Private Pilot Knowledge Test Workbook

Prepared for members of Purdue Pilots, Inc.

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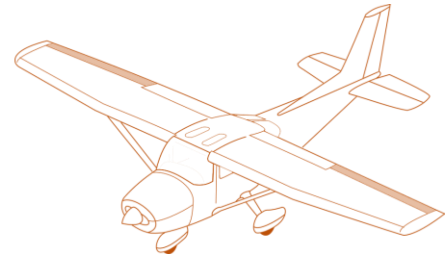
1. Flight controls and aerodynamics

The aircraft has three **primary flight controls**:



- _____
- _____
- _____

To control the aircraft, we move these primary **control surfaces** to change the _____ and _____ around the airfoil.

Ailerons roll the aircraft about the _____ by moving in opposite direction to each other. Moving the yoke to the left deflects the _____ upward and turns the aircraft to the _____.

The **elevator** changes the pitch about the _____. Pulling back on the yoke deflects the _____, creating a downward aerodynamic force on the tail, moving the tail _____ and the nose _____.

A **stabilator** is a horizontal stabilizer and elevator together. Piper Warriors have stabilators, Cessna Skyhawks have elevators.

The **rudder** yaws the aircraft about its vertical axis by exerting a horizontal force in the opposite direction of deflection.

Control effectiveness increases with speed.

*How about **canards**?*

We have a number of **secondary flight controls**. For example…

-
-
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Flaps are used during to increase lift. They allow for a higher descent angle without an increased airspeed.

What are some types of flaps we can find?

Spoilers . We can find them on gliders and high-speed aircraft. Not on our aircraft!

Trim systems (trim tabs, antiservo tabs, and ground adjustable tabs) are designed to help us by relieving us of the need to maintain pressure on the controls. Find the trim tab on the Piper Warrior next time you are at the airport.

During flight, there are four aerodynamic forces acting on our aircraft.

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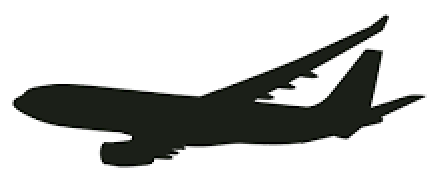
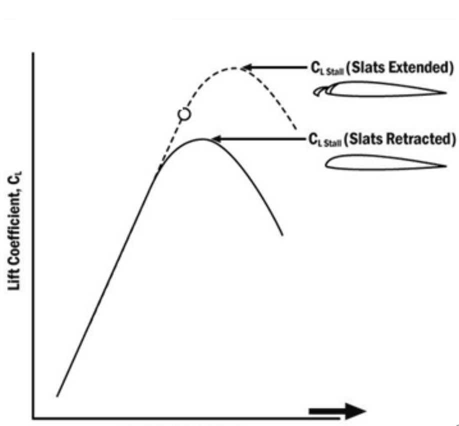


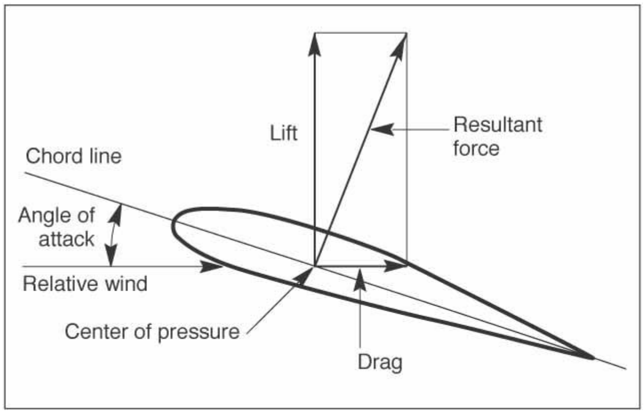
During unaccelerated flight, these forces are in **equilibrium**. What do we mean by that?

Let's talk about **lift**. Where does it come from? And who is **Bernoulli**?



$$L = \frac{1}{2}\rho S C_L V^2$$

Let's start with **angle of attack**, or the angle between the direction of the ________ and the ________.



The **critical angle of attack** is the angle at which the wing will ____. This angle is independent of factors like weight and loading.

> ⚠ *Exceeding critical angle of attack = stall*

Assuming that the aircraft is configured the same way (flaps, weight, etc.) it will stall at a given **indicated airspeed**.

A spin could occur after a stall, if one wing is more stalled than the other. However, <u>both wings have to be stalled first</u>.

We don't always generate as much lift as we think we should. For example, if the wings are not smooth because of **frost**, we will have ________. Frost may make it difficult or impossible for the airplane to take off—remove it first!

How can we use lift to **turn**? We already talked about ailerons, but how do they affect lift? The ________ produces a turn.

Lift is affected when we are flying really close to the ground because of ________. The ground interferes with the wingtip vortices about the wings and results in reduced ________. The wing can produce the required lift at a reduced angle of attack. Ground effect is most pronounced when we are less than half a wingspan above the ground, but is "active" when we are within a height equal to the aircraft's wingspan.

How does ground effect affect us?

In general, we want aircraft that are stable. What does this mean? An airplane that is inherently stable after being disturbed.

What do you think determines the airplane's longitudinal stability?

When the CG is further back (rear of the aft CG limit) the airplane will be less stable and may be unable to recover from a stall.

A non-T-tail airplane will normally pitch when reducing power if you don't adjust the controls. Why?

The airplane will also generally yaw to the (and your CFI may scream) when applying power for takeoff. Why is that?

The **torque effect** is a **left-turning tendency** that is greatest at low airspeed, high angles of attack, and high power (so takeoff!)

P-factor, or **asymmetric propeller loading**, also causes a left yawing motion at high angles of attack. The right side of the propeller (the descending one) has a higher angle of attack and provides more thrust.

[This video should help you visualize propeller tendencies.]()

We covered lift… so let's talk about the force opposing lift, . The wings usually carry more than just the weight of the aircraft, fuel, passengers, etc. They also "carry" the . refers to the additional weight and is a multiple of the usual weight.

The load factor that can be imposed depends on the airspeed and excess lift available. Remember the lift equation? When do we have excess lift?

A higher load factor results in a stall speed. A higher bank angle results in a load factor.

Angle of bank φ	Load factor n
0°	1.0
10°	1.015
30°	1.154
45°	1.414
60°	2.000
70°	2.923
80°	5.747
85°	11.473
90°	∞

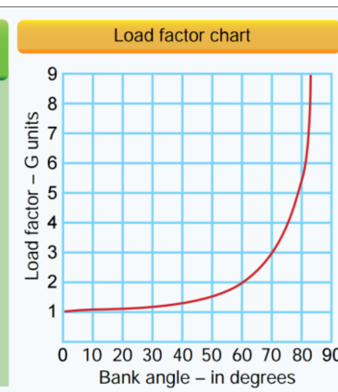


Figure 2.—Load Factor Chart.

2. Systems

We'll cover systems in three parts: instruments, general aircraft systems, and engines.

One of the oldest instruments used is the **compass**. However, it is not a very accurate instrument—it is only considered accurate during straight and level flight at a constant airspeed. It has various errors.

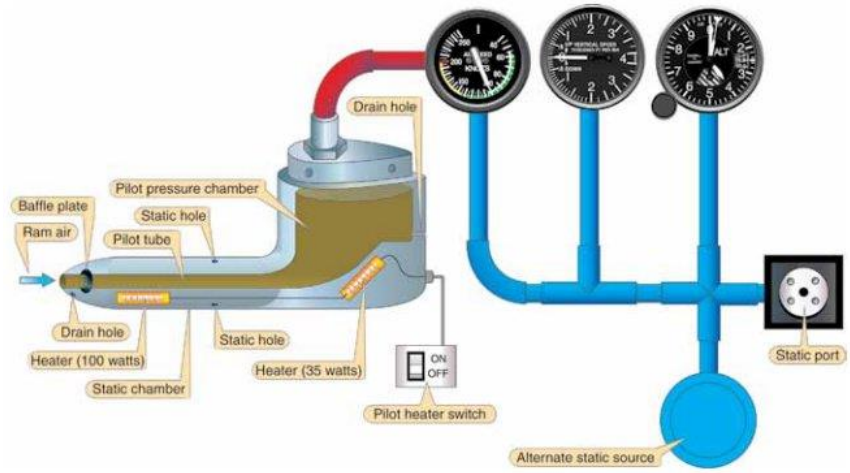
is the difference between the direction indicated by the compass and a compass not installed in the airplane. It is caused by disturbances due to magnetic fields produced by metals and other accessories.

When flying in the Northern hemisphere:

- and turning from a north or south heading
    - When turning to the east from the north, the compass will initially indicate a turn to the west and then lag behind the actual heading
    - When turning to the west from the north, the compass will initially indicate a turn to the east and then lag behind the actual heading
    - When turning from the south, the compass will precede the heading
    - https://www.youtube.com/watch?v=gAMnzB_7K-k
- on an east/west heading we have acceleration/deceleration error
    - When accelerating, the magnetic compass will indicate a turn toward the north. When decelerating, it will indicate a turn towards the south.
    - https://www.youtube.com/watch?v=jv0Pv1E09Gs&t=2s

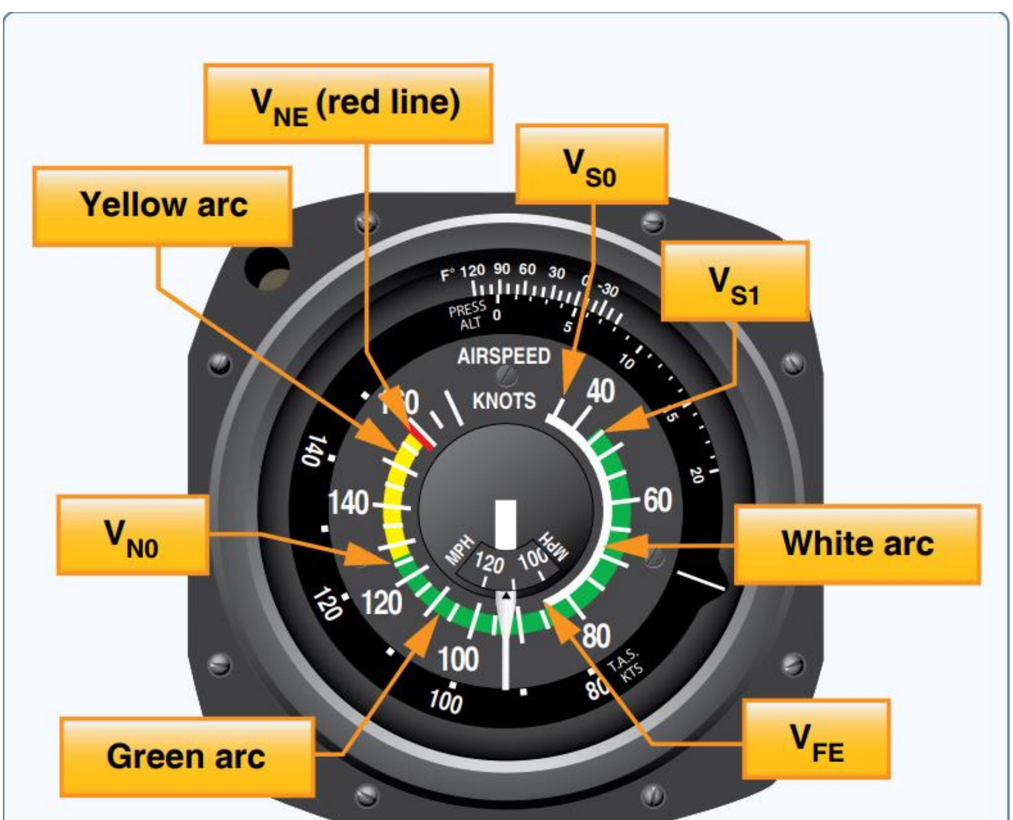
The **pitot-static system** provides pressure information for the ______, the ______, and the ______.

The **pitot tube** provides ______ (or impact pressure) for the airspeed indicator.



How are instruments affected when different tubes are clogged?

The airspeed indicator has color markings for a lot of important airspeeds **except** ______.



The altimeter indicates altitude using three hands (short needle for 10,000 ft, medium needle for 1,000 ft, and long needle for 100 ft).

FIGURE 3.—Altimeter.

There are different types of altitude:

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-
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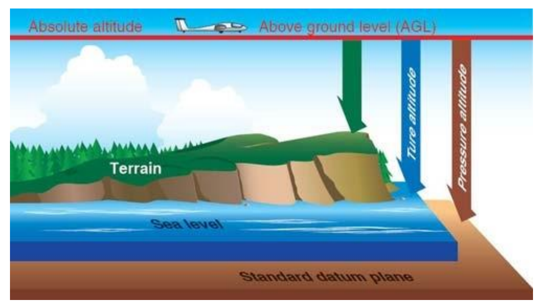
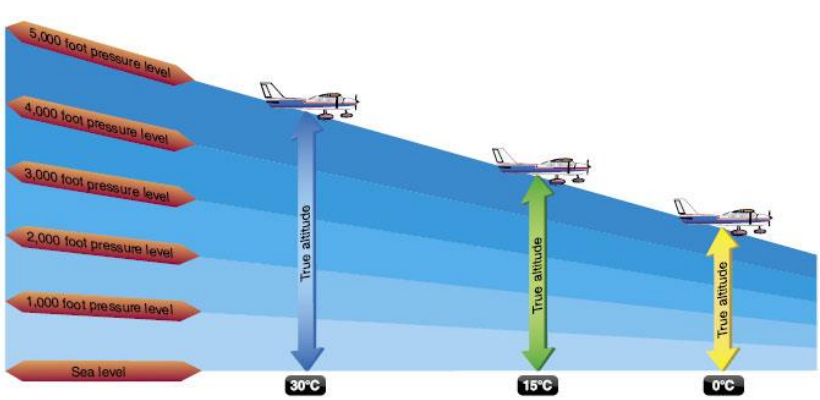


We adjust the altimeter setting on the ground so that indicated altitude is approximately equal to true altitude.

When the altimeter setting goes up the indicated altitude goes up (1,000 ft for 1" of pressure change)

The altimeter is not perfect! We can adjust it for changes in barometric pressure, but not for changes in . On a warm day, the indicated altitude will be lower than the actual altitude. If the pressure increases enroute, the indicated altitude will be lower than the actual altitude.

High to low, look out below. Low to high, clear the sky.



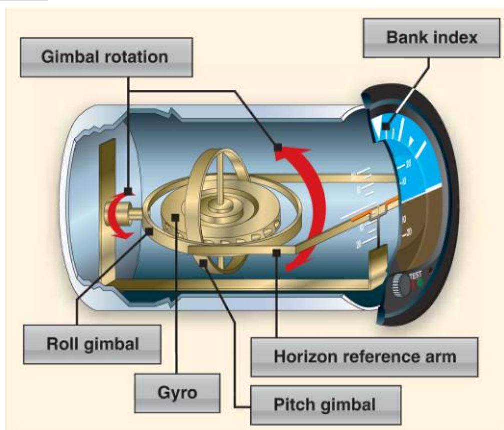
The **gyroscopic instruments** include

- ______
- ______
- ______

The attitude indicator includes an adjustment knob for alignment to the pilot's field of vision.

The miniature airplane on the turn coordinator moves proportionally to the aircraft's roll rate. If constant, it shows the rate of turn. The ball shows if the turn is coordinated.

The heading indicator should be readjusted periodically due to ______.



Newer airplanes have replaced everything with ______ designed to decrease workload and enhance situational awareness. Do not rely on them too much—look outside and be safe.

The ______ integrates all the necessary flight instruments in one screen and can overlay navigation instruments...

The ______ can combine information from multiple systems. Usually engine monitoring, moving map, weather...

The planes you will most likely be flying have constant-pitch propellers. ______ **propellers**, or variable/controllable-pitch propellers, differ in that the pilot can choose the propeller blade angle that will give them the best performance for the current operation.

If you have a constant-speed propeller, you will have two controls: a throttle, and a propeller control. The throttle controls power output, which appears on the ______. The propeller control controls engine revolutions (RPM) which appear on the ______.

> ⚠ *Do NOT use high manifold pressure with low RPM settings.*

For additional information, check out [Professor Von Kliptip's guide]!

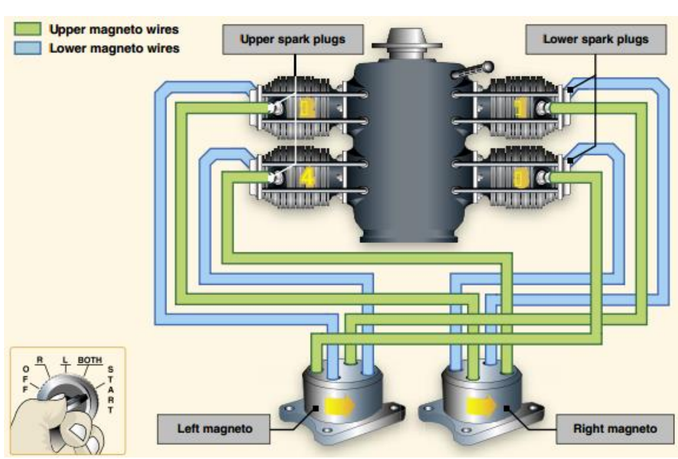
The **electrical system** you'll find in most airplanes is 14- or 28-volt DC. The ______ turns on all electrical systems (lights, radios, fuel pump) except the ignition system.

Engine-driven **alternators** or **generators** supply electrical current to the electrical system to maintain charge on battery. Alternators provide more electrical power at lower engine RPMs than generators.

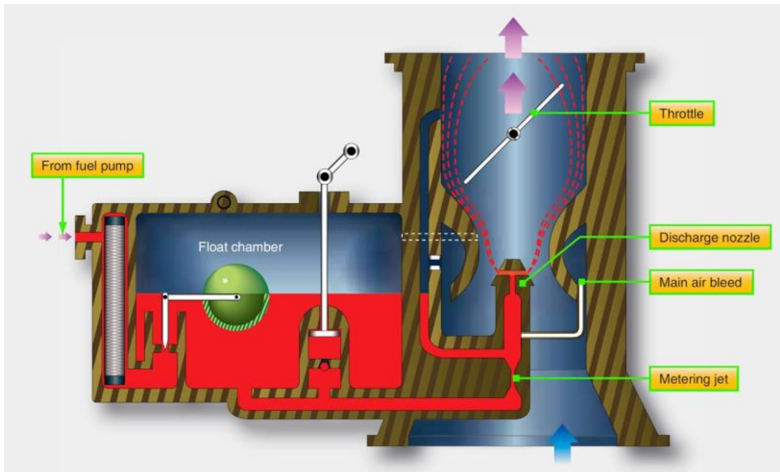
The ______ indicates positively if the battery is charging; negatively if the current being drawn from the battery is higher than the current being replaced.

The **dual-ignition system** improves ______.

The magneto may continue to fire with the ignition switch OFF if the ground wire is disconnected. Then how do you stop the engine? And how do we avoid this issue?



The planes you will be flying also have **carburetor**-equipped engines (as opposed to **fuel-injected** engines). Float-type carburetors operated based on the difference in air pressure between the venturi throat and the air inlet.



A disadvantage of carbureted-engines is **carburetor icing**, likely to form when . The first indication for the pilot is a loss of RPM. To correct, apply carburetor heat and expect a further RPM decrease (richer mixture, more on that in a bit) followed by an increase as the ice melts.

The fuel/air mixture refers to the ratio between the mass of fuel to air being combusted. At higher altitudes, we need to **lean** the mixture to keep it constant because the air is less dense. At airports of high elevation, to eliminate engine roughness.

What will happen if you descend from a high altitude without adjusting the mixture?

Some people struggle with **starting the engine**. Ask me to show you my foolproof technique if you see me at the airport! Two things you need to know in theory though:

✈After the engine starts, adjust for proper RPM and check the oil pressure (and other engine gauges).

✈If starting by hand (hand-propping) you NEED to have a competent pilot at the controls.

What do you know about aviation fuel, other than it is expensive? All of our airplanes in the club run on 100LL.

In general, use the next-higher-than-specified grade of fuel (octane) if needed, not the next-lower. Using lower octane can result in ________, or running the engine too hot.

Fuel Type and Grade	Color of Fuel	Equipment Control Color	Pipe Banding and Marking	Refueler Decal
AVGAS 82UL	Purple	82UL AVGAS	AVGAS 82UL	82UL AVGAS
AVGAS 100	Green	100 AVGAS	AVGAS 100	100 AVGAS
AVGAS 100LL	Blue	100LL AVGAS	AVGAS 100LL	100LL AVGAS
JET A	Colorless or straw	JET A	JET A	JET A
JET A-1	Colorless or straw	JET A-1	JET A-1	JET A-1
JET B	Colorless or straw	JET B	JET B	JET B

At the end of the day, fill up the tanks to prevent moisture condensation. Drain all fuel strainer drains and fuel tank sumps before each flight to make sure you don't have water in the fuel system.

Where are the fuel sumps located in our airplanes? How many do they have? How will you know if there is water in the fuel system? What else are you looking for when draining fuel?

Use the auxiliary electric fuel pump if the engine-driven fuel pump fails.

We will discuss two kinds of abnormal combustion.

- [illegible] happens when the mixture explodes instead of burning evenly. Usually caused by using a lower octane fuel or excessive engine temperatures. It causes excessive wear and higher operating temperatures. *How do we react to it?*
- [illegible] is the uncontrolled firing of the mixture charge in advance of the normal spark ignition.

For a graphical depiction : https://youtu.be/UfqXhnr2Ho4

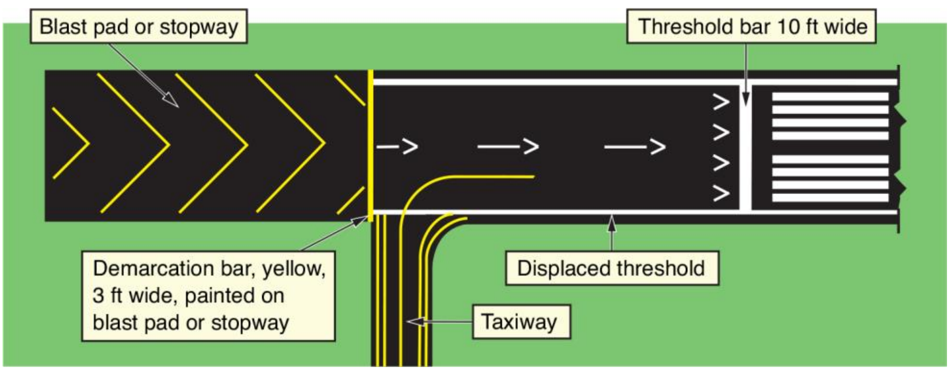
3. Airports

The most important feature of an airport is the runway. Runways are numbered based on **magnetic alignment** divided by 10. For example, runway 10 at KLAF points to ~100˚ magnetic.

Look at Elkhart Municipal Airport (KEKM)!

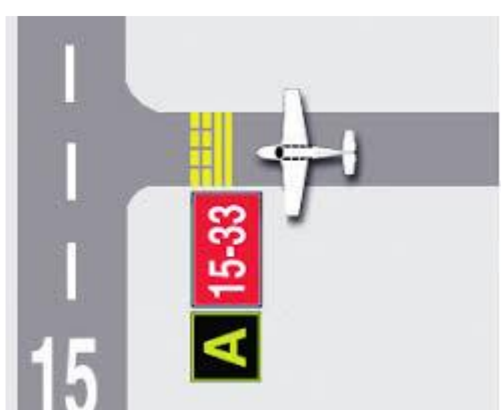
Runways sometimes have quirks. For example, a **displaced threshold** is a threshold which is not located at the beginning of the runway. The **landing portion** of the runway starts after the displaced threshold. **Chevrons** mark the unusable portion of the runway.

Where can you be at different phases of flight?

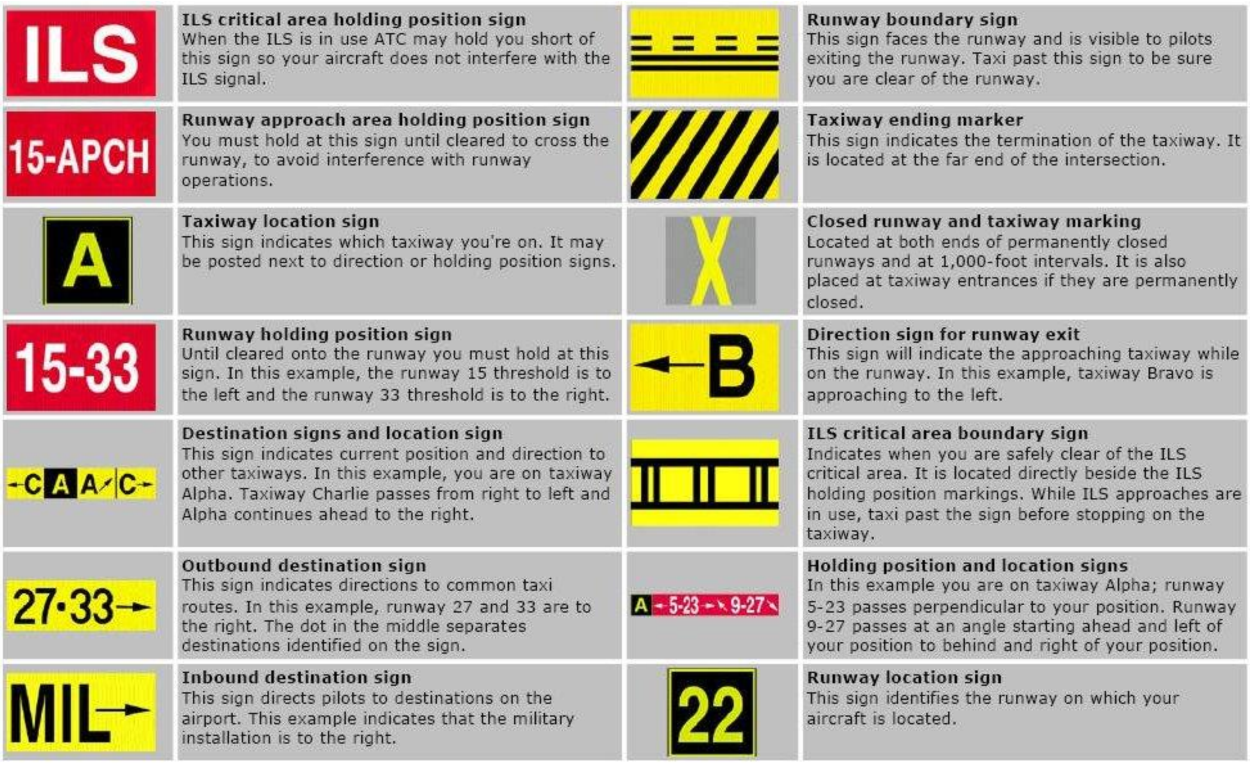


Runways can also close for various reasons. A closed runway is marked with an **X** on each runway end.

Runway holding position markings show the pilot where to stop. DO NOT cross without ATC clearance. **Taxiway holding lines** are yellow lines painted across the taxiway. A **runway holding position sign** is a **mandatory instruction sign** (white on red) located at the holding position on taxiways/wunways.



Pilots also use signs to figure out where they are and where they are going. **Destination signs** (black on yellow) show direction to listed destination. **Taxiway directional signs** show the direction of a taxiway, for example when coming out of an intersection. **Taxiway location signs** (yellow on black) identify which taxiway you are on.



ILS	**ILS critical area holding position sign** When the ILS is in use ATC may hold you short of this sign so your aircraft does not interfere with the ILS signal.		**Runway boundary sign** This sign faces the runway and is visible to pilots exiting the runway. Taxi past this sign to be sure you are clear of the runway.
15-APCH	**Runway approach area holding position sign** You must hold at this sign until cleared to cross the runway, to avoid interference with runway operations.		**Taxiway ending marker** This sign indicates the termination of the taxiway. It is located at the far end of the intersection.
A	**Taxiway location sign** This sign indicates which taxiway you're on. It may be posted next to direction or holding position signs.	X	**Closed runway and taxiway marking** Located at both ends of permanently closed runways and at 1,000-foot intervals. It is also placed at taxiway entrances if they are permanently closed.
15-33	**Runway holding position sign** Until cleared onto the runway you must hold at this sign. In this example, the runway 15 threshold is to the left and the runway 33 threshold is to the right.	←B	**Direction sign for runway exit** This sign will indicate the approaching taxiway while on the runway. In this example, taxiway Bravo is approaching to the left.
←C A A↗ C→	**Destination signs and location sign** This sign indicates current position and direction to other taxiways. In this example, you are on taxiway Alpha. Taxiway Charlie passes from right to left and Alpha continues ahead to the right.		**ILS critical area boundary sign** Indicates when you are safely clear of the ILS critical area. It is located directly beside the ILS holding position markings. While ILS approaches are in use, taxi past the sign before stopping on the taxiway.
27·33→	**Outbound destination sign** This sign indicates directions to common taxi routes. In this example, runway 27 and 33 are to the right. The dot in the middle separates destinations identified on the sign.	A ←5-23→ ↖9-27↘	**Holding position and location signs** In this example you are on taxiway Alpha; runway 5-23 passes perpendicular to your position. Runway 9-27 passes at an angle starting ahead and left of your position to behind and right of your position.
MIL→	**Inbound destination sign** This sign directs pilots to destinations on the airport. This example indicates that the military installation is to the right.	22	**Runway location sign** This sign identifies the runway on which your aircraft is located.

Airports use **rotating beacons** at night to indicate their type and location. We usually go for green and white rotating beacons. A lighted heliport has a green, yellow, and white rotating beacon. Military airport beacons are white, white, green.

If the green/white rotating beacon is operating during the day at a Class D airspace airport→ the field is not VFR! (visibility < 3 SM or ceiling < 1,000')