pitch can be adjusted on the ground with special tools. Each blade is connected to a central hub.

Constant Speed Propellors whose blade pitch can be adjusted in flight.

3. POWERPLANTS

Two types of engines: reciprocating and turbine. Reciprocating engines convert linear motion from the cylinders to rotational motion of the crankshaft to spin the propellor. Turbine engines use high-speed airflow to spin blades that output to a fan or shaft.

Reciprocating engines thrive in the low-altitude and low-airspeed realm and thus are found on most training aircraft. For a thorough review on reciprocating engines, see:

ERAU Engine Overview

Looking Inside the Engine

3.1. Induction Systems

With the exception of more modern reciprocating engines, most utilize a carburetors to mix fuel and air together.

3.2. Ignition System

Aircraft engines employ a self-sustaining source of ignition independent of the electrical system. Magnetos, geared to the crankshaft, covert the reciprocating motion into a magnetic field to generate an electric current which is sent to the spark plugs at the appropriate time.

3.3. Oil System

Proper oil circulation is imperative for engine cooling, lubrication, and sealing. A small transducer on a oil line relays the oil pressure to the cockpit.

3.4. Turbochargers and Superchargers

To augment the performance of reciprocating engines, especially at high altitudes, turbochargers and superchargers are fitted to the induction system to increase the pressure of the intake air. These systems are known as “turbo-normalized”, meaning they increase intake pressure to that of sea level until a critical altitude, or “boosted”, meaning they increase intake pressure as much as possible.

4. LANDING GEAR

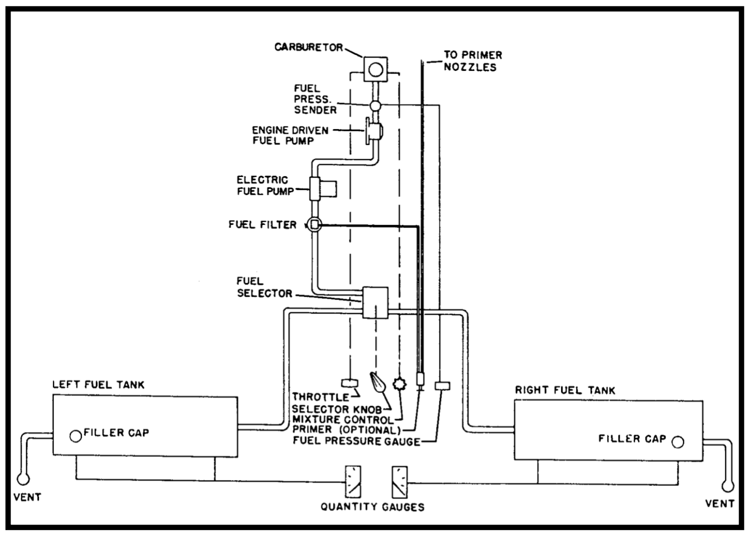
Landing gear can be fixed or retractable and conventional or tricycle. The Piper Tomahawk utilizes a rectangular steel strut for the main landing gear and a compression oleo strut. Each tire is mounted to a 5-inch rim and inflated to 26 psi.

5. HYDRAULIC SYSTEM

Hydraulic systems range in complexity from flight controls actuation in large jets to simple brake systems in smaller airplanes. The Piper Tomahawk has a small hydraulic fluid reservoir in the engine compartment and small cylinders above each brake pedal to provide brake actuation to each main wheel. An additional cylinder is located behind the parking brake handle.

6. FUEL SYSTEM

Larger and multi-engine aircraft have more complex and redundant fuel systems than their single-engine trainer counterparts. The Piper Tomahawk utilizes two wing tanks, each holding 15 gallons usable and 16 gallons total. Fuel is drawn from the fuel tanks with an engine driven fuel pump. An electric/boost/auxiliary pump is used if the engine driven pump fails, or during takeoff, landing, and fuel tank switching. The carburetor assembly houses a small, separate fuel reserve. Additionally, upon application of full open throttle, a small ancillary fuel jet located in the Venturi shoots supplemental fuel to improve engine response times.



7. ELECTRICAL SYSTEM

The electrical system is responsible for powering onboard avionics and instrumentation. Most electrical systems utilize a “bus bar”, similar to a power strip. The bus provides a place where everything can be connected. The Piper Tomahawk runs off a DC 12/14V system, as opposed to the DC 24/28V system found on many other aircraft.

An alternator is connected directly to the crankshaft to provide power. Sometimes, at low RPMs, the alternator may not be spinning fast enough to generate adequate voltage, and the alternator warning annunciator may illuminate.

8. AVIONICS SYSTEM

"Six pack" avionics – Airspeed, attitude, altimeter, turn coordinator, directional gyro, vertical speed. Discuss pitot static system and blockage effects. De-icing systems for pitot and static.

A vacuum pump is connected to the engines accessory case and provides suction for the attitude indicator and directional gyro. The Piper Tomahawk has a dry pump, which does not require oil. A shear drive protects the engine from damage should the pump freezes. If the drive shears, the gyros will become inoperative.

9. ENVIRONMENTAL SYSTEM

Environmental systems refer to the air conditioning, heating, ventilating, and pressurization systems. Air conditioning systems are heavy and sizable, and pressurization is only required for aircraft operating at sufficiently high altitudes. The Piper Tomahawk only has heating and ventilation systems. Heat is provided by routing air around the exhaust manifold.

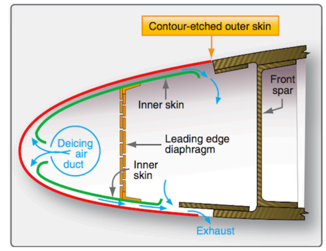
10. DEICING AND ANTI-ICING SYSTEMS

10.1. Airframe Icing

10.1.1.Leading Edge Boots

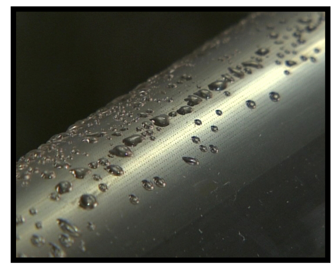
The leading edge of the wing is replaced with an inflatable “boot” (think very stiff balloon), that can inflate using air from an engine-driven pump. See this video for an in-flight example. Since boots only remove ice, they are de-icing systems. These are typically found on high-performance piston and turboprop aircraft, but occasionally can be found on jets.

10.1.2.Heated Leading Edges



Hot engine air can be rerouted to the leading edges of the wing to remove and precent ice buildup with heat. This is typically found on jets, as the system uses engine bleed air. This could function as anti-ice or de-ice.

10.1.3.TKS System



Why not just coat the wing in anti-freeze? Well – that is the essence of the TKS system. Tiny pinholes in the leading edge release an anti-freeze solution that both prevents ice from accumulating on the wing and releases ice already formed.

10.1.4.Windshield

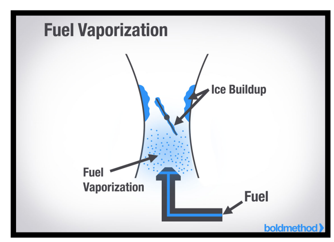
Just like a car’s rear defroster, some windshield contain resistive elements that heat when current is passed through them. This heats the windshield to precent and remove ice. However, compass errors of up to 40° can occur!

Similar to the TKS system, a fluid can be released on the windshield from small pipes at the base of the windshield. The airflow then spreads the fluid across the windshield.

10.2. Propellor Boots

Propellor boots do not function the same as wing boots. Rather than expand and physically release ice, they are heated electrically.

10.3. Induction Icing



It is a misconception that induction icing is limited to carbureted aircraft. Fuel injected aircraft can buildup ice in their induction system or on the air filter, requiring alternate air to be activated.

10.4. Fuel System Icing

Jet fuel additives.

10.5. Pitot-Static System Icing

Ice buildup begins on small protuberances before flat, streamlined bodies. One of the most common icing locations is the pitot tube.

The Piper Tomahawk is equipped with pitot heat to de-ice the pitot tube. This will also function as anti-ice, but remember the Tomahawk (and many other light aircraft) are not certified for flight into known icing.

Some aircraft are equipped with heated static ports. If not, alternate static air can be used if the static ports ice over. **Review pitot-static system errors.**