


VDFP General Aviation Firefighting for Structural Firefighters

VIRGINIA DEPARTMENT OF FIRE PROGRAMS
Aviation Firefighting for Structural Firefighters



Chapter 4
General Aviation Aircraft Systems

GENERAL AVIATION AIRCRAFT SYSTEMS

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Learning Objectives

- Identify the two main engine types used in general aviation
- Identify the general location of the throttle and mix control in aircraft that use reciprocating engines and describe how fire personnel can use these controls for safety

GENERAL AVIATION AIRCRAFT SYSTEMS

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Learning Objectives

- Identify the storage location and type of fuel for fixed-wing and rotary wing aircraft using either reciprocating engines or turbine engines
- Explain how to tell the difference between an aircraft using a reciprocating engine or a turbine engine

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Learning Objectives	GENERAL AVIATION AIRCRAFT SYSTEMS
<ul style="list-style-type: none">• Identify the location of the power and condition controls used in turbine engine aircraft and how fire personnel can set them for safety• Explain why reciprocating engines and turbine engines can continue to run even with the battery switch off and the battery disconnected	
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Learning Objectives	GENERAL AVIATION AIRCRAFT SYSTEMS
<ul style="list-style-type: none">• Explain how a reciprocating engine aircraft can start just by turning the propeller• Identify the key switches and controls to address for scene safety• Identify the ingress/egress considerations for general aviation safety	
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Introduction	GENERAL AVIATION AIRCRAFT SYSTEMS
<ul style="list-style-type: none">• There are many different types of aircraft• Most prevalent types include:<ul style="list-style-type: none">– Single and twin reciprocating engine airplanes used by private pilots– Turbine engine aircraft including jets and turboprops primarily used for business– Helicopters which use reciprocating and turbine engines• There are more different models and types than can be memorized, however they all share several basic system	
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GA Engines

- Two Types of Engines
 - Reciprocating
 - Turbine
 - Includes turbojet, turbofan, & turboprop
- Fixed wing aircraft may use reciprocating engine to turn a propeller
- A turbine engine that uses a propeller is called a turboprop
- Jet engines use turbines that do not require a propeller and instead used the thrust of hot gasses exiting the rear of the engine

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GENERAL AVIATION AIRCRAFT SYSTEMS


GA Engines



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GENERAL AVIATION AIRCRAFT SYSTEMS

GA Engines




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GA Engines



GENERAL AVIATION AIRCRAFT SYSTEMS

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GA Engines



GENERAL AVIATION AIRCRAFT SYSTEMS

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GA Engines




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GA Engines



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GA Engines

- Rotary wing aircraft (helicopters) can use a single reciprocating engine to turn both the main and tail rotors
 - Rotors are actually wings that are forced through the air to create lift
 - Many medium and large helicopters have two turbine engines powering the single main rotor and tail rotor

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GA Engines



GENERAL AVIATION AIRCRAFT SYSTEMS

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GA Engines

- Reciprocating Engines
 - Used in the majority of GA aircraft
 - Similar to the internal combustion engine found in cars
 - Spark plugs are powered by magnetos that generate electricity whenever they turn
 - Most are air cooled
 - Redundant systems to include dual ignition systems with dual magnetos and spark plugs

GENERAL AVIATION AIRCRAFT SYSTEMS

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GA Engines

- Reciprocating Engines
 - Significant controls for the engine are grouped into the “power quadrant”
 - In GA aircraft it is found near the lower center of the control panel between the pilots seat and the seat to the right of the pilot
 - In GA aircraft the pilots seat is on the left, except in helicopters

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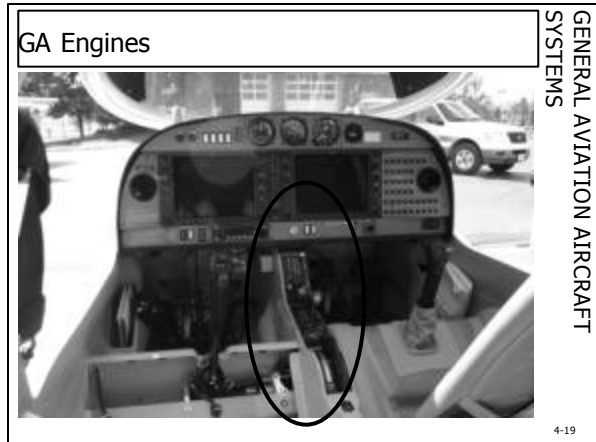
GA Engines



GENERAL AVIATION AIRCRAFT SYSTEMS

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GA Engines

- Reciprocating Engines
 - Controls found in the power quadrant include:
 - Primer
 - A manual pump used to inject fuel into the cylinders just prior to starting the engine
 - Throttle
 - Used to increase/decrease engine speed
 - Fuel/air mix control
 - Used to regulate the ratio of fuel to air mixture for the engines

GENERAL AVIATION AIRCRAFT SYSTEMS

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GA Engines

- Reciprocating Engines
- Safety! The battery can be disconnected or removed from the aircraft and the engine can still be started and run!
- Safety! Firefighters can turn the propeller, even by accident and it is possible for the engine to start!

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GA Engines


- Reciprocating Engines
- Safety! Make sure the switch for the magnetos is in the "Off" position when working around the aircraft. A magneto circuit can be active even though the magneto switch is off!
- Safety! Treat all GA reciprocating aircraft as if it has a hot magneto

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GA Engines

- Reciprocating Engines and Helicopters
 - Engine works on the same principle however the throttle is located to the left side of the pilots seat on a lever called the **collective**



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GA Engines

- Turbine Engines
 - Propel aircraft by forceful exhaust of expanding burning gas
 - The turbine engine of a turbojet has rotating blades at the front used to compress air, the compressed air is mixed with fuel in a combustion chamber and burned resulting hot expanding gases turn additional sets of rotating blades before the push out the rear of the engine, producing thrust

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GA Engines

- Turbine Engines
 - There are different types of turbine engines:
 - Turbojet
 - Turbofan
 - Turboprop
 - In GA turbine engines are usually found on business aircraft and helicopters

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GA Engines

The image contains three detailed cross-sectional diagrams of turbine engines. The top diagram is a Turbojet, showing the intake, compressor, combustion chamber, turbine, and exhaust jet. The middle diagram is a Turboprop, showing the intake, compressor, combustion chamber, turbine, and a propeller driven by the turbine. The bottom diagram is a Turbofan, showing the intake, compressor, combustion chamber, turbine, and a large fan driven by the turbine. Labels include: Turbojet, Turbofan, Turboprop, High speed exhaust gases, Turbine, Compressor chamber, Compressor, Exhaust jet, Propeller, High speed intake, Bypass air, Compressor, Compressor chamber, and Fan.

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GA Engines

- Turbine Engines
 - On some larger turbine engine aircraft, a small turbine engine known as the auxiliary power unit (APU) may be used to provide electrical power to the aircraft when it is on the ground
 - Once a turbine engine is running cutting the electrical master switches or disconnecting the battery will not stop the engines. This must be done by shutting off the fuel supply!

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GA Engines

- Turbine Engines
 - Safety! Stay clear of any turbine engines exhaust and intakes!
 - A turbine engine control is called a **power lever**, there will be one for each engine and are all grouped together
 - At idle when pulled back
 - There is also a condition lever that regulates the flow of fuel to each engine
 - There is no magneto, instead a series of switches is used to start the engine

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GA Engines




GENERAL AVIATION AIRCRAFT SYSTEMS

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GA Engines

- Turbine Engines and Helicopters
 - Turbine engines used in helicopters have controls similar to fixed wing aircraft
 - Location of power levers is different



GENERAL AVIATION AIRCRAFT SYSTEMS

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Fuel Systems	GENERAL AVIATION AIRCRAFT SYSTEMS
<ul style="list-style-type: none">• Two predominate types of fuel used in GA aircraft<ul style="list-style-type: none">– 100-octane AVGAS (100LL)<ul style="list-style-type: none">• Properties similar to automobile gas– Jet A<ul style="list-style-type: none">• Properties similar to kerosene• Basic premise of dealing with spilled fuel:<ul style="list-style-type: none">– Confine spill– Reduce production of vapors– Eliminate ignition sources– Reduce of stop leak	
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Fuel Systems	GENERAL AVIATION AIRCRAFT SYSTEMS
<ul style="list-style-type: none">• Three types of aircraft fuel systems firefighters should be familiar with:<ul style="list-style-type: none">– Fuel storage tanks– Fuel pumps– Fuel shutoffs	
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Fuel Systems	GENERAL AVIATION AIRCRAFT SYSTEMS
<ul style="list-style-type: none">• Fuel Tanks<ul style="list-style-type: none">– GA aircraft fuel load can be 15 - 60 gallons of AVGAS, up to hundreds of gallons of Jet A in larger GA jets– Fuel can be stored in tanks under the floor, behind seats, or under seats though typically it is stored in the wings– Some aircraft have de-icing systems on the leading edges of the wings that used anti-freeze which is often mistaken for leaking fuel	
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Fuel Systems



GENERAL AVIATION AIRCRAFT SYSTEMS

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Fuel Systems

- Fuel Pumps
 - Two types of fuel delivery systems are gravity or pump fed
 - High wing aircraft typically use gravity
 - Fuel pumps may be electrically operated (using a separate switch) or engine operated so the pump works when the engine is running

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Fuel Systems

- Fuel Selector
 - All GA aircraft have some type of fuel selector switch or valve in the cockpit
 - Some are simply "on/off", more common is an "off, left wing, right wing, or both" switch
 - Used to use fuel from different tanks to keep weight evenly dispersed
- Safety! Regardless of how many tanks are on the aircraft, the important thing for firefighters to remember is the "OFF" position!

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Fuel Systems




GENERAL AVIATION AIRCRAFT SYSTEMS

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Fuel Systems

- Fuel Sumps
 - Generally located at the lowest point or near the fuel tank, fuel sumps are spring loaded valves used to drain a small amount of fuel to check for contamination
 - Sometimes they get stuck open spilling fuel



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Hydraulic Systems

- Augment human and mechanical forces used to control aircraft
- Systems in the family car are similar to those used in some GA aircraft braking systems
- Generally, the larger the aircraft the more hydraulics are used
- Helicopters are especially dependant on hydraulic systems
- Pressures can be as high as 3000 p.s.i.

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Landing Gear Systems

- Two types of landing gear, fixed and retractable
- Retractable is more of a concern because it involves complex mechanical, electrical, hydraulic systems that are subject to various failures
- Some small and most all large GA aircraft have retractable gear
- Gear is operated by a switch or wheel in the cockpit

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Landing Gear Systems



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Landing Gear Systems



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Landing Gear Systems



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Landing Gear Systems



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Landing Gear Systems

- Safety! It is a good idea for fire personnel not to touch the landing gear switch!
- Landing gear control typically have three green lights means that indicate the landing gear is down and locked
- Some aircraft wheels may contain magnesium which reacts violently with water once it starts burning
- Wheels may also contain fusible plugs which blow out to control the release of tire pressure
- Safety! Fire crews should approach tire fires from the front or rear of the aircraft

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Oxygen Systems

- Typical, small GA aircraft do not have oxygen systems
- High altitude aircraft (above 12,500 feet) with have some oxygen system on board
- May be a single "D" size cylinder to larger systems with multiple lines and controls
- When doing size up consider pressurized tanks and the effect the oxygen could have if released
- Aero medical aircraft may have pressurized or liquid oxygen (LOX) for patients on board

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Oxygen Systems



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Fire Suppression Systems

- Many small, single engine, fixed wing GA aircraft using reciprocating engines have no firefighting equipment on board
- Many larger and/or multi-engine aircraft have fixed suppression systems using pressurized Halon or similar agents
- These systems are activated by controls in the cockpit

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Fire Suppression Systems



GENERAL AVIATION AIRCRAFT SYSTEMS

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Electrical Systems

- Voltages used in small aircraft may be 12 or 24 volts DC
- Voltages of 110-115 volts AC on medium to large aircraft
- On board batteries provide the initial DC current
- Batteries can be located almost anywhere on the aircraft
- Batteries typically have quick disconnects

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Electrical Systems



GENERAL AVIATION AIRCRAFT SYSTEMS

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Electrical Systems



GENERAL AVIATION AIRCRAFT SYSTEMS

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Electrical Systems

- Master Switches
 - Important controls in an aircraft cockpit are marked in red such as the battery circuit, alternator circuit, and main power switches
 - The number of controls in the cockpit can be overwhelming, look for ones with red markings first and READ to find the controls you need!
 - Safety! Never just start moving controls and throwing switches just because they are red!

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Electrical Systems



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Ingress or Egress Access

• Aircraft Materials

- Predominate material used in GA is aluminum or aluminum alloy
- To a lesser degree, steel, magnesium, titanium and wood also may be found
- The use of composite materials such as carbon fiber, fiberglass, Kevlar and graphite is increasing

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Ingress or Egress Access



GENERAL AVIATION AIRCRAFT SYSTEMS

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Ingress or Egress Access



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Ingress or Egress Access

- Aircraft Materials
 - Thin materials used as skin means fire on the outside will penetrate into the interior in a short time
 - Cooling stream at the point of impingement and a foam blanket to prevent fuel vapors from escaping is one way to address this situation

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Ingress or Egress Access

- Aircraft Materials
 - Thin material also allow relatively easy access to cutting and piercing tools
 - The key is to know where to cut and the danger is to avoid fuel, hydraulic, oxygen, and electrical lines
 - Use normal means of ingress/egress such as doors or even window first

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Ingress or Egress Access



GENERAL AVIATION AIRCRAFT SYSTEMS

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Ingress or Egress Access

• Doors

- Some aircraft do not have doors but a sliding canopy
- Some have door on either side or just one side
- GA doors and handles are relatively easy to figure out
- Turboprop, turbofan, and turbojet business aircraft many times have emergency doors available

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Ingress or Egress Access



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Ingress or Egress Access



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Ingress or Egress Access



GENERAL AVIATION AIRCRAFT SYSTEMS

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Ingress or Egress Access



GENERAL AVIATION AIRCRAFT SYSTEMS

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Ingress or Egress Access



GENERAL AVIATION AIRCRAFT SYSTEMS

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Ingress or Egress Access



GENERAL AVIATION AIRCRAFT SYSTEMS

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Ingress or Egress Access

- Restraint Systems
 - Some GA aircraft have seatbelts and shoulder harness with fasteners similar to cars
 - There is also a fastener type that needs to be turned counter clockwise to release
 - When in doubt on how to release it may be necessary to cut

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Summary

- GA aircraft and it's use is complex and changing
- All aircraft have many features in common
- The class of engine determines the type of fuel used
- Not all GA aircraft have doors
- Additional information on aircraft can be found in manuals or by visiting your local airport

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