BALANCED FIELD LENGTH

V1 concept is critical to takeoff planning. The FARs require the flight crew of a transport-category airplane to ensure that the runway intended for use (including any clearway or stopway off the end of the runway) is long enough to allow the takeoff to be safely continued or rejected from a predetermined go/no-go point on the runway. The go/no-go point is where the airplane reaches V1 while accelerating for takeoff

“To assure that the takeoff can be safely continued from the go/no-go point, the length of the runway plus any clearway must be long enough for the airplane to reach a height of 35 feet (10.6 meters) by the end of that distance, even if a total loss of power from the most critical engine occurs just before reaching the V1 speed,” said FAA. “This distance is known as the accelerate-go distance.

“If the pilot finds it necessary to reject the takeoff, the runway plus any stopway must be long enough for the airplane to be accelerated to the V1 speed and then brought to a complete stop. This distance is known as the accelerate-stop distance.”

The accelerate-go distance and the accelerate-stop distance vary according to the airspeed designated as V1 by the manufacturer for certification flight tests. “A lower V1 speed, corresponding to an engine failure early in the takeoff roll, increases the accelerate-go distance and decreases the accelerate-stop distance,” said FAA. “Conversely, a higher V1 speed decreases the accelerate-go distance and increases the accelerate-stop distance.”

Typically, the manufacturer designates V1 airspeeds that result in equal accelerate-go distances and accelerate-stop distances. When the accelerate-go distance and the accelerate-stop distance are equal, the distance is called the balanced field length. “In general, the balanced field length represents the minimum runway length that can be used for takeoff,” said FAA.

The manufacturer is required to designate V1 speeds and airplane takeoff configuration, and compile takeoff performance data for the full range of weight, altitude and temperature conditions in which the airplane is expected to operate. The data must be developed according to runway and wind factors specified in Part 25. The data then are published in the airplane flight manual (AFM).

The flight crew is required to use a V1 speed from the AFM that results in accelerate-go and accelerate-stop distances, or a balanced field length, appropriate for the airplane’s takeoff weight, the airplane’s takeoff configuration, the runway length, the runway gradient, the surface wind conditions, the air temperature, and the runway (airport) elevation.

Based on the takeoff-performance data in the AFM, the flight crew or airline dispatch personnel may have to make adjustments such as reducing fuel, passenger and/or cargo loads to reduce the airplane's gross weight; selecting a more suitable runway; or rescheduling the departure for a time of day when the air temperature will be more favorable for a safe takeoff.
After the appropriate calculations and adjustments are made by the flight crew or airline dispatch personnel, the selected V1 speed theoretically establishes a go/no-go point from which the takeoff either can be safely completed, even if the airplane loses power from the critical engine just before reaching V1, or rejected and the airplane can be brought safely to a halt on the remaining runway and/or stopway.

Inconsistent terminology has caused confusion about the V1 concept. An important assumption in the V1 concept today is that the decision to continue the takeoff or reject the takeoff is made before reaching V1. The accelerate-stop performance data in AFMs are based on the pilot flying taking the first action to reject the takeoff at V1.

[For airplane-certification purposes, the actions required to reject a takeoff include applying the wheel brakes, reducing thrust, and deploying the speed brakes or spoilers. The manufacturer establishes the order in which these actions are taken.]

Previous definitions of V1 did not state clearly that V1 is the maximum speed at which the pilot flying must take the first action to reject the takeoff. "[There is] a great deal of misunderstanding and disagreement regarding the definition and use of the V1 speed," said FAA. "In general, inconsistent terminology used over the years in reference to V1 has probably contributed to this confusion."

Before 1978, Part 1 defined V1 as the critical-engine failure speed. In 1978, the definition of V1 was changed to takeoff decision speed, and VEF was established as the critical-engine failure speed. V1 also is referred to as the engine failure recognition speed in the FAA Flight Test Guide for Certification of Transport Category Airplanes (Advisory Circular 25-7). FAA currently is revising the circular.

FAA's 1998 redefinition of V1 responded to a 1990 recommendation by NTSB based on a study of accidents that occurred during high-speed rejected takeoffs.

In its report on the study, NTSB said, "Runway overruns following high-speed [RTOs] have resulted and continue to result in airplane incidents and accidents. Although most RTOs are initiated at low speeds (below 100 knots) and are executed without incident, the potential for an accident or an incident following a high-speed (at or above 100 knots) RTO remains high."

Balanced Field Length Means that Accelerate-stop Distance And Accelerate-go Distance Are Equal