(2) For turbine engine-powered airplanes, the propulsive thrust not greater than zero at the stalling speed, or, if the resultant thrust has no appreciable effect on the stalling speed, with engine(s) idling and throttle(s) closed;
(3) The propeller(s) in the takeoff position;
(4) The airplane in the condition existing in the test, in which \( V_{SO} \) and \( V_{S1} \) are being used;
(5) The center of gravity in the position that results in the highest value of \( V_{SO} \) and \( V_{S1} \); and
(6) The weight used when \( V_{SO} \) and \( V_{S1} \) are being used as a factor to determine compliance with a required performance standard.

(b) \( V_{SO} \) and \( V_{S1} \) must be determined by flight tests, using the procedure and meeting the flight characteristics specified in § 23.201.

(c) Except as provided in paragraph (d) of this section, \( V_{SO} \) and \( V_{S1} \) at maximum weight must not exceed 61 knots for—
(1) Single-engine airplanes; and
(2) Multiengine airplanes of 6,000 pounds or less maximum weight that cannot meet the minimum rate of climb specified in § 23.67(a)(1) with the critical engine inoperative.

(d) All single-engine airplanes, and those multiengine airplanes of 6,000 pounds or less maximum weight with a \( V_{SO} \) of more than 61 knots that do not meet the requirements of § 23.67(a)(1), must comply with § 23.562(d).

[Doc. No. 27807, 61 FR 5184, Feb. 9, 1996]

§ 23.51 Takeoff speeds.

(a) For normal, utility, and acrobatic category airplanes, rotation speed, \( V_R \), is the speed at which the pilot makes a control input, with the intention of lifting the airplane out of contact with the runway or water surface.

(1) For multiengine landplanes, \( V_R \) must not be less than the greater of 1.05 \( V_{MC} \); or 1.10 \( V_{S1} \);
(2) For single-engine landplanes, \( V_R \) must not be less than \( V_{S1} \); and
(3) For seaplanes and amphibians taking off from water, \( V_R \) may be any speed that is shown to be safe under all reasonably expected conditions, including turbulence and complete failure of the critical engine.

(b) For normal, utility, and acrobatic category airplanes, the speed at 50 feet above the takeoff surface level must not be less than:

(1) or multiengine airplanes, the highest of—
   (i) A speed that is shown to be safe for continued flight (or emergency landing, if applicable) under all reasonably expected conditions, including turbulence and complete failure of the critical engine;
   (ii) 1.10 \( V_{MC} \); or
   (iii) 1.20 \( V_{S1} \).

(2) For single-engine airplanes, the higher of—
   (i) A speed that is shown to be safe under all reasonably expected conditions, including turbulence and complete engine failure; or
   (ii) 1.20 \( V_{S1} \).

For commuter category airplanes, the following apply:
(1) \( V_1 \) must be established in relation to \( V_{EF} \) as follows:
   (i) \( V_{EF} \) is the calibrated airspeed at which the critical engine is assumed to fail. \( V_{EF} \) must be selected by the applicant but must not be less than 1.05 \( V_{MC} \) determined under § 23.149(b) or, at the option of the applicant, not less than \( V_{MCG} \) determined under § 23.149(f).
   (ii) The takeoff decision speed, \( V_1 \), is the calibrated airspeed on the ground at which, as a result of engine failure or other reasons, the pilot is assumed to have made a decision to continue or discontinue the takeoff. The takeoff decision speed, \( V_1 \), must be selected by the applicant but must not be less than \( V_{EF} \) plus the speed gained with the critical engine inoperative during the time interval between the instant at which the critical engine is failed and the instant at which the pilot recognizes and reacts to the engine failure, as indicated by the pilot’s application of the first retard means during the accelerate-stop determination of § 23.55.
   (iii) The rotation speed, \( V_R \), in terms of calibrated airspeed, must be selected by the applicant and must not be less than the greatest of the following:
      (i) \( V_1 \);
      (ii) 1.05 \( V_{MC} \) determined under § 23.149(b);
      (iii) 1.20 \( V_{S1} \); or
      (iv) The speed that allows attaining the initial climb-out speed, \( V_2 \), before
reaching a height of 35 feet above the takeoff surface in accordance with §23.57(c)(2).

(3) For any given set of conditions, such as weight, altitude, temperature, and configuration, a single value of \( V_{R} \) must be used to show compliance with both the one-engine-inoperative takeoff and all-engines-operating takeoff requirements.

(4) The takeoff safety speed, \( V_{2} \), in terms of calibrated airspeed, must be selected by the applicant so as to allow the gradient of climb required in §23.67 (c)(1) and (c)(2) but must not be less than 1.10 \( V_{MC} \) or less than 1.20 \( V_{S1} \).

(5) The one-engine-inoperative takeoff distance, using a normal rotation rate at a speed 5 knots less than \( V_{R} \), established in accordance with paragraph (c)(2) of this section, must be shown not to exceed the corresponding one-engine-inoperative takeoff distance, determined in accordance with §§23.57 and 23.59(a)(1), using the established \( V_{R} \). The takeoff, otherwise performed in accordance with §23.57, must be continued safely from the point at which the airplane is 35 feet above the takeoff surface and at a speed not less than the established \( V_{2} \) minus 5 knots.

(6) The applicant must show, with all engines operating, that marked increases in the scheduled takeoff distances, determined in accordance with §23.59(a)(2), do not result from over-loading the airplane or out-of-trim conditions.

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§ 23.55 Accelerate-stop distance.

For each commuter category airplane, the accelerate-stop distance must be determined as follows:

(a) The accelerate-stop distance is the sum of the distances necessary to—

(1) Accelerate the airplane from a standing start to \( V_{EF} \) with all engines operating;

(2) Accelerate the airplane from \( V_{EF} \) to \( V_{1} \), assuming the critical engine fails at \( V_{EF} \); and

(3) Come to a full stop from the point at which \( V_{1} \) is reached.

(b) Means other than wheel brakes may be used to determine the accelerate-stop distances if that means—

(1) Is safe and reliable;

(2) Is used so that consistent results can be expected under normal operating conditions; and

(3) Is such that exceptional skill is not required to control the airplane.


§ 23.57 Takeoff path.

For each commuter category airplane, the takeoff path is as follows:

(a) The takeoff path extends from a standing start to a point in the takeoff at which the airplane is 1500 feet above the takeoff surface at or below which height the transition from the takeoff to the enroute configuration must be completed; and

(1) The takeoff path must be based on the procedures prescribed in §23.45;

(2) The airplane must be accelerated on the ground to \( V_{EF} \) at which point the critical engine must be made inoperative and remain inoperative for the rest of the takeoff; and

(3) After reaching \( V_{EF} \), the airplane must be accelerated to \( V_{2} \).

(b) During the acceleration to speed \( V_{2} \), the nose gear may be raised off the ground at a speed not less than \( V_{R} \). However, landing gear retraction must