Airspeeds, V-Speeds, Vx, Vy, Vs0, Vs1, Va, Vno, Vfe, Vne...

Airspeed Limitations, Manoeuvring Speeds and Performance

Alphabet Soup?
Aviation Acronyms can seem like Alphabet Soup!

With Airspeeds and V-Speeds, there are dozens of Aviation Acronyms for the student pilot to learn and remember.

Your Aviation Acronym Decoder begins with some talk about Velocity.

V is for Velocity
Important aviation Airspeeds are identified and defined using standard terms. Scientists and Engineers refer to Speed as Velocity. Therefore these standard Airspeeds (Velocity) are defined as V-Speeds where the V is for Velocity.

Aircraft designers and manufacturers perform flight tests to help determine performance limitations of aircraft. The resulting flight test data is used to help determine specific best practice speeds for safe operation of the aircraft. Recommended Velocity Speeds (V-Speeds) are published and these airspeeds are relied on for best performance and safety of the aircraft. Pilots should be knowledgeable about the published V-Speeds for each type and configuration of aircraft they fly.

Pilot’s Operating Handbook
Pilots should consult the Pilot’s Operating Handbook, or POH, for the aircraft they fly. These important V-Speeds will be published in the POH (Information Manual) for their specific Aircraft type and model.

Airspeed Indicator
Fortunately, the Airspeed Indicator in your airplane will have some of the more important V-Speeds highlighted or emphasized directly on the dial of the flight instrument. This helps the pilot to visually recognize these V-Speeds and easily determine how close they are to the V-Speeds while in flight.

General aviation aircraft depict the most commonly-used and most safety-critical airspeeds or V-Speeds on the Airspeed Indicator. These are displayed as color-coded arcs and lines located on the face of an aircraft’s airspeed indicator flight instrument.

White, Green, Yellow and Red
You will notice the colour-coded bands or arcs on the Airspeed Indicator. Pictured is a sample ‘Steam Gauge’ Airspeed Indicator. Let’s take a closer look, to determine some of these important V-Speeds. Remember, this is just an example, and the V-Speeds will differ based on the exact type, model and configuration of aircraft you fly.

The White Arc
The Flaps Operating Range is denoted by the White Arc. Flaps may only be used within this range of speeds.

Vs0
The beginning of the White Arc is the power off Stalling Speed with gear and full flaps extended, also known as Vs0. The Vs0 (Velocity Stall 0) represents the Stalling Speed of the aircraft configured for landing. (i.e. Gear Down and Flaps Down) An easy way to remember this is to think of the Velocity (V) of Stall (s) with everything hanging Out (0) or Vs0.

Vs and Vs1
Now that you are familiar with Vs0, it’s easy to remember Vs1. The beginning of the Green Arc is the power off Stalling Speed with the Gear and Flaps retracted. Vs is the Velocity (V) of the Stall (s), or minimum steady flight speed for which the aircraft is still controllable. As a memory aid, Vs1 is the Velocity (V) of the Stall (s) with everything inside (1 looks like the letter i for inside). This is the Stall speed or minimum steady flight speed for which the aircraft is still controllable in a specific configuration.

The lower ends of the Green Arc and the White Arc depict the stalling speed with wing flaps retracted (Vs1), and stalling speed with wing flaps fully extended (Vs0), respectively. These Vs (Velocity of Stall) speeds are the stalling speeds for the aircraft at its maximum weight.

Vfe
The Top of the White Arc depicts the Maximum Flap Extended Speed. This is referred to as Vfe for Velocity (V) with Flaps (f) Extended (e). This represents the maximum airspeed at which you may extend the flaps, or fly with them extended. The flaps may not be used above this range (White Arc) or possible structural damage may occur to the aircraft.

The Green Arc
The Green Arc on the Airspeed Indicator depicts the normal operating airspeed range. As we have learned, Vs is the Velocity (V) of the Stall (s) and the Vs or Vs1 speed is denoted by the beginning of the Green Arc. At the top end of the Green Arc, is the Vno.

Vno
As the Green Arc is the Normal Operating Range, the top of the green arc is the Velocity (V) of Normal (n) Operations (o) or Vno. This is the maximum structural cruising speed. Operation of the Aircraft at the Vno speed, and lower, is within the certified range for operations within gusts. The aircraft is certified to withstand substantial wind gusts without experiencing structural damage. Operations above Vno move into the Yellow Arc on the Airspeed Indicator. Do not exceed Vno, except in Smooth Air, and only with caution.

V-Speeds Designated

http://www.learntofly.ca/airspeeds-v-speeds-vx-vy-vs-vs1-va-vno-vfe-vne/
The Airspeed Indicator Flight Instrument shown here has some of the V-Speeds high-lighted. Standard colours and markings help pilots to immediately identify some of these very important V-Speeds. Click on the Airspeed Indicator for a larger view.

The Yellow Arc
Beyond the Green Arc, we see the Yellow Arc. The speed range marked by the Yellow Arc is the Caution Speed Range. The Airspeed range indicated by the Yellow Arc is for Smooth Air Only.

Operations above Vno (Top of the Green Arc) will bring you into the Caution Range of the Yellow Arc. Flight Operations in the Yellow speed range are to be conducted in Smooth Air only!

Vne
The Red Line at the top of the Yellow Arc is the Velocity (V) that you Never (n) Exceed (e). This is the Red Line of the Airspeed Indicator, and the Vne is the Maximum Speed the Aircraft should ever be operated in Smooth Air. Remember, the Yellow Arc is for Smooth Air Only. You should not exceed the Green Arc speed range unless the Air is Smooth and without gusts. Exceeding the Vne Airspeed can cause uncontrollable and destructive flutter, and cause serious or catastrophic failure of structural components on the aircraft. Aircraft designers include a slight safety margin, but do not risk or rely on this slim margin. The Vne is the Velocity (V) you Never (n) Exceed (e).

Other V-Speeds
There are other important V-Speeds, but they are not shown on the Airspeed Indicator Flight Instrument. The Pilot will need to be familiar with these other speeds, but they can't simply look at the Airspeed Dial to determine these other V-Speeds.

Vx
Manoeuvring Speed is found well below Vno. Manoeuvring Speed may be remembered as Velocity (V) of Acceleration (a) or Va. The pilot should not make full or abrupt control movements above this speed. In turbulence, you should always be at, or below, the Manoeuvring Speed (Va). The only way to ensure you will not damage the aircraft with full or abrupt control movement is to fly at or below this speed.

Retractable Gear Aircraft
Most student pilots will learn to fly on airplanes with fixed landing gear. However, if you fly an aircraft with Retractable Landing Gear, you will need to be aware of two more important V-Speeds. These are Vlo and Vle.

Vlo
Vlo is the Maximum Velocity (V) for Landing (l) gear Operation (o). Do not extend or retract the landing gear above this airspeed. When the landing gear is in transition, it is more vulnerable to damage from the effects of speed. However, once the landing gear is fully extended and locked, it may sustain higher airspeeds.

Vle
Vle is the Maximum Velocity (V) of Landing (l) gear Extended (e). Do not exceed this speed with the landing gear extended.

Glass Cockpits
The newer Glass Cockpits are ideal for presenting tremendous amounts of critical data to the Pilot in an organized and familiar manner.

This Garmin G1000 Primary Flight Display (PFD) may not look too much like the older Six Pack of ‘Steam Gauge’ Flight Instruments, but there are still many similarities. For instance, the Pilot previously accustomed to the Airspeed Indicator Dial will find similar colour coding on the Airspeed Indicator Tape Strip. Click on the glass cockpit image for a larger view.

Tape Strip
The Airspeed is typically indicated by a Tape Strip (Left Side of Glass Panel) that moves up and down to depict the Airspeed. The current speed is shown as a digital number. However, you will also see the familiar Green and Yellow Bars. From this familiar colour coding, the pilot can easily visualize some of these critical V-Speeds. The Glass Cockpit technology is incredible, and the pilot will be provided with considerable additional information including Ground Speed calculations and True Air Speed (TAS) calculations. You'll learn more about TAS as you continue reading below.

Vx and Vy
Two easily confused Airspeeds are Vx and Vy. The student pilot must have these important airspeeds committed to memory very early in their flight instruction. These airspeeds will be demonstrated and explained. They are Best Rate of Climb (Vy) and Best Angle of Climb (Vx).

Best Rate of Climb (Vy)
After takeoff, the aircraft should normally be configured for the Best Rate of Climb. This will provide the best climb for the maximum gain in altitude in the shortest time possible. You will get to your selected cruising altitude in the least time possible. Altitude is your friend, and particularly after takeoff, you want to gain the maximum height above the ground in the least time possible. Vy provides you with the Best Rate of Climb.

Best Angle of Climb (Vx)
Occasionally, it may be necessary to gain the maximum altitude possible over the shortest distance on the ground. To achieve this, the pilot would use the Best Angle of Climb or Vx. This would be applicable if you needed to clear an obstacle or obstruction on the ground shortly after takeoff. The pilot would configure the aircraft for the Best Angle of Climb to gain the maximum altitude possible before reaching the obstacle (i.e. Tree) located beyond the runway. Vx is slower than Vy. This makes sense, as Vx will have a slower forward speed. The slower forward speed of the airplane will provide more opportunity for altitude gain before reaching the obstacle to be cleared. An easy way to remember Vx vs. Vy, is to ask yourself which letter has more angles? The letter X has more angles than the letter Y. As such, you will always remember Vx is the Best Angle of Climb, and Vy is the Best Rate of Climb.

We've already looked at quite a few V-Speeds, and there are dozens more for the progressing pilot to master. We've touched upon some of the most important V-Speeds in your early flight training. Now that we have considered some V-Speeds, let's look closer at some other types of Airspeed.
IAS, CAS and TAS

When you read the Airspeed on the Airspeed Indicator Flight Instrument, you are reading the Indicated Air Speed (IAS). This is simple. What you see on the dial, is the IAS.

For instance, if the Airspeed Indicator Needle is pointing to 85 knots, then the Indicated Airspeed (IAS) would obviously be 85 knots.

Calibrated Air Speed (CAS)
The Airspeed Indicator is subject to slight errors. These errors are caused by factors such as the placement of the Pitot Tube and Static Sources and flying configuration such as the degrees of flap extended. Your POH reference guide may be used to determine the amount of ‘Correction’ you need to calculate your Calibrated Airspeed. The difference between IAS and CAS may be slight, but your Aircraft Information Manual will outline the adjustments and assist you in determining your Calibrated Airspeed or CAS.

True Air Speed (TAS)
The IAS and CAS are still not your True Air Speed (TAS). To calculate TAS, you will need to factor in the Outside Air Temperature (OAT) and the Pressure Altitude. Some Airspeed Indicators have a moveable ring on the outer scale of the dial to assist with determining your TAS.

Air Density
At Sea Level, Air is very dense. This dense air helps the wings create lift, but there is also additional drag. As the aircraft ascends, the higher altitude air is less dense. This reduces drag, and allows the airplane to fly faster through the air. However, the less dense air does not ‘strike’ the Pitot Tube quite as hard, causing the Indicated Air Speed (IAS) to be less than the True Air Speed being flown through the less-dense, higher altitude air.

2% per 1,000 feet
For every 1,000 feet of altitude gain, True Air Speed (TAS) increases approximately 2% over Indicated Air Speed (IAS).

For example, if you were flying 10,000 feet above sea level, with an Indicated Air Speed of 100 knots, your True Air Speed (TAS) would be approximately 120 Knots. This is 20% faster than your Airspeed being indicated on your flight instruments. You simply take your Altitude above sea level (i.e. 10,000 feet) and increase your IAS by 2% for each 1,000 feet. (e.g. 2% times 10) This would result in a TAS of 120 knots, or a 20% increase of your IAS.

Your handy electronic Flight Computer and POH will help you accurately calculate your TAS for ground speed calculations.

As you can see, as a student pilot, you need to know quite a bit about Airspeeds, V-Speeds, IAS, CAS, TAS, and more.