Speeds frequently used in General Aviation

V_A

design maneuvering speed (stalling speed at the maximum legal G-force, and hence the maximum speed at which abrupt, full deflection, elevator control input will not cause the aircraft to exceed its G-force limit). The aircraft will stall prior to any structural damage occuring. Maneuvering speed is adjusted based on the weight of the aircraft. As the weight increases, Maneuvering speed increases. This is because the aircraft is less subject to rapid acceleration at the higher weight.

V_{FE}

maximum flap extended speed (a different maximum speed may be specified for partial flap extension).

V_{LE}

maximum landing gear extended speed. The maximum speed at which the aircraft may be flown with the landing gear extended. V_{LE} is typically higher than V_{LO}

V_{LO}

maximum landing gear operating speed. The maximum speed at which the aircraft may be flying while raising or lowering the gear. Although V_{LO} is designated as one speed, in most cases it will have both an extension and retraction speed. Many aircraft can extend the gear at V_{LE}, but (because of possible G-loading in climbout) must retract the gear at a lower speed. For example the Piper Seminole can extend the gear at its V_{LE} of 140 but must be below 109 to retract the gear, thus V_{LO} is read as 109,140 instead of a single airspeed. Another factor to consider is the direction of drop of the nose-wheel. In aircraft where the nosewheel retracts forward into the fuselage, the V_{le} can actually be higher than V_{lo}. V_{lo} can be approximated by 1.1 times V_{stall}.[1]

V_{MC} or V_{MCA}

minimum control speed with the critical engine inoperative. The speed below which control will be lost, normally due to roll or yaw divergence. In initial aircraft type testing and certification, this is tested at a safe height above ground and, when established, is factored in to V_2 (refer below) that by regulation has a set margin over Vmca and also over Vs.

V_{NE}

The V_{NE}, or never exceed speed, is the V speed which refers to the velocity that should never be exceeded because of the risk of structural failure, due for example to wing or tail deformation, or aeroelastic flutter. On many airspeed indicators the V_{NE} is marked with a red line. This speed is specific to each aircraft model, and represents the edge of its performance envelope in terms of speed.

V_{NO}

The V_{NO} of an aircraft is known as the maximum structural cruising speed (the maximum speed to be used in turbulent conditions) or can refer to the **velocity of normal operation**. V_{NO} is specified as the upper limit of the green arc on many airspeed indicators. This speed is specific to the aircraft model. The range above V_{NO} is marked on the airspeed indicator as a yellow arc from V_{NO} to the V_{NE}.

V_R

rotation speed. The speed of an aircraft at which the pilot initiates rotation to obtain the scheduled takeoff performance. It must be greater or equal to the V_1 speed.

V_{REF}

reference landing approach speed; speed (in calm air) at the landing screen height of 50 ft. Often used by pilots as a base from which to calculate speeds to be used during landing, and calculated as a margin over the stall speed - usually $1.3 \times V_{S0}$.

V_S

the stalling speed or the minimum steady flight speed at which the aircraft is controllable. Usually synonymous with V_{S1}. This speed is specific to the aircraft model and depends upon the weight and balance of the aircraft. The true stall speed increases as atmospheric pressure decreases. (i.e. as temperature increases and/or as altitude increases.) The indicated stall speed, i.e. the speed indicated by the airspeed indicator, remains essentially unchanged with air pressure.

V_{S0}

the stalling speed or the minimum steady flight speed in the landing configuration.

V_{S1}

the stalling speed or the minimum steady flight speed obtained in a specific configuration (usually a "clean" configuration without flaps, landing gear and other sources of drag).

V_X

speed for best angle of climb. This provides the best altitude gain per unit of horizontal distance, and is usually used for clearing obstacles during takeoff.

V_Y

speed for best rate of climb. This provides the best altitude gain per unit of time.

Other reference speeds

V_B

design speed for maximum gust intensity.

V_C

The V_C of an aircraft is the V speed which refers to the velocity of cruising. V_C is within the green arc on many airspeed indicators. This speed is different for each aircraft model. V_C is also called the design cruising speed or the optimum cruise speed – the latter being the speed giving the most velocity (i.e. greatest distance/time) from a litre of fuel, usually utilising 75% power at Maximum Take-Off Weight (MTOW) and about 1.3 times the maximum lift-to-drag ratio (L/D) speed – Vbr above. The speed and power required decrease as the aircraft weight decreases from MTOW.

For normal category aircraft FAR Part 23 specifies a minimum design cruising speed (in knots) based on the wing loading of (weight in pounds divided by wing area in square feet). For the utility category, the minimum design cruising speed is . Many ultralight aeroplanes are unable to comply with the FAR part 23 requirement for a minimum design cruising speed.

V_D

design diving speed. Usually $1.4 \times V_{NO}$.

V_{DF}/M_{DF}

demonstrated flight diving speed.

V_{EF}

the speed at which the critical engine is assumed to fail during takeoff.

V_F

design flap speed.

V_{FC}/M_{FC}
: maximum speed for stability characteristics.

V_{FTO}
: final takeoff speed

V_H
: maximum speed in level flight with maximum continuous power.

V_{LOF}
: lift-off speed.

V_{MO}/M_{MO}
: maximum operating limit speed.

V_{MU}
: minimum unstick speed.

V_{SR}
: reference stall speed.

V_{SR0}
: reference stall speed in the landing configuration.

V_{SR1}
: reference stall speed in a specific configuration.

V_{SW}
: speed at which onset of natural or artificial stall warning occurs.

V_{TOSS}
: takeoff safety speed for Category A rotorcraft.

V_{WW}
: maximum speed for windshield wiper operation.

V_1
: Takeoff decision speed. V_1 is the minimum speed in the takeoff, following a failure of the critical engine at V_{EF}, at which the pilot can continue the takeoff with only the remaining engines. Any problems after V_1 are treated as in-flight emergencies. In the case of a balanced field takeoff, V_1 is the maximum speed in the takeoff at which the pilot must take the first action (e.g., apply brakes, reduce thrust, deploy speed brakes) to stop the aircraft within the accelerate-stop distance and the minimum speed at which the takeoff can be continued and achieve the required height above the takeoff surface within the takeoff distance. In this context, V_1 is the takeoff decision speed.

V_2
: the minimum safe speed in the second segment of a climb following an engine failure. Also called takeoff screen speed and sometimes, takeoff safety speed, although as the second climb segment indicates, V2 is an after takeoff speed frequently achieved shortly after rotate (Vr) as the aircraft accelerates. The engine failure case that is taken in the calculation of V2 is that of the "most adverse engine" because the effects of different engines when failed, differ. The calculation of V2 also includes set margins over the stall and other safety factors are built in as well.

V_{2min}
: minimum safe speed in the second segment of a climb following an engine failure.

Non-regulatory speeds

These values are not defined by FAA regulations.

V_{BE}
: best endurance speed; the speed that gives the greatest airborne time for fuel consumed. This may be used when there is reason to remain aloft for an extended period, such as waiting for a forecast improvement in weather on the ground.

V_{BG}
: best power-off glide speed; the speed that provides maximum lift-to-drag ratio and thus the greatest gliding distance available.

V_{XSE}
: speed for best angle climb with the critical engine inoperative.

V_{YSE}
: speed for best rate of climb with the critical engine inoperative.

V_2
: t/o safety speed

V_3
: steady initial climb speed with all engines operating

V_4
: steady climb speed with all engines operating to be achieved by 400 ft gross height

V_a
: design maneuvering speed

V_c
: design cruising speed.

V_{clmax}
: max coefficient of lift speed.

V_d
: design diving speed

V_{dmin}
: minimum drag

V_{df}
: demonstrated flight diving speed

V_{ef}
: the CAS at which the critical engine is assumed to fail

V_f
: design flap speed

V_{fe}
: max flap extended speed

V_{fto}
: final t/o speed

V_{imd}
: minimum drag

V_{imp}
: minimum power

V_h
: max speed in level flight with max continuous power.

V_{le}
max landing gear extended speed

V_{lo}
max landing gear operating speed

V_{lof}
lift-off speed

V_{mbe}
max brake energy speed

V_{md}
minimum drag

V_{mc}
minimum control speed with critical engine inoperative

V_{mca}
minimum control speed, air
Air minimum control speed is the minimum flight speed at which the aircraft is directionally controllable as determined in accordance with applicable aviation regulations. Aircraft certification conditions include one engine becoming inoperative and windmilling, not more than a 5 degree bank towards the operative engine, takeoff power on the operative engine, landing gear up, flaps in takeoff position, and most rearward C of G.

V_{mcg}
minimum control speed, ground, with nose wheel steering assumed inoperative

V_{mcl}
minimum control speed, approach and landing

V_{me}
max endurance

V_{mini}
minimum IFR speed for helicopters

V_{mo}
max operating limit speed

V_{mp}
minimum power

V_{mr}
max range

V_{mu}
minimum unstick speed

V_{nd}
max structural cruising speed

V_{p}
aquaplaning speed.

V_{ra}
rough air speed

V_{ref}
reference landing speed

V_{s}
V-stall

V_{s0}
stall speed in landing configuration

V_{s1}
stall speed in a specified configuration
V_{s1g}
one g stall speed
V_{sr}
reference stall speed
V_{sse}
safe single engine speed
V_t
threshold speed
V_{tmax}
max threshold speed
V_x
best angle of climb
V_{xe}
best angle of climb, single engine
V_y
best rate of climb
V_{yse}
best rate of climb single engine

Speeds indicated on Airspeed Indicator

Airspeed Indicator

Several V speeds are denoted on the color-coded Airspeed Indicator, to give pilots an immediate reference, as follows:

- **V_{S0}**

  Least speed of white arc

- **V_{S1}**

  Least speed of green arc

- **V_{FE}**

  Greatest speed of white arc.

- **V_{NO}**

  Intersection of green and yellow arcs. The yellow arc is a caution, as speeds in this region may add dangerous stress to the aircraft, and are only to be used in smooth air when no turbulence or abrupt control inputs are expected.

- **V_{NE}**

  red line and greatest speed of yellow arc.

- In addition, on light multi-engine aircraft, **V_{YSE}** is indicated by a blue line, and **V_{MC}** is indicated by a red line near the least speed of the green arc.