# Beech E-18S Super 18 Pictorial Tour

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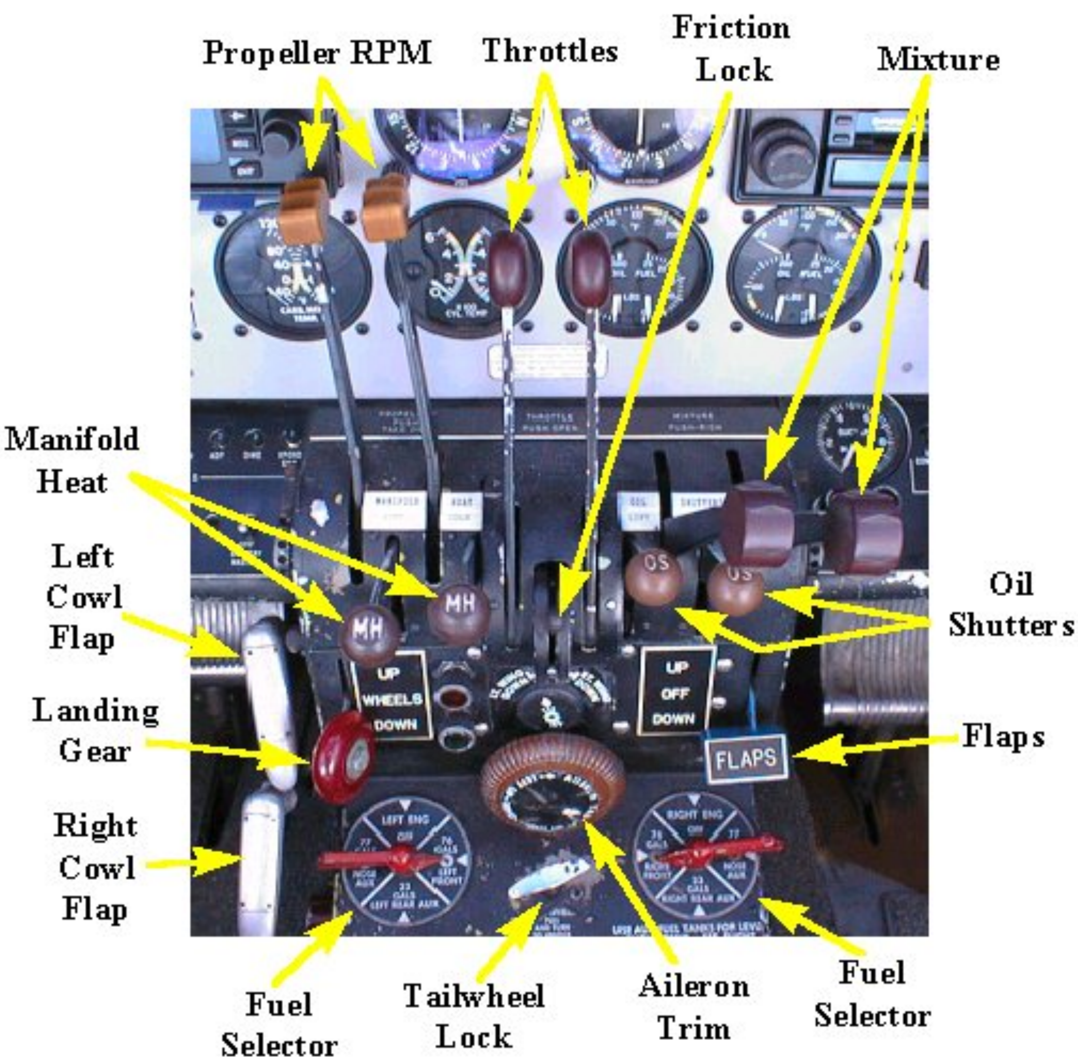
*NOTE: This page has extensive large graphics, as the primary target audience is the students at the USAF Test Pilot School, who have a high-speed Internet connection to view them with. Anyone is welcome to look at this page--just be patient if you a viewing this over a modem...*



The Beech 18 was designed prior to World War II as a light twin-engined transport. Beech 18s served with the Army Air Force as the C-45 Twin Beech. This aircraft, a 1954 Beech E-18S Super 18, was designed as an executive transport, with several modifications from the original Beech 18. The interior height of the cabin was increased, and the tail incidence angle was changed and the wingtips modified as part of a Supplemental Type Certificate (STC) to allow a higher maximum takeoff gross weight.

## Cockpit and Systems

The instrument panel is typical, with flight instruments in a T-formation on both sides. In the center section of the panel are the engine instruments, radios, and other equipment. The engine starting switches are on the lower console on the left side. A large number of the controls are on the center console.




On the center console you will be greeted by this forest of levers. Your biggest challenge will getting through your entire flight without ever grabbing the wrong lever. Actually grabbing the wrong lever isn't that bad, as long as you realize your mistake BEFORE you move it!

The six tallest levers are your primary engine controls: propeller RPM, throttles, and mixture control. Take note that each set of levers has its own unique knob shape. These are the standard FAA knob shapes for these controls.

The throttles are your primary power control. The primary instrument for setting throttle position is the manifold pressure gauge. Just like in the C-12, as you push the throttle forward, the RPM will not change (because of the constant speed propeller). The manifold pressure will increase, and more power will go into the propellers. Use the manifold pressure gauge in a similar fashion as you use the torque and TGT in the C-12. There are limiting manifold pressures for each flight condition. Your IP will brief you on these. Do not just push the throttles all the way forward without watching the manifold pressure.

Propeller RPM is set with the propeller levers. For takeoff, the propeller RPM is normally full increase (red line RPM). This allows the engines to generate the maximum power available for takeoff, since power is Torque x RPM. In a similar fashion as the C-12, you will probably reduce the RPM in flight, especially for cruise. Reducing the RPM significantly reduces the propeller noise and also reduces the fuel consumption somewhat. The primary gauge for setting the RPM is the tachometer. In some aircraft, you would increase the RPM back to full increase as part of your Before Landing checklist. This again makes full power available in the event of a go-around. In this aircraft, approaches are flown with the propellers at cruise RPM. In the event of a go-around, the throttles are advanced about half way. This gets the propellers to move from essentially flat pitch to a coarser pitch. Then the propeller RPM is increased, followed by advancing the throttles to the final power setting. This procedure prevents overspeeding the engines that might happen if the power was advanced faster than the propellers could react to maintain RPM. Your IP will brief you on specifics of these procedures.

The mixture control changes the fuel-air ratio of the engine. Reciprocating engines are normally run at full rich for high power settings, such as takeoff and climb. This provides the engine more fuel than necessary to burn, but the additional liquid has a powerful effect on engine cooling. Engine cooling systems, in this case the fins for air cooling, are typically sized for some continuous power setting less than 100 percent--typically about 75 percent or lower. For takeoff and climb, the extra fuel supplies the additional cooling. Once in cruising flight and the power setting has been reduced, the mixture will be reduced to a more optimum setting for fuel economy. One technique for leaning an engine with a constant speed prop is to lean until the exhaust gas temperature (EGT) peaks, then richen the mixture by a specified number of degrees on the EGT. Another technique is to lean to a specified fuel flow. You will enrichen the mixture as part of the Before Landing checklist. After your flight, you will typically shut down the engines by leaning the mixture all the way, which will cut off the fuel flow (idle cutoff). This technique is used instead of turning off the ignition to minimize the amount of unburnt fuel left in the intake manifold and cylinders.

A basic technique that you should remember with all reciprocating engines:

**To Increase Power:**

1. Increase Mixture (as required)
2. Increase RPM (as required)
3. Increase Throttle

**To Decrease Power:**

1. Decrease Throttle
2. Decrease RPM (as required)
3. Decrease Mixture (as required)

Using these techniques give you the best margin against overboosting or overheating an engine.

The manifold heat levers are used as required to prevent or remove carburetor ice. As the air moves through the venturi of the carburetor, continuity tells us its velocity increases and Bernoulli tells us that its pressure is reduced. Since we know that at local Mach numbers below 0.3 that air is essentially incompressible, the

Equation of State ($P = rRT$) tells us that when the pressure drops, the temperature will also drop. Additionally, the vaporization of fuel extracts more thermal energy from the air, causing the temperature to further drop. Since this temperature drop can be as much as 60°F, the water vapor in the air can condense and then freeze in the carburetor, causing a partial blockage, resulting in a loss of power.

At high to normal power settings, the temperature of the engine and the high flow rate through the carburetor generally prevent ice formation. Ice is more likely to form at low power settings as the engine cools and the flow rate is reduced. Above 70°F outside air temperature, the air normally will not cool enough for ice formation. Below 20°F, there is usually insufficient humidity for ice formation. In between these temperatures, ice formation is more likely.

Manifold heat runs air over the exhaust pipes to heat it and then feeds it into the carburetor. Since the exhaust manifold cools with the rest of the engine at low power settings, if you wait until ice forms to turn on manifold heat, there may not be enough manifold heat left to melt the ice. If icing is expected, apply manifold heat before reducing the throttle to prevent ice formation.

Manifold heat is not used during normal power operations because

1. The hotter induction air reduces the air density, thus reducing power and enrichening the mixture
2. Manifold heat air is typically unfiltered, and thus not suitable for use near the ground

The Oil Shutters control the flow of cooling air to the oil coolers. While these engines are referred to as "air cooled," much of the waste heat is removed from the internal engine parts by the oil. The oil shutters are modulated as required to maintain the desired oil temperature. The oil should be warm enough that any trapped moisture in the oil boils off, but not so high that the engine is damaged.

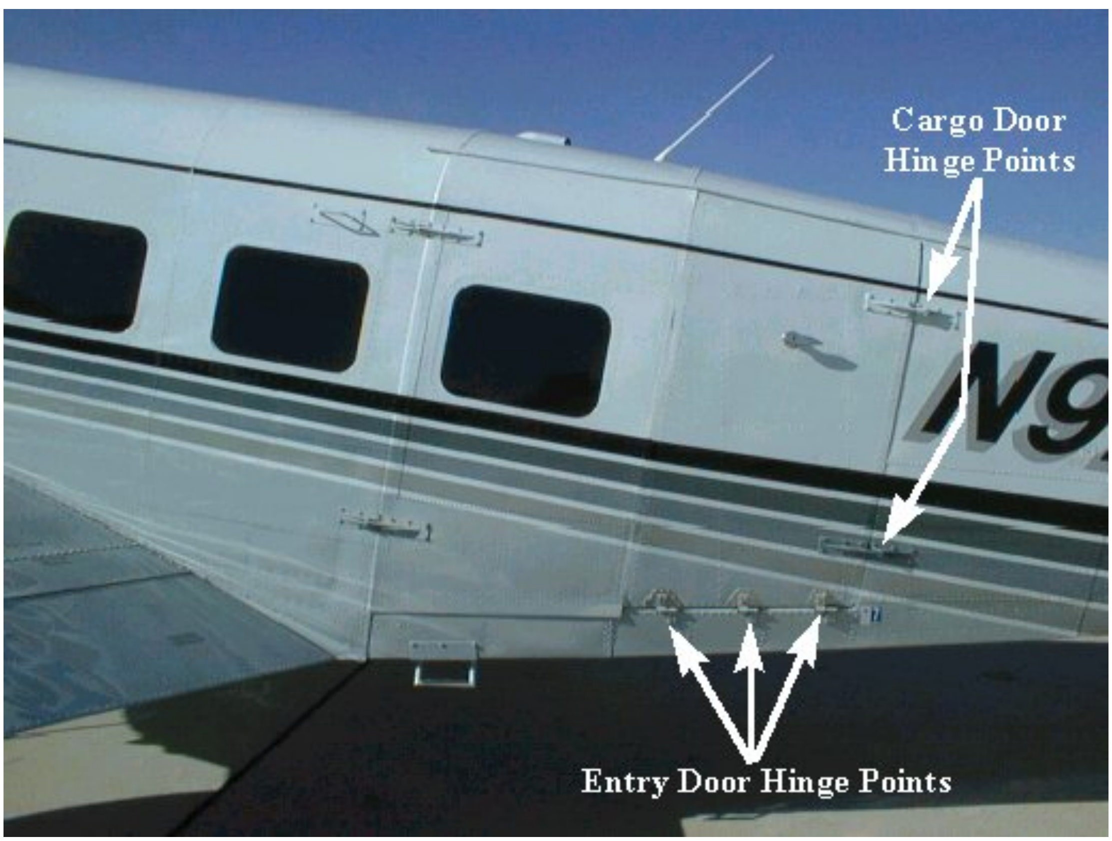
The landing gear lever is pretty straightforward and intuitive. The flap lever commands movement of the flaps, not position. There are no "detents." To lower the flaps, push the flap lever down and monitor the flap position gauge (on the pilot's side). If you let go of the flap lever, it will stay in the down position and the flaps will lower to full down. To stop the flaps at an intermediate position, move the lever back to the center when the flaps reach the desired position. The procedure to raise the flaps is similar. Leaving the lever in the up position will cause the flaps to fully retract.

An aileron trim wheel is provided on the center pedestal. Directly below it is the tailwheel lock. Pull up and twist to release the tail wheel to full swivel. After taxiing straight ahead, untwist and push down to lock the tailwheel.

The fuel selector levers control which fuel tank feeds each engine. The short end of the lever is the pointer. As shown, the two fuel selectors are pointing inward toward each other

The cowl flap controls are push-pull cables which control the position of the cowl flaps. The cowl flaps control the amount of cooling air passing through the engine nacelles.

A view looking forward through the cabin. When photographed, this aircraft was set up to carry four passengers in addition to the two crew members. Consider evaluating the comfort of the passenger seats for use as an executive transport. This could be at least as important to mission suitablity as performance and flying qualities, if not more so.

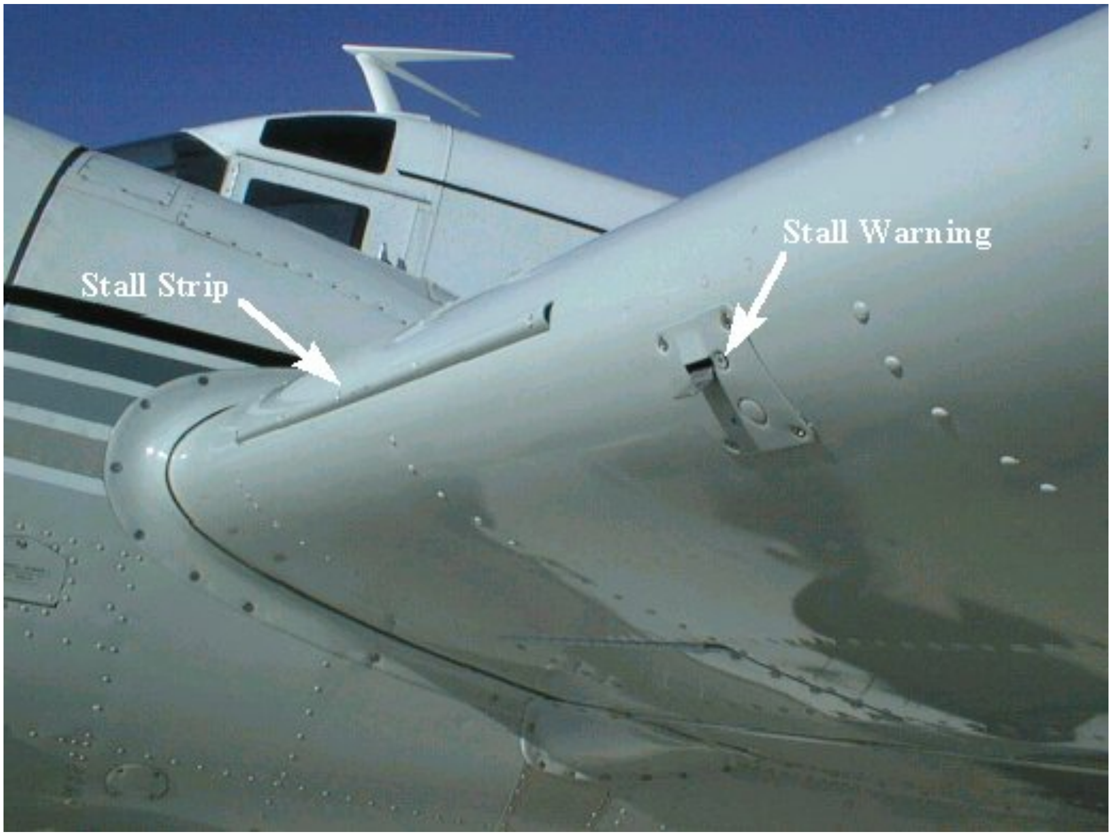



This aircraft is equipped with cargo doors. The purpose of the aft door changes depending on where the hinge pin bolts are located. With the bolts in the cargo door hinge points, both doors can be opened to allow large cargo to be loaded directly off of a pickup truck. You will probably see the aircraft with the bolts in the entry door hinge points.

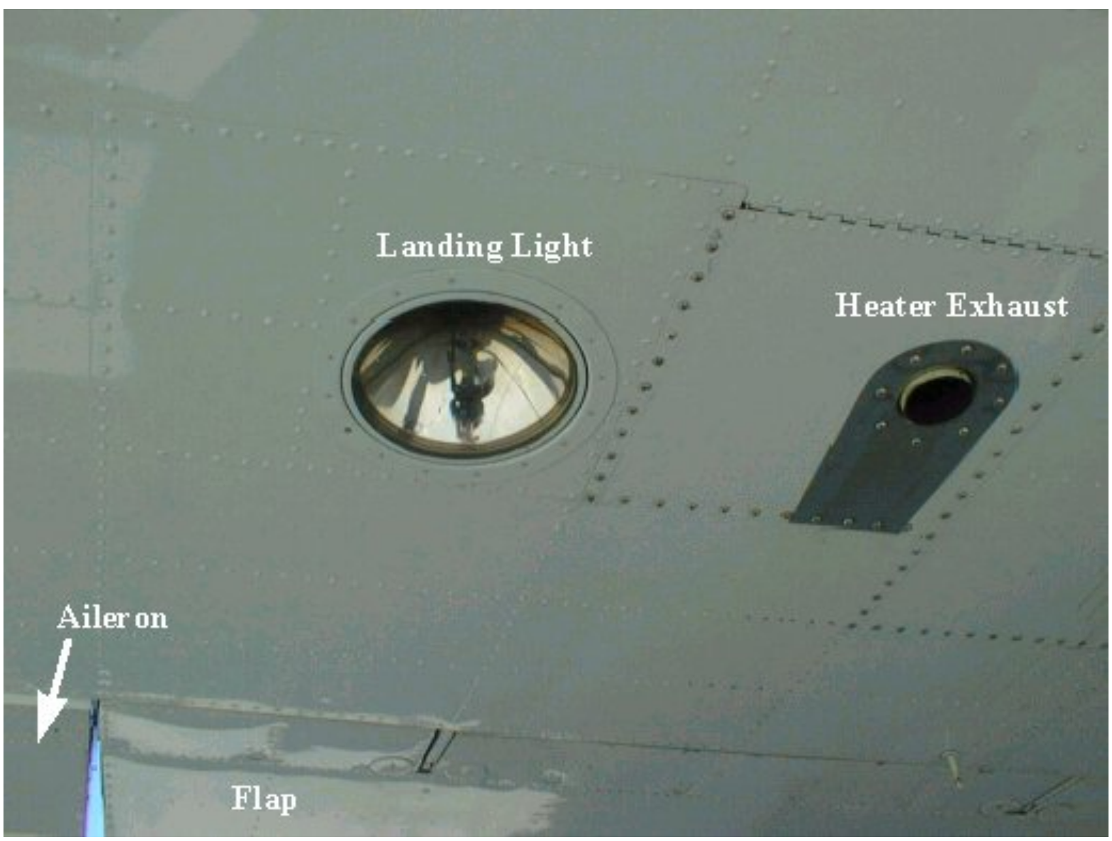

With the bolts in the entry door hinge points, the door opens like this to provide boarding stairs for passengers. You should limit yourselves to one person on the door at a time.


Separate Pitot tubes are provided for the pilot and copilot instruments, located beneath the nose.


One static system is used for all instruments. Static ports are located on both sides of the aft fuselage and are manifolded together to reduce errors due to sideslip.




Stall strips are located on the leading edge of both wings outboard of the nacelles. These will trip the boundary layer at high angles of attack and improve the natural stall warning. An electric stall warning vane is installed on the left wing. In normal flight conditions, the airflow pushes the vane to the aft position, seen here. At high angles of attack, the stagnation point moves behind the vane, and the reverse flow around the leading edge pushes the vane forward, closing a switch. Determine what type of cockpit stall warning system this vane is attached to and its suitability.




A landing light is installed in the undersurface of each wing outboard of the nacelle. When the landing light is turned on, the light will rotate down about a hinge at its leading edge. This photo shows the landing light in the right wing. Also shown is the exhaust for the cabin heater. This heater burns avgas to heat the cabin.

# Aerodynamics and Flight Controls

The elevator is a single piece, equipped with two trim tabs. The longitudinal control system includes a downspring, which causes the elevator to rest in the down position. All of the Super 18 models (E-18S, G-18S, H-18S) were equipped with a downspring. Evaluate how this affects the handling qualities.

Notice how the elevator leading edge extends above the stabilizer. This bump gives the air a favorable (proverse) pressure gradient to energize the boundary layer and encourage it to remain attached.

Each rudder is equipped with a aerodynamic balance horn and a trim tab. This is one way to distinguish a Beech 18 from a Lockheed 10 (Electra). The Lockheed 10 does not have an aerodynamic balance horn on the rudder.

A fairing (or fillet) is installed on each vertical fin to reduce interference drag and flow separation.

A fairing is also installed between the fuselage and horizontal tail.

Note also the beacon with the circular cross section. This serves a dual purpose as an anti-collision flasher and as a drag producing device.

Another beacon/drag producing device is mounted on the lower side of the aft fuselage.

A plain flap extends from the fuselage to the aileron on each wing. The flaps are controlled and actuated electrically.

Here the flap is shown in the lowered position. How would its position in the slipstream of the engine affect the flap effectiveness?

The left aileron is equipped with a trim tab. The ailerons create a significant amount of adverse yaw on this aircraft. An interesting demo is that rolling down the runway with the tail up, turning the yoke to the left will turn the aircraft right (**!**), and turning the yoke to the right will turn the aircraft left (**!**). You can imagine the problems this could create for a pilot who forgets to steer with his feet and tries to steer like a car. Ask your IP to see this effect.

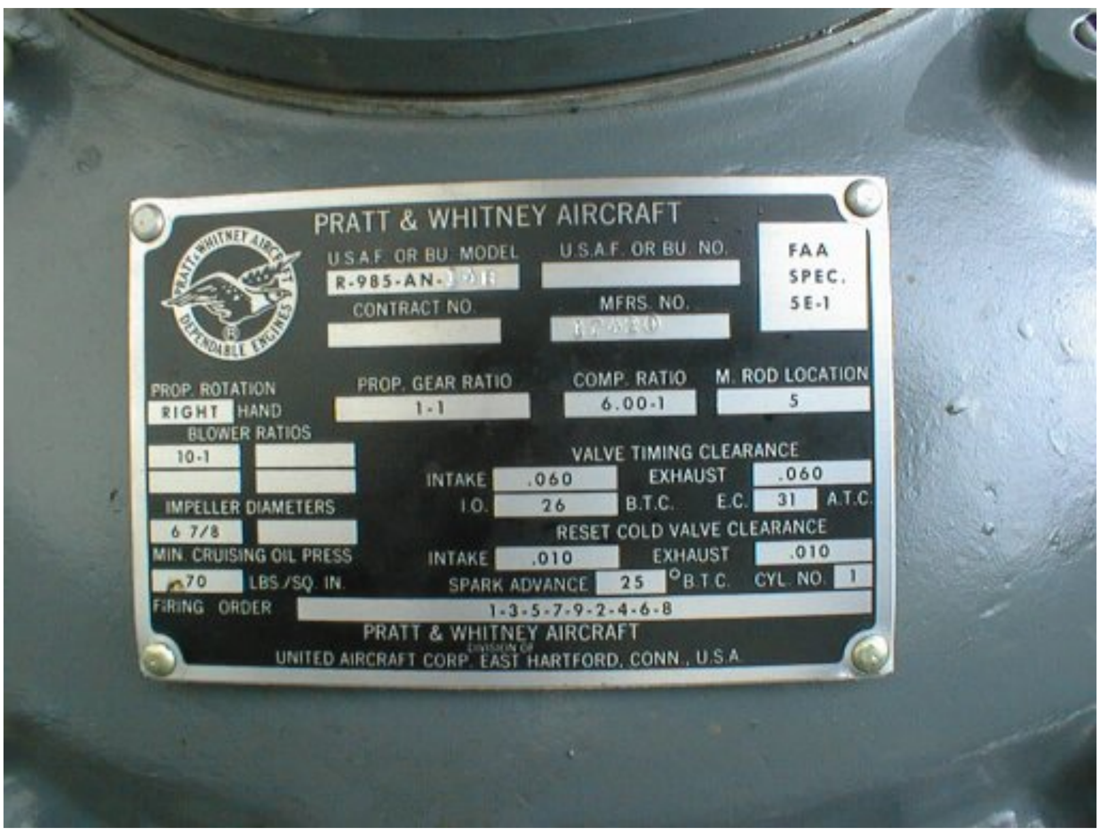
The right aileron is not equipped with a trim tab.

The wingtips installed are modified from the original design. We do not have sufficient information at this time about the original wingtip to evaluate the aerodynamic effects of the change. These wingtips were added as part of an STC to increase the maximum gross weight rating. This design had been tested and certified on earlier models of the Beech 18 as part of a gross weight increase STC. Instead of designing new wingtips for this model and going to the expense of testing and certifying them, wingtips that were part of the previously certified package were used. Sometimes aircraft modifications are driven more by cost and certification issues than by aerodynamics, performance, or handling qualities.

# Propulsion

Power is supplied by two Pratt & Whitney R-985 engines of 450 horsepower each, driving constant speed propellers. The propeller blades change pitch as required to maintain the desired RPM. The pitch change mechanism, located in the propeller hub, is driven by engine oil pressure.

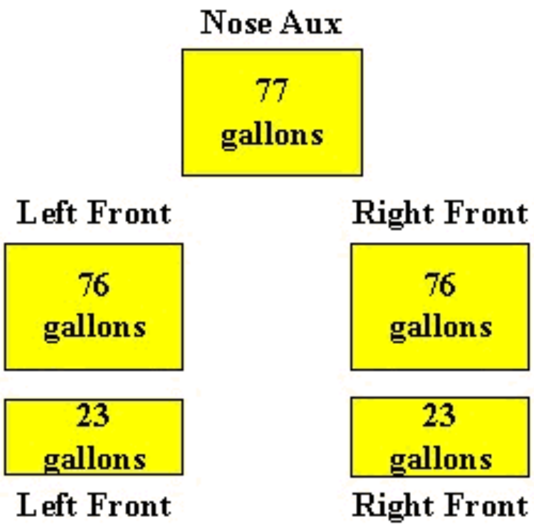
The propellers are made by Hamilton-Standard. Be sure to use the charts for Hamilton-Standard props in the flight manual. Three-bladed propellers are available as an option for this aircraft.




You can find detailed information on the engine on this dataplate affixed to the front of the engine.

Cowl flaps on both sides of each cowling control the amount of cooling air passing through the engine nacelle by changing the exit area available to the air. Cowl flap position can be easily determined from the cockpit by looking out the window at the cowl flaps on the inboard side of the nacelles.

Here the cowl flaps are shown in the closed position. The exhaust pipes are located underneath the cowl flaps.




Total fuel capacity is 275 gallons of 100LL avgas. A 77 gallon auxiliary tank is located in the nose. 76 gallon main tanks are located in each wing center section between the fuselage and the nacelle. Additional 23 gallon auxiliary tanks are located in the wings aft of the main tanks.

Takeoffs will be done with main tanks selected, as should any large maneuvers. The auxiliary tanks (wing and nose) are placarded for use in level flight only. Normally, the left engine will feed from the left wing, and the right engine from the right wing. Both engines can feed from the nose auxiliary tank. If necessary to maintain fuel balance (such as with one engine shut down), provisions are made to allow crossfeed from the opposite wing.

# Landing Gear


The landing gear is of the conventional (taildragger) type. An interesting point is that the brakes for both main gear are installed on the left side, instead of both being inboard or outboard. This allows use of common parts for both main gear. The landing gear are controlled and actuated electrically.

As can be seen from the gear doors, the tires do not completely retract. Cutouts in the doors allow the tires to remain exposed. This type of landing gear can also be seen on the B-17 or the DC-3/C-47.

The tail wheel is retractable. (The tail wheel on the Lockheed 10 does not retract) The tail wheel is full swiveling for taxiing, and is locked straight ahead for takeoff and landing. With the tailwheel locked, it improves the directional control during the ground phases of takeoff and landing. For taxiing, directional control is accomplished with differential thrust and differential braking (if required). Evaluate the ground handling characteristics and how much pilot compensation is required for taxiing. While this system of ground control may seem odd in light of nosewheel aircraft you have flown, it was actually a very common system for large taildragger aircraft.


Another view of the tailwheel.

# Other Cool Stuff

Be sure to check out the map inside the cabin of all the places this aircraft has been. Of note is that this aircraft was judged the Best Classic Beechcraft at EAA Oshkosh 1996.


The pilot's station is also equipped with a small overwing door. Check out the painting of Daffy Duck flying.


As you can see, this aircraft is connected to the right organizations and has been to all of the right places.

## Your Hosts

Your friendly Beech 18 hosts and instructor pilots are Rick Siegfried (left) and Rand Siegfried (right).

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Revised -- 21 November 2002