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1-g Stall Speed as the Basis for Compliance With Part 25 of the Federal Aviation Regulations; Final Rule

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Parts 1, 25, and 97

[Docket No. 28404; Amendment Nos. 1–49, 25–108, 97–1333]

RIN 2120–AD40

1-g Stall Speed as the Basis for Compliance With Part 25 of the Federal Aviation Regulations

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final rule.

SUMMARY: This action amends the airworthiness standards for transport category airplanes to redefine the reference stall speed for transport category airplanes as a speed not less than the 1-g stall speed instead of the minimum speed obtained in a stalling maneuver. The FAA is taking this action to provide for a consistent, repeatable reference stall speed; ensure consistent and dependable maneuvering margins; provide for adjusted multiplying factors to maintain approximately the current requirements in areas where use of the minimum speed in the stalling maneuver has proven adequate; and harmonize the applicable regulations with those currently adopted in Change 15 to the European Joint Aviation Requirements-25 (JAR–25). These changes will provide a higher level of safety for those cases in which the current methods result in artificially low operating speeds.

EFFECTIVE DATE: December 26, 2002.

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Background

These amendments are based on notice of proposed rulemaking (NPRM) Notice No. 95–17, which was published in the **Federal Register** on January 18, 1996 (61 FR 1260). In that notice, the FAA proposed amendments to 14 CFR parts 1, 25, 36, and 97 to redefine the reference stall speed (V_{SR}) for transport category airplanes as the 1-g stall speed instead of the minimum speed obtained in the stalling maneuver. The FAA received nearly 40 comments from 12 different commenters on the proposals contained in Notice No. 95–17. As a result of these comments, this final rule differs in some aspects from the original proposals.

As explained in Notice No. 95–17, the stalling speed (V_S) is defined as the minimum speed demonstrated in the performance stall maneuver described in § 25.103 of 14 CFR part 25 (part 25). V_S has historically served as a reference speed for determining the minimum operating speeds required under part 25 for transport category airplanes. Examples of minimum operating speeds that are based on V_S include the takeoff safety speed (V_2), the final takeoff climb speed, and the landing approach speed. For example, under part 25, V_2 must be at least 1.2 times V_S, the final takeoff climb speed must be at least 1.25 times V_S, and the landing approach speed must be at least 1.3 times V_S.

The speed margin, or difference in speed, between V_S and each minimum operating speed provides a safety ''cushion'' to ensure that normal operating speeds are sufficiently higher than the speed at which the airplane stalls. Using multiplying factors applied to V_S to provide this speed margin, however, assumes that V_S provides a proper reference stall speed. Since V_S is the minimum speed obtained in the stalling maneuver, it can be less than the lowest speed at which the airplane's weight is still supported entirely by aerodynamic lift. If V_S is significantly less than this speed, applying multiplying factors to V_S to determine the minimum operating speeds may not provide as large a speed margin as intended.

A proper reference stall speed should provide a reasonably consistent approximation of the wing's maximum usable lift. Maximum usable lift occurs at the minimum speed for which the lift provided by the wing is capable of supporting the weight of the airplane. This speed is known as the 1-g stall speed because the load factor (the ratio of airplane lift to weight) at this speed is equal to 1.0 ''g'' (where ''g'' is the acceleration caused by the force of gravity) in the direction perpendicular to the flight path of the airplane. Speeds lower than the 1-g stall speed during the stalling maneuver represent a transient flight condition that, if used as a reference for the deriving minimum operating speeds, may not provide the desired speed margin to protect against inadvertently stalling the airplane.

For transport category airplanes, the minimum speed obtained in the stall maneuver of § 25.103 usually occurs near the point in the maneuver where the airplane spontaneously pitches nose-down or where the pilot initiates recovery after reaching a deterrent level of buffet, *i.e.*, a vibration of a magnitude and severity that is a strong and effective deterrent to further speed reduction. Early generation transport category airplanes, which had fairly straight wings and non-advanced airfoils, typically pitched nose-down near the 1-g stall speed. The minimum speed in the maneuver was easy to note and record, and served as an adequate approximation of the speed for maximum lift.

For the recent generation of high speed transport category airplanes with swept wings and highly advanced airfoils, however, the minimum speed obtained in the stalling maneuver can be substantially lower than the speed for maximum lift. Furthermore, the point at which the airplane pitches nose down or exhibits a deterrent level of buffet is more difficult to distinguish and can vary with piloting technique. As a result, the minimum speed in the stalling maneuver has become an inappropriate reference for most modern high speed transport category airplanes for establishing minimum operating speeds since it may: (1) Be inconsistently determined, and (2) represent a flight condition in which the load factor perpendicular to the flight path is substantially less than 1.0 g.

In recent years, advanced technology transport category airplanes have been developed that employ novel flight control systems. These flight control systems incorporate unique protection features that are intended to prevent the airplane from stalling. They also prevent the airplane from maintaining speeds that are slower than a small percentage above the 1-g stall speed. Because of their unique design features, the traditional method of establishing V_S as the minimum speed obtained in the stalling maneuver was inappropriate for these airplanes. The FAA issued special conditions for these airplanes to define the reference stall speed as not less than the 1-g stall speed for the flight requirements contained in subpart B of part 25.

In these special conditions, the multiplying factors used to determine the minimum operating speeds were reduced in order to maintain equivalency with acceptable operating speeds used by previous transport category airplanes. Since the 1-g stall speed is generally higher than the minimum speed obtained in the stalling maneuver, retaining the current multiplying factors would have resulted in higher minimum operating speeds for airplanes using the 1-g stall speed as a basis for the reference stall speed. However, increasing the minimum operating speeds could impose costs on operators because payloads might have to be reduced to comply with the regulations at the higher operating speeds under some performance-limited conditions. Based on the service experience of the current fleet of transport category airplanes, the costs imposed would not be offset by a commensurate increase in safety.

Several airplane types with conventional flight control systems have also been certificated using the 1-g stall speed as a lower limit to the reference stall speed. Because of the potential deficiencies in using the minimum speed demonstrated in the stalling maneuver, the FAA has been encouraging applicants to use the 1-g stall speed methodology in lieu of the minimum speed obtained in the stalling maneuver. Applicants generally desire to use 1-g stall speeds because the 1-g stall speeds are less dependent on pilot technique and other subjective evaluations. Hence, 1-g stall speeds are easier to predict and provide a higher level of confidence for developing predictions of overall airplane performance. Again, reduced multiplying factors are applied to the 1-g stall speeds to obtain minimum operating speeds equivalent to the speeds that have been found acceptable in operational service. Using 1-g stall speeds ensures that the airplane's minimum operating speeds will not be unreasonably low.

Discussion of the Proposals

In Notice No. 95–17, the FAA proposed to define the reference stall speed in § 25.103 as a speed not less than the 1-g stall speed, rather than the minimum speed obtained in the stalling maneuver. This proposal was made to provide a consistent basis for use in all type design certification requirements for transport category airplanes. The FAA proposed to introduce the symbol V_{SR} to represent this speed and to indicate that it is different than the minimum speed obtained in the stalling maneuver, V_S.

In addition, the FAA proposed to reduce the multiplying factors that are used in combination with the reference stall speed to determine the minimum operating speeds by approximately 6 percent. This change would result in minimum operating speeds equivalent to those for most current transport category airplanes since the 1-g stall speed for these airplanes is approximately 6 percent higher than the minimum speed obtained in the stalling maneuver. Demonstrating a minimum stalling speed more than 6 percent slower than the 1-g stall speed, which is possible under the current standards, would provide an unacceptable basis for determining the minimum operating speeds. The proposed standards would prevent this situation from occurring. In this respect, the proposed standards would provide a higher level of safety than the existing standards.

However, the proposed reduced factors would allow lower minimum operating speeds to be established for those airplanes that have a minimum speed in the stalling maneuver approximately equal to the 1-g stall speed. One particular class of airplanes for which this applies is airplanes equipped with devices that abruptly push the nose down (*e.g.*, stick pushers) near the angle of attack for maximum lift. These devices are typically installed on airplanes with unacceptable natural stalling characteristics. The abrupt nose down push provides an artificial stall indication and acceptable stall characteristics, and prevents the airplane from reaching a potentially hazardous natural aerodynamic stall. Typically, the minimum speed obtained in this maneuver is approximately equal to the 1-g stall speed.

Traditionally, the existing multiplying factors have been applied to these airplanes. The proposal to define the reference stall speed as the 1-g stall speed would generally have no impact for these airplanes, but reducing the multiplying factors would allow lower minimum operating speeds to be established. Therefore, this proposal would allow these airplanes to be operated at speeds and angles of attack closer to the pusher activation point than has been experienced in operational service.

The FAA considered this reduction in operating speeds for pusher-equipped airplanes to be acceptable, provided the pusher reliably performs its intended function and that unwanted operation is minimized. The FAA has addressed the majority of these concerns in a revision to Advisory Circular (AC) 25–7, the ''Flight Test Guide for Certification of Transport Category Airplanes.'' This revision, AC 25–7A, dated March 31, 1998, provides criteria for the design and function of stall indication systems, including arming and disarming, indicating and warning devices, system reliability and safety, and system functional requirements. The FAA plans to address other concerns, such as system design and manufacturing tolerances, and system design features like filtering and phase advancing, in a future revision to AC 25–7A.

In addition to proposing to define the reference stall speed as a speed not less than the 1-g stall speed and to reduce the multiplying factors for establishing the minimum operating speeds, the FAA also proposed to require applicants to demonstrate adequate maneuvering capability during the takeoff climb, en route climb, and landing approach phases of flight. During a banked turn, a portion of the lift generated by the wing provides a force to help turn the airplane. To remain at the same altitude, the airplane must produce additional lift. Therefore, banking the airplane (at a constant speed and altitude) reduces the stall margin, which is the difference between the lift required for the maneuver and the maximum lift capability of the wing. As the bank angle increases, the stall margin is reduced proportionately. This bank angle effect on the stall margin can be determined analytically, and the multiplying factors applied to V_{SR} to determine the minimum operating speeds are intended to ensure that an adequate stall margin is maintained.

In addition to the basic effect of bank angle, however, modern wing designs also typically exhibit a significant reduction in maximum lift capability with increasing Mach number. The magnitude of this Mach number effect depends on the design characteristics of the particular wing. For wing designs with a large Mach number effect, the maximum bank angle that can be achieved while retaining an acceptable stall margin can be significantly reduced. Because the effect of Mach number can be significant, and because it can also vary greatly for different wing designs, the multiplying factors applied toV_{SR} are insufficient to ensure that adequate maneuvering capability exists at the minimum operating speeds.

To address this issue, the FAA proposed to require a minimum bank angle capability in a coordinated turn without encountering stall warning or any other characteristic that might interfere with normal maneuvering. This requirement would be added to § 25.143 as a new paragraph (g). The proposed minimum bank angles were derived by adding a 15 degree allowance for wind gusts and inadvertent overshoot to a maneuvering capability the FAA considers necessary for the specific cases identified in the proposed new paragraph. These proposed maneuver margin requirements would increase the level of safety in maneuvering flight.

Consistent with the proposed maneuver margin requirements, the FAA proposed adding §§ 25.107(c)(3), 25.107(g)(2), and 25.125(a)(2)(iii) to reference § 25.143(g) in the list of constraints applicants must consider when selecting the minimum takeoff safety speed, final takeoff speed, and reference landing speeds, respectively. The normal all-engines-operating takeoff climb speed selected by the applicant would also have to provide the minimum bank angle capability specified in the proposed § 25.143(g).

Section 25.145(a) requires that there be adequate longitudinal control available to promptly pitch the airplane's nose down from at or near the stall in order to return to the original trim speed. The intent of this requirement is to ensure sufficient pitch control for a prompt recovery if the airplane is inadvertently slowed to the point of stall. The FAA proposed to change the wording of this requirement to replace ''V_S'' with ''the stall,'' ''§ 25.103(b)(1)'' with ''§ 25.103(a)(6),'' and ''at any speed'' with ''at any point.'' These changes would be consistent with the proposed change to the definition of the reference stall speed and the proposed reformatting of § 25.103.

Although compliance with § 25.145(a) must be demonstrated both with power off and with maximum continuous power, there is no intention to require flight test demonstrations of full stalls at engine powers above that specified in § 25.201(a)(2). Instead of performing a full stall at maximum continuous power, compliance will be assessed by demonstrating sufficient static longitudinal stability and nose down control margin when the deceleration is ended at least one second past stall warning during a one knot per second deceleration. The static longitudinal stability during the maneuver and the nose down control power remaining at the end of the maneuver must be sufficient to assure compliance with the requirement.

Section 25.207 requires that a warning of an impending stall must be provided in order to prevent the pilot from inadvertently stalling the airplane. The warning must occur at a speed sufficiently higher than the stall speed to allow the pilot time to take action to avoid a stall. The speed difference between the stall speed and the speed at which the stall warning occurs is known as the stall warning margin. The FAA proposed amending the size of the stall warning margin required by § 25.207(c) because of the change in definition of the reference stall speed.

Currently, the stall warning must begin at a speed exceeding V_S by seven knots, or a lesser margin if the stall warning has enough clarity, duration, distinctiveness, or other similar properties. Requiring the same seven knot warning margin to be provided relative to V_{SR} would result in an increase to the minimum operating speeds. This increase in the minimum operating speeds would be necessary to meet the maneuvering margin requirements proposed in § 25.143(g), which are defined relative to the stall warning speed. However, as discussed previously, requiring an increase to the minimum operating speeds would impose costs to airplane operators that cannot be justified by service experience.

On the other hand, if the stall warning margin were reduced to retain approximately the same stall warning speed, the warning would occur only one or two knots prior to reaching the 1-g stall speed. Although reaching the 1-g stall speed is not likely to be a catastrophic occurrence, the FAA considers such a small stall warning margin to be unacceptable. The FAA proposed requiring a stall warning margin of at least 3 knots or 3 percent, whichever is greater, relative to V_{SR}. The FAA's proposal was made on the basis that this margin represents a reasonable balance between providing the pilot with enough warning to avert an impending stall, and providing adequate maneuvering capability at the minimum operating speeds. This proposal would retain the existing level of safety.

The FAA proposed to require a larger stall warning margin for airplanes equipped with devices that abruptly push the nose down at a selected angle of attack (*e.g.*, stick pushers). Inadvertent operation of such a device, especially close to the ground, can have more serious consequences than a comparable situation in which the pilot of an airplane without the device inadvertently slows to V_{SR}. Therefore, the FAA proposed adding § 25.207(d) to require the stall warning, for airplanes equipped with one of these devices, to occur at least 5 knots or 5 percent, whichever is greater, above the speed at which the device activates. This proposal was made on the basis of retaining the existing level of safety for airplanes equipped with such devices.

The FAA proposed to add a new paragraph, § 25.207(e), to require that, in a slow-down turn with load factors up to 1.5 g and deceleration rates up to 3 knots per second, sufficient stall warning must exist to prevent stalling when recovery is initiated not less than one second after stall warning occurs. The FAA considered this proposed requirement necessary to provide adequate stall warning during a dynamic maneuver, such as a collision avoidance maneuver. In addition, this new paragraph would provide a quantitative requirement with which to assess whether ''sufficient margin to prevent inadvertent stalling * * * in turning flight'' has been provided as required by § 25.207(a). This proposal would increase the level of safety during maneuvering flight.

The FAA proposed to add a new paragraph, § 25.207(f), to require that stall warning be provided for abnormal airplane configurations likely to be used following system failures. This proposal would add a requirement currently contained in JAR–25 and is consistent with current transport category airplane designs. There would be no impact on the existing level of safety.

On modern transport category airplanes, the natural buffet or vibration caused by the airflow separating and reattaching itself to the wing as the airplane approaches the stall speed is usually not strong enough by itself to provide an effective stall warning. Therefore, stall warning on modern transport category airplanes is usually provided through an artificial means, such as a stick shaker that shakes the pilot's control column. Production tolerances associated with these systems can result in variations in the size of the stall warning margin for different airplanes manufactured under the same approved type design.

The FAA considers the stall warning margins proposed in §§ 25.207(c) and (d) to be the minimum acceptable warning margins, and that these margins should not be reduced by production tolerances associated with a system added to the airplane to provide an artificial stall warning. The FAA intends for the proposed stall warning margins to be available at the most critical tolerance expected in production. Applicants would be expected to demonstrate compliance with the proposed stall warning margin either by flight testing with the stall warning system set to its critical tolerance setting, or by adjusting flight test data obtained at some other setting.

The tolerances associated with the stall warning system must also be considered in relation to the proposed minimum maneuvering requirements of § 25.143(g). As proposed, § 25.143(g) would require that the airplane be capable of reaching a minimum bank angle during a coordinated turn without encountering stall warning. Because the proposed requirements already provide the capability to overshoot the intended bank angle by 15 degrees, the small differences in the speed at which the stall warning system operates due to system tolerances are not as critical. Therefore, the FAA intends for the minimum bank angles in the proposed § 25.143(g) to apply at the designed nominal setting of the stall warning system. To ensure that large production tolerances do not adversely impact the airplane's maneuvering capability free of stall warning, the bank angle capability specified in the proposed § 25.143(g) should not be reduced by more than two degrees with the stall warning system operating at its most critical tolerance. Applicants would be expected to demonstrate this capability either by flight test with the system set to its critical tolerance, or by analytically adjusting flight test data obtained at some other setting.

To be consistent with the proposed revision of the definition of the reference stall speed, the FAA proposed to incorporate reduced multiplying factors throughout part 25, where appropriate, in requirements that use speeds based on a multiple of the reference stall speed. The FAA also proposed numerous minor wording and structural changes to various sections to improve editorial clarity and to harmonize with the wording and structure proposed for JAR–25. Note that the proposed change to the term ''1.3 V_{S0}'' in § 25.175(d) reflects not only the change in multiplying factor, but also corrects a typographical error. (''1.3 V_{S0}'' should have been ''1.8 V_{S0}.'')

The FAA proposed to add the nomenclature ''final takeoff speed'' and ''reference landing speed'' and the abbreviations ''V_{FTO}'' and ''V_{REF}'' to denote these speeds, respectively, to part 1 of the FAR. These terms and abbreviations, which are commonly used in the aviation industry, would be referenced throughout the proposed amendments to part 25. The reference landing speed would be defined as the speed of the airplane, in a specified landing configuration, at the point where it descends through the landing screen height in the determination of the landing distance for manual landings. The term ''landing screen height'' refers to the height of the airplane at the beginning of the defined landing distance. This height is normally 50 feet above the landing surface (see § 25.125(a)), but approvals have been granted for steep approaches that use a landing screen height of 35 feet. The final takeoff speed would be defined as the speed of the airplane that exists at the end of the takeoff path in the en route configuration with one engine inoperative.

The FAA also proposed to add the abbreviations V_{SR}, V_{SR0}, and V_{SRI} to part 1, and use them in part 25 to denote the reference stall speed corresponding to different airplane configurations. In addition, the FAA proposed adding the abbreviation V_{SW} to part 1 to refer to the speed at which the onset of stall warning occurs.

The FAA proposed to amend § C36.9(e)(1) of Appendix C to part 36 by replacing ''1.3 V_S + 10 knots'' with ''V_{REF} + 10 knots'' and by removing the words ''or the speed used in establishing the approved landing distance under the airworthiness regulations constituting the type certification basis of the airplane, whichever speed is greatest.'' The words proposed for deletion would no longer be necessary because V_{REF} would denote the speed used in establishing the approved landing distance under the airworthiness regulations constituting the type certification basis of the airplane. Also, V_{REF} would refer to the speed at the landing screen height, regardless of whether that speed for a particular airplane is 1.3 V_S, 1.23 V_{SR}, or some higher speed.

In the same manner, the FAA proposed to amend § 97.3(b) by replacing ''1.3 V_{S0}'' with ''V_{REF}.'' As noted above, V_{REF} would refer to the speed at the landing screen height used in establishing the approved landing distance under the airworthiness regulations constituting the type certification basis of the airplane, regardless of whether that speed for a particular airplane is 1.3 V_S, 1.23 V_{SR}, or some higher speed.

These proposals were discussed extensively with the European Joint Aviation Authorities (JAA) with the intent of harmonizing the certification requirements related to stall speed for transport category airplanes. The Joint Aviation Requirements (JAR) 25 prescribes the airworthiness standards for transport category airplanes that are accepted by the aviation regulatory authorities of a number of European states. The JAA introduced an equivalent proposal to the FAA's NPRM 95–17, called Notice of Proposed Amendment (NPA) 25B–215, to amend JAR–25 accordingly. The JAA's final 1-g stall requirements, which are equivalent to those adopted by the FAA in this rulemaking, were adopted by the JAA as part of Change 15 to JAR–25, dated October 1, 2000.

Discussion of the Comments

The FAA received nearly 40 comments from 12 different commenters on the proposals contained in Notice No. 95–17. The commenters include airplane pilots, manufacturers, operators, and the associations representing them, foreign airworthiness authorities, an organization specializing in flight testing, and private citizens. In general, the proposal to redefine the reference stall speed for transport category airplanes as the 1-g stall speed instead of the minimum speed obtained in a stalling maneuver was supported, although there were comments critical of specific details, and some commenters were supportive only if the current minimum speed method would be retained as an option that would be available for the certification of small transport category airplanes.

Those commenters who recommend retaining the minimum stall speed methodology for small transport category airplanes—small airplane manufacturers and the association representing them—believe that the proposed changes introduce additional cost and complexity into applicants' type certification programs with no increase in safety for this class of airplanes.

One manufacturer of small transport category airplanes notes that when 1-g stall speeds were determined for one of their airplanes, the resulting operating speeds were virtually the same as those determined using the current requirements. This commenter also states that variation in piloting technique remains an issue even if the stall speeds are defined as a 1-g condition, and a more expensive flight test data system is needed to determine where the 1-g stall break occurs. The commenter points out that straight (*i.e.*, non-swept) winged airplanes, for which the discussion in Notice No. 95–17 implied the current minimum speed method is adequate, will continue to be designed and produced in the future. On airplanes with swept wings, due to different stiffness characteristics between large and small airplanes, which result in different responses to aerodynamic influences, the minimum speed in the stalling maneuver is not difficult to obtain on small transport category airplanes. The commenter concludes that the current methods should be retained for airplanes weighing less than 75,000 pounds because of the costs involved in changing to the 1-g stall speed methodology for no apparent increase in safety. (100,000 pounds is suggested as an appropriate cutoff by another commenter.)

The FAA disagrees that the proposed rule changes significantly increases cost and does not increase safety. Cost data supplied by one commenter substantially overstates the incremental cost of the test instrumentation and other items needed to support a 1-g stall speed evaluation. This commenter allocates the entire cost of a new data collection system, including purchase, installation, and calibration, to the proposed rule change, stating that this new system would be needed to determine the ''g-break'' denoting the 1-g stall speed.

The only additional instrumentation the FAA considers necessary to determine the 1-g stall speed instead of the minimum speed in the stalling maneuver would be accelerometers capable of resolving the load factor normal to the flight path. At the minimum, one accelerometer aligned along the expected 1-g stall pitch angle may provide acceptable data. Determining the point at which the 1-g stall condition is reached is most readily accomplished by a continuous calculation of the load factor-corrected lift coefficient and noting the point at which this parameter is first a maximum. Experience to date with applicants voluntarily complying with the proposed requirements has not highlighted any significant difficulties in determining the 1-g stall speed using typically existing data recording equipment. These applicants have included manufacturers of both large and small transport category airplanes.

The FAA is not surprised that for one of the commenter's airplane types, the current requirements and the 1-g stall proposal yielded virtually the same minimum operating speeds. As noted in Notice No. 95–17 and repeated in the background discussion above, the proposed change to the multiplying factors that are applied to the reference stall speed to obtain the minimum operating speeds was intentionally chosen to yield equivalent operating speeds, on average, for current transport category airplanes. However, the proposed standards would prevent the reference stall speed from being more than six percent slower than the 1-g stall speed, which the current standards do not prohibit. In this respect, the proposed standards would provide a higher level of safety than the existing standards by ensuring that unreasonably low minimum operating speeds will not be obtained.

The FAA agrees that the use of a 1-g stall speed may not entirely remove the effect of pilot technique from being a factor during the flight tests to determine the reference stall speed. However, the use of a 1-g stall speed would significantly mitigate this effect. Subjective assessments of airplane behavior for identifying the stalled condition (using the criteria specified in § 25.201(d)) would no longer be used to determine the reference stall speed. (These criteria will continue to be used, however, for evaluating the airplane handling characteristics during the stalling maneuver.) Test pilot techniques that take advantage of these subjective assessments and allow unreasonably low load factors, and hence unreasonably low stall speeds, to be achieved would no longer be permitted.

In addition, it is usually much easier to measure airspeed accurately at the 1-g stall condition than at the minimum speed reached in the stalling maneuver. Based on the experience gained from the many type certification programs that have already used the 1-g stall speed methodology, the FAA has determined that this methodology provides a more consistent, repeatable reference stall speed than the existing method.

One commenter notes that the International Civil Aviation Organization's (ICAO) Airworthiness Technical Manual (Document 9051, 1987) uses the abbreviation V_{S1g} to denote the 1-g stall speed, which is the reference speed for determining the minimum operating speeds for transport category airplanes with a certified takeoff mass of over 5,700 kg. The commenter suggests that the FAA could further international standardization by adopting ICAO's V_{S1g} abbreviation to denote the reference stall speed as a part of the rulemaking to redefine the reference stall speed as a 1-g stall speed.

The FAA actively promotes international standardization and has been working closely with the regulatory authorities of Europe and Canada during this rulemaking. The FAA considered using the abbreviation V_{S1g} to denote the reference stall speed; however, the reference stall speed may not always be equal to the 1-g stall speed. It is only required to be no less than the 1-g stall speed. Other design constraints may dictate using a reference stall speed that is higher than the 1-g stall speed. Since the reference stall speed may be different than the 1-g stall speed, the abbreviation V_{SR} was proposed and has been adopted in § 1.2 to denote the reference stall speed. This abbreviation has also been adopted by the JAA of Europe and is expected to be adopted by the Canadian regulatory authority. There were no comments on the other proposed abbreviations nor on the proposed definitions for final takeoff speed and reference landing speed. Therefore, these abbreviations and definitions are adopted as proposed.

One commenter questions the reason for the new wording in § 25.103(a)(1) to describe the option of idle or zero thrust. The commenter does not see the new wording as an improvement in clarity. The current rule states that zero thrust must be used in determining the stalling speed, except that idle thrust may be used when it does not appreciably affect the stalling speed. Stated in this manner, the rule permits the use of zero thrust when idle thrust causes an increase in the stalling speed. On some turboprop airplanes, where flight idle thrust may be negative, a lower stall speed may be demonstrated using zero thrust than would occur with idle thrust.

The FAA considers such a loss of stall speed margin in a normal flight condition to be unacceptable. In Notice No. 95–17, the FAA proposed a change such that the reference stall speed must be determined with idle thrust, except in cases where that thrust level causes an appreciable decrease in the stall speed. For such cases, not more than zero thrust must be used. There were no comments regarding the substance of the proposed change; therefore, this section is adopted as proposed.

One commenter notes that while the proposal to the reference stall speed in terms of a 1-g stall speed would reduce the amount of scatter in the flight test data used to determine the stall speed, a significant amount of scatter would remain. To further limit the amount of experimental error inherent in the data analysis process, the commenter suggests defining the reference stall speed in terms of the maximum normal force coefficient instead of the maximum lift coefficient. Using the normal force coefficient would yield slightly higher reference stall speeds, which could penalize an airplane's load carrying capability due to the resulting increase in minimum takeoff and landing speeds, but certification costs might be reduced because the data reduction process would be simplified.

The FAA agrees that defining the reference stall speed in terms of the maximum normal force coefficient instead of the maximum lift coefficient may further reduce flight test data scatter and simplify data acquisition and analysis. However, these slight benefits are outweighed by the potentially significant economic penalties associated with the resulting higher reference stall speed. Many recent airplane types have been certified using 1-g stall criteria similar to those contained in Notice No. 95–17 and this experience does not indicate any significant problems in data quality or in the acquisition and analysis process. Data scatter using the proposed 1-g stall criteria is inconsequential compared to the data uncertainty inherent in the current stall speed definition. Therefore, the commenter's suggested change is not being adopted. However, the FAA would find it acceptable if an applicant proposed using the higher reference stall speeds derived from the maximum normal coefficient in order to simplify the data acquisition and analysis process. The proposed amendment need not be changed to allow this option.

A commenter suggests that it is technically more accurate in § 25.103(c) to refer to the lift coefficient in the definition of V_{CLMAX} as the load factor-corrected lift coefficient. The commenter also considers the proposed definition of V_{CLMAX} to be ambiguous and lacking in guidance material that would provide clarification. Other commenters made various editorial and formatting suggestions to further improve the clarity of § 25.103. The FAA agrees with these suggestions and has modified the proposal accordingly. In addition, the FAA proposes to revise Advisory Circular (AC) 25–7A, ''Flight Test Guide for Certification of Transport Category Airplanes,'' to add clarifying guidance material. A notice of proposed advisory circular revisions was published in the **Federal Register** on November 21, 2002.

Detailed comments were received from one commenter regarding the effect of the proposed rules on airplanes equipped with devices that abruptly push the nose down (*e.g.*, stick pushers) to define the point of stall. As noted in Notice No. 95–17, this proposal would allow airplanes equipped with such devices that have a trigger point set close to or before $C_{L_{MAX}}$ to achieve lower minimum operating speeds than under the existing requirements, and hence, operate at speeds and angles-of-attack closer to the device activation point than has been experienced in operational service. The FAA considered this aspect of the proposal to be acceptable provided the device performs its intended function and unwanted operation is minimized.

The commenter points out that ensuring operation when desired and preventing unwanted operation are contradictory goals that result in design tradeoffs. Regardless of the design choice, however, allowing operation closer to the device activation point increases both the probability of reaching the activation point, where the device may fail to operate, and the probability of unwanted operation. Considering these aspects, the commenter contends that the proposed standards would reduce the level of safety relative to the current standards.

The commenter suggests adding the stipulation, for airplanes equipped with a device that abruptly pushes the nose down at a selected angle-of-attack, that V_{SR} must not be less than the greater of 2 knots or 2 percent above the speed at which the device activates. The commenter further suggests that this additional requirement need not apply to turbopropeller powered airplanes that demonstrate a significant reduction in stall speed in the one-engine-inoperative power-on condition. The commenter points out that this additional requirement is very similar in scope and intent to the Notice No. 95–17 proposed requirements for stall warning, where, in addition to the requirement applying to all transport category airplanes that stall warning be 3 knots or 3 percent above V_{SR}, the stall warning for airplanes equipped with devices that abruptly push the nose down at a selected angle-of-attack would be 5 knots or 5 percent above the speed at which the device operates. The commenter believes that the proposed stall warning requirements represent an acknowledgment that the class of airplanes cannot be treated the same as conventionally stalling airplanes with respect to minimum operating speeds and associated margins.

The FAA agrees with the commenter's analysis and fundamental principle that in terms of the protection from stall provided by such a device, the characteristics resulting from its operation, and its reliability and safety, there are significant differences from a conventionally stalling airplane. Also, the difference between the 1-g stall speed and the minimum speed obtained in the stalling maneuver for this class of airplanes is closer to 0 to 3 percent, rather than the 6 percent average for conventionally stalling airplanes upon which the reduction in operating speed factors was based. Permitting a reduction in the operating speeds for this class of airplanes could potentially result in a reduction in safety that is not justified by existing operational experience.

The commenter's suggested additional constraint on V_{SR} represents a reasonable means to retain approximately equivalent safety without penalizing airplanes for which the device trigger point is at an angle-of-attack well beyond $C_{L_{MAX}}$. Therefore, § 25.103(d) is revised accordingly to require, for airplanes equipped with a device that abruptly pushes the nose down at a selected angle-of-attack, that V_{SR} not be less than 2 percent or 2 knots, whichever is greater, above the speed at which the device operates. The suggested exception for turbopropeller powered airplanes that demonstrate a significant reduction in stall speed in the one-engine-inoperative power-on condition is not included, however, because the applicable minimum operating speeds already allow for a significant effect of power on stall speeds.

The effect of this provision is to increase the minimum operating speeds, relative to the Notice No. 95–17 proposals, for airplanes equipped with devices that abruptly push the nose down at a selected angle-of-attack, but only if the device activates at a speed higher than $V_{C_{L_{MAX}}}$ (at a load factor of one) minus 2 knots or 2 percent. This requirement for a supplementary speed margin, in combination with criteria added to AC 25–7A, dated March 31, 1998, for system arming and disarming, indicating and warning devices, system reliability and safety, and system functional requirements are intended to provide an equivalent level of safety to the requirements existing prior to the adoption of this amendment. Other considerations, such as the effect of system design and manufacturing tolerances, and system design features like filtering and phase advancing are also relevant, and should be considered when showing compliance with the applicable requirements. The FAA is currently trying to harmonize its policy in these areas with those of Transport Canada and the JAA, and intends to add guidance in these areas in a future revision to AC 25–7A.

The FAA received several comments regarding the proposed addition of specific maneuvering requirements as a new § 25.143(g). One commenter suggests that the FAA should perform a rigorous study before including a specific gust margin in airplane maneuvering requirements. The commenter points out that the same atmospheric gust would have different effects at different airspeeds, and that using the same gust margin throughout causes the proposed after takeoff maneuvering requirement at V_2 speed to be unduly restrictive. Similarly, another commenter states that the need for a 15-degree overshoot capability should first be justified by the FAA. This commenter suggests that a 5-degree overshoot, as specified as an objective for accomplishing steep turns in the ''Airplane Transport Pilot and Type Rating Practical Test Standards,'' would be more reasonable.

Several commenters claim that the proposed maneuvering requirements, particularly the one associated with the final takeoff speed (V_{FTO}), are excessive and would be difficult to meet without increasing the operating speeds. One commenter notes that for an airplane equipped with a stick pusher that activates near $C_{L_{MAX}}$, due to design tolerances for the stick pusher and stall warning systems, V_2 and V_{FTO} would most likely be set by the proposed maneuvering requirements rather than the 1.13 and 1.18 factors applied to V_{SR}, respectively. Another commenter notes that the maneuvering requirement associated with V_{FTO} relates to a one-engine-inoperative condition of short duration, after which the airplane is accelerated to the en route climb speed. This commenter suggests that a maneuvering bank angle of 30 degrees, the same as specified for the takeoff safety speed (V_2) one-engine-inoperative condition, would be more appropriate for this condition.

This commenter further states that for many existing large transport category airplanes, an early onset of natural stall warning results in a larger stall warning margin than the minimum margin required by the regulations. At V_{FTO}, these airplanes would have a maneuvering capability to stall warning of less than the proposed 40 degrees of bank, possibly as low as 27 degrees. Requiring 40 degrees of bank capability would necessitate an increase in V_{FTO}, which could affect the net takeoff flight path used for clearance of distant obstacles. Either a different departure path may be necessary in the event of an engine failure, or takeoff weight may have to be reduced. The commenter considers the existing rule to be adequate, and the potential penalties associated with the FAA's proposal to be unjustifiable.

This commenter also questions whether the proposed 40 degree bank angle requirement at V_{FTO} was based on a 25 degree bank angle limit used by many current flight guidance systems. If so, this commenter considers such reasoning to be flawed in that not all flight guidance systems use 25 degrees as their bank angle limit. In some cases, flight guidance systems are limited to a 15 degree bank angle at the final takeoff speed.

As a final comment on this section, this commenter suggests that if the FAA believes that increased bank angles are appropriate for the en route flight paths, which are of longer time duration, this need should be addressed separately from the takeoff flight path requirements. However, the commenter does not consider it necessary to do so as this commenter is unaware of any associated safety issues.

The FAA disagrees that the maneuvering requirements specified in the proposed § 25.143(g) are excessive, including the proposed 40 degree bank angle requirement at V_{FTO}. These maneuvering requirements are comparable to the maneuvering capability implied by the current regulations assuming the stall warning margin is near the regulatory minimum. Safety records and operating practices indicate that low speed maneuvering capability is a genuine concern. Some airports necessitate close-in maneuvering on a regular or contingency basis. Accidents and incidents have occurred due to windshear, icing, and high-lift device anomalies. The ability to tolerate such operational conditions can depend on the maneuvering capability at the designated minimum operating speeds.

The proposed maneuvering requirements consist of the minimum bank angle capability the FAA deems adequate for the specified regimes of flight combined with a further 15 degrees of bank angle to provide a safety margin for various operational factors. These operational factors include both potential environmental conditions (*e.g.*, turbulence, wind gusts) and an allowance for piloting imprecision (*e.g.*, inadvertent overshoots). Because this safety margin does not represent either a specific gust margin or expected piloting precision alone, the FAA does not consider it necessary to either perform a rigorous study of the effect of atmospheric gusts nor to restrict the size of the margin to a piloting test standards objective as suggested by the commenters. The allowance and magnitude of the proposed bank angle margin is also consistent with typical industry practice.

The maneuvering requirement at V_2 speed with one engine inoperative is derived from the 15 degree bank angle allowed under § 121.189(f) after takeoff plus the specified 15 degree safety margin. At the higher speed of V_{FTO}, after the airplane has transitioned to the en route configuration and is farther along in the flight path, it is reasonable to require additional maneuvering capability appropriate to that phase of flight. The FAA considers an additional 10 degrees of maneuvering capability to be a reasonable expectation for a minimum capability after transitioning to the en route configuration and accelerating to the final takeoff climb speed. This same level of maneuvering capability exists on most transport category airplanes currently in service, and the FAA has determined that there is not a compelling reason to set a lower minimum standard. The FAA considers this same maneuvering capability (25 degrees of bank plus a 15 degree safety margin) to also be appropriate for the normal all-engines-operating takeoff case as well as for the landing approach.

For those airplane types for which the proposed maneuvering requirements would lead to an increase in V_{FTO}, any resulting penalty is expected to be small. An increase in V_{FTO} would only cause a penalty (in terms of a reduced payload capability) when the takeoff weight is restricted due to an obstacle that must be cleared in the final takeoff climb segment and cannot be avoided by turning or using an alternative flight path procedure (*e.g.*, retracting the flaps at the maximum level-off height or extending the second segment to the takeoff thrust time limit). Recent FAA acceptance of proposals to increase the time limit for using takeoff thrust from five minutes to ten minutes should further reduce the potential for economic penalties resulting from an increase in V_{FTO}.

In addition to receiving comments on the minimum bank angles proposed for the new § 25.143(g), the FAA received comments on the footnotes accompanying the table of conditions to be demonstrated. A commenter notes that because the trigger point of an artificial stall warning device may vary with thrust or power setting, the proposed wording of footnote 1 may not cover the most critical condition for determining the airplane's maneuver margin. This commenter suggests adding the phrase ''or any greater thrust or power if more critical'' to the thrust/power setting references in footnotes 1 and 3 to the table in § 25.143(g).

Although the FAA agrees with the intent of this comment, the FAA believes that the comment may stem from a misinterpretation of the proposed requirement. The condition specified in the proposed footnote 1 to § 25.143(g) represents the highest thrust or power setting for the applicable conditions of weight, altitude, and temperature. If system design features or other relevant characteristics result in any condition of weight, altitude, or temperature being more critical than another, compliance with this requirement must be demonstrated for the most critical condition of weight, altitude, and temperature. This point is addressed further in guidance material being proposed for inclusion into AC 25–7A (a notice of proposed advisory circular revisions will be published in the **Federal Register** shortly after publication of this final rule).

The commenter further suggests simplifying the text of footnote 3 by replacing the FAA proposed text with, ''The critical thrust or power for all engines operating should be that which in the event of an engine failure would result in the minimum climb gradient specified in § 25.121, or any greater thrust or power if more critical.'' Although the FAA agrees with the intent of simplifying this footnote, the wording proposed in Notice No. 95–17 is needed to address all-engines-operating climb procedures, such as those used for noise abatement, that may use a thrust or power setting less than that used during the takeoff. Therefore, the FAA does not concur with the commenter's suggestion.

Section 25.143(g) is adopted as proposed.

One commenter suggests that the Notice No. 95–17 proposal to replace ''V_S'' with ''the stall'' in § 25.145(a) is misleading and inaccurate relative to the Notice No. 95–17 supporting discussion. The commenter believes that changing ''V_S'' to ''the stall'' is unsatisfactory for two reasons: (1) ''The stall'' is a vague terminology that might generally be defined by § 25.201(d), but without defining the configuration (*i.e.*, flaps, center-of-gravity position, power, *etc.*); and (2) The Notice No. 95–17 preamble discussion states that the demonstration should only have to be conducted down to stall warning speed plus one second, which is less demanding than the proposed new § 25.145(a). Therefore, the commenter suggests adding the words ''In a deceleration'' at the beginning of § 25.145(a) and replacing the proposed reference to ''the stall'' with ''one second after stall warning.'' Guidance could then be provided in AC 25–7 to clarify that there must be sufficient longitudinal control in this maneuver to provide confidence that pushout from an actual stall could still be accomplished.

The FAA does not intend for the change in the reference stall speed to alter the basic requirement of § 25.145(a), namely that the capability exists on transport category airplanes, at the specified configurations and power settings, to pitch the nose down from any point in the stalling maneuver and regain the trim speed. The commenter's suggested change would reduce the stringency of the regulatory requirement, while depending on non-regulatory guidance material to provided assurances that equivalent capability is retained.

Because the FAA cannot rely on non-regulatory material to establish a capability required of the airplane, the FAA has not adopted the commenter's suggested change. However, to improve clarity, the words ''the stall,'' proposed in Notice No. 95–17, have been replaced by ''stall identification (as defined in § 25.201(d))'' in the adopted § 25.145(a). In addition, techniques to show compliance with this requirement without performing a stall at maximum continuous power/thrust were included in the recent issuance of AC 25–7A. Consistent with the preamble discussion of Notice No. 95–17, compliance at maximum continuous power may be assessed by demonstrating sufficient static longitudinal stability and nose down control margin when the deceleration is ended at least one second past stall warning during a one knot per second deceleration. The static longitudinal stability during the maneuver and the nose down control power remaining at the end of the maneuver must be sufficient to assure compliance with the requirement.

Two comments were received regarding the flight test demonstrations to show compliance with § 25.177. Both comments were relative to the safety aspects of conducting full rudder sideslips at low airspeeds, as required by the current rule, although both commenters also noted that this situation may be exacerbated by the lower speeds that can result from the proposed change. The proposed changes were not intended to result in overall lower speeds. Because these comments raise issues with not only speed, but also rudder deflection, they are considered beyond the scope of the Notice No. 95–17 proposals, and § 25.177 has been adopted as proposed. These comments will be retained for consideration of potential future rulemaking to address the concerns expressed by the commenters.

There were many comments on the proposed changes to the stall warning requirements of § 25.207. One commenter requests explicit criteria to address whether or not a stick shaker is required to provide stall warning, or if a visual or aural warning is sufficient. This same commenter also asked whether production tolerances affecting the stall warning margin will be addressed in AC 25–7.

The issue of what constitutes an acceptable artificial stall warning is beyond the scope of this rulemaking. However, as stated in the current § 25.207(b) (and unchanged by this rulemaking), ''a visual stall warning device that requires the attention of the crew within the cockpit is not acceptable by itself.'' The FAA is considering future rulemaking to further address the issue of what constitutes an acceptable stall warning. Regarding stall warning tolerances, the FAA has proposed the inclusion of material addressing stall warning system tolerances into a proposed revision to AC 25–7A (a notice of proposed advisory circular revisions will be published in the **Federal Register** shortly after publication of this final rule). This material is consistent with the FAA positions expressed in the preamble of Notice No. 95–17.

Several commenters took issue with the proposed three percent or three knots stall warning margin of § 25.207(c). One commenter believes that the proposal represents an unjustified increase in the severity of this requirement relative to the current rules. This commenter notes that a requirement for stall warning to begin one percent above the 1-g stall speed would be equivalent to the current requirement of a seven percent margin from the minimum speed obtained in the stalling maneuver. As a compromise, this commenter suggests a two percent or two knot stall warning margin relative to the redefined reference stall speed. Another commenter has a concern over possible difficulties in showing compliance with the proposed arbitrary numerical margin for airplanes with a gradual loss of lift as the angle-of-attack for maximum lift is exceeded. Both of these commenters request that any increase in the severity of this requirement: (1) Be tempered such that inappropriate design changes are not imposed for small shortfalls in meeting the strict numerical criteria; and (2) be taken into account in the Aviation Rulemaking Advisory Committee (ARAC) discussions of stall warning margin when operating in icing conditions.

Another commenter has concerns that the change in stall warning margin requirements will reduce the margin that is currently required and therefore would not retain the existing level of safety. This commenter believes that the proposed margin would not represent a reasonable balance between providing the pilot with enough warning to avert an impending stall and providing adequate maneuvering capability at the minimum operating speeds. This commenter suggests retaining the current seven knot stall warning margin from the reference stall speed, even though the reference stall speed would be redefined as the 1-g stall speed, in order to retain the existing level of safety.

Another commenter considers the proposed § 25.207(c) to represent an unjustified increase in the currently required minimum stall warning margin that would inhibit use of part of the airplane flight envelope within which the airplane is controllable without risk of structural damage. The commenter remarks that in windshear avoidance maneuvers, the likelihood of escape is maximized by flying at the minimum controllable airspeed. The commenter also disagrees with the statement made in Notice No. 95–17 that a speed lower than the 1-g stall speed represents a transient flight condition. The commenter notes that in steady climbing flight, the lift force needed to sustain steady flight is less than the airplane weight, and for larger climb angles, steady flight is sustainable at speeds lower than the 1-g stall speed. This commenter suggests revising the proposed § 25.207(c) to require the stall warning to begin at the greater of: (1) A speed higher than either one knot or one percent higher than the reference stall speed; or (2) seven knots or seven percent higher than the speed at the occurrence of a stall (as defined in § 25.201(d)).

Other comments were received on the proposed § 25.207(c) relative to the engine thrust or power setting associated with the proposed three percent or three knot stall warning margin. Two commenters support removing the reference to ''engines idling and throttles closed'' so that the same stall warning margin would apply to all power and thrust settings. One commenter suggests that to be consistent with the proposed § 25.103(a)(1) it is unnecessary to refer to throttles. This commenter also questions why the proposal states that ''§ 25.103(a)(5) does not apply'' when defining the reference stall speed to be used in connection with this requirement.

In combination with adopting the 1-g stall speed as the appropriate benchmark for the low speed end of an airplane's limit flight envelope, the FAA considers a warning three knots or three percent prior to reaching this speed to be the minimum margin needed to prevent the crew from inadvertently slowing beyond this speed. A categorical statement regarding the severity of this requirement relative to the current requirement cannot be made since the effect of the change in the reference stall speed will vary with airplane type (and with the high lift device configuration on a given type). It would, however, be inappropriate to couple the existing seven percent margin requirement relative to the minimum speed reached in the stalling maneuver with the redefined reference stall speed as one commenter suggests.

The FAA does not consider the proposed stall warning margin to unduly restrict access to useable parts of the airplane flight envelope. Relative to windshear escape, the dynamic nature of windshear warrants, if anything, a larger speed margin to the stalled condition. Using current windshear escape procedures, frequent and irregular penetrations of the stall warning margin are more likely to occur. This type of trained maneuver was not envisioned when the current stall warning requirements were promulgated. Regarding the comment that for climbing flight the lift force will be less than the airplane's weight, this condition is irrelevant for establishing the reference stall speed or defining a reasonable stall warning margin. The FAA has determined that the intent of the proposal is sufficiently clear in this respect.

The FAA agrees that the stall warning margin for other than idle thrust or power settings should be addressed. The FAA did not intend to restrict consideration of the adequacy of the stall warning margin to only the idle thrust or power condition. The general requirement for a stall warning with sufficient margin to prevent inadvertently stalling prescribed by § 25.207(a) applies to all normal configurations and flight conditions. The three knot or three percent warning margin reference in the proposed § 25.207(c) would specifically quantify this requirement for the conditions under which V_{SR} is determined. At other conditions, the FAA would have expected an equivalent margin to that prescribed by § 25.207(c). However, there is an inherent difficulty in either specifying an appropriate warning margin or determining an equivalent warning margin to that specified in the proposed § 25.207(c) for conditions other than idle thrust or power, straight flight, and the center-of-gravity position defined in the proposed § 25.103(a)(5), because VSR is undefined for those other conditions.

In response to the comments, and to clarify the situation regarding the acceptable stall warning margin for conditions other than those under which VSR is defined, the FAA has revised the proposed § 25.207(c) by specifying that stall warning must begin at least five knots or five percent, whichever is greater, prior to the speed at which the airplane is considered stalled (as defined in § 25.201(d)). This is also the stall warning margin required by JAR–25 prior to the adoption of Change 15, and is considered to neither increase nor decrease the current level of safety. By referencing the speed at which the stall is identified for determining the adequacy of the stall warning margin, and not limiting this requirement to specific conditions of thrust or power, bank angle, or center-of-gravity position, the adopted rule requires that the five knot or five percent margin must be available at all thrust/power settings, bank angles, and center-of-gravity positions.

The FAA expects this stall warning margin to be demonstrated for the conditions of bank angle, power, and center-of-gravity position prescribed for the stall demonstration tests by § 25.201(a). If, however, the stall warning margin may be affected by the system design (*e.g.*, a stall warning or stall identification system that modifies the stall warning or stall identification system as a function of thrust, bank angle, angle-of-attack rate, etc.), compliance with the adopted § 25.207(c) should be demonstrated at the most critical conditions in terms of stall warning margin.

The proposed three knot or three percent (whichever is greater) stall warning margin requirement relative to V_{SR} is retained in § 25.207(d) as an additional criterion applicable to that specific flight condition. The reference to throttles has been removed, as has the statement that the proposed § 25.103(a)(5) should not apply when defining the reference stall speed to be used in connection with this requirement. In response to the commenter's question, the reference to § 25.103(a)(5) had been proposed because the proposed definition of the reference stall speed would have required that the center-of-gravity position for determining the reference stall speed would be that which results in the highest value of the reference stall speed. Since the center-of-gravity position at which the proposed three knot or three percent stall warning requirement would apply was not specified, it presumably would apply to all center-of-gravity positions. Therefore, without the proposed statement, a literal interpretation of the proposed requirement would have required the stall warning speed at any center-of-gravity position to be three knots or three percent above the stall speed evaluated at the most adverse center-of-gravity position. This was not the intention. Any evaluation of the effect of center-of-gravity position on the stall warning margin should be based on the same center-of-gravity position for both the stall speed and the stall warning speed.

The proposed wording, along with additional explanatory material that would have been proposed for addition to AC 25–7A, was intended to clarify that for center-of-gravity positions other than that specified in the proposed § 25.103(a)(5), the same center-of-gravity position should be used for both the stall speed and the stall warning speed. However, due to the potential for confusion over the proposed wording, and because the explicit stall warning speed margin prescribed by the proposed § 25.207(c) only applies to the conditions under which VSR is determined, the proposed wording regarding center-of-gravity position has been removed. Instead, the center-of-gravity position specified in § 25.103(b)(5) (re-numbered from the proposed § 25.103(a)(5)) has been included in the list of conditions for which the specific three knot or three percent stall warning margin of the adopted § 25.207(d) applies. For other center-of-gravity positions, the acceptable stall warning margin is now addressed in the adopted § 25.207(c).

Because of the differences between naturally stalling airplanes and those that employ a device to abruptly push the nose down at a selected angle of attack to identify the stall, the FAA proposed that the stall warning margin for airplanes that employ these devices would be required to be five knots or five percent prior to the speed at which the device activates. The application of § 25.207(d), as adopted, in combination with the adopted new requirement of § 25.103(d) will ensure that there must be a 5 knot or 5 percent stall warning margin relative to VSR for these airplanes. Therefore, the proposed § 25.207(d) is removed.

The stall speed margins required by the adopted §§ 25.207(c) and (d) must be available in terms of calibrated airspeed. Normally, test demonstrations at the conditions specified in § 25.201 (Stall demonstration) will be sufficient to show compliance with these requirements. However, if the stall warning margin for a particular airplane type varies significantly with power or thrust, center-of-gravity position, bank angle, of some other characteristic, additional test conditions may be necessary.

As with other part 25 requirements, shortfalls in demonstrating compliance with the literal terms of the stall warning margin requirements would necessitate either a design change, an exemption (per § 11.25), or features that would provide equivalent safety using an alternate means of compliance (per § 21.21(b)(1)). Other rulemaking projects in which the stall warning margin is an issue (*e.g.*, discussions of flight in icing conditions by the ARAC) will be considered on their own merits.

Several commenters object to the accelerated stall warning margin requirement proposed as a new § 25.207(e). Some of the commenters claim that, in some cases, attempts to demonstrate compliance with this proposed requirement during flight testing resulted in maneuvers that the commenters consider inappropriate for a transport category airplane. These commenters provide several examples of the maneuvers they described as inappropriate. Other commenters note that the phrase ''to prevent stalling'' needs further clarification. One commenter questions the lack of a bank angle stipulation in the proposed requirement and provided an analysis indicating that bank angles of about 45 degrees have the greatest effect on aerodynamics. This commenter also claims that a prescribed load factor and deceleration rate are not simultaneously achievable at C_{LMAX}. The commenter suggests revising the proposed § 25.207(e) to specify 30 degree banked turns (for consistency with the turning flight stall characteristics demonstration required by § 25.201(a)) with accelerated rates of entry into the stall, up to the greater of 1.5g load factor and 3 knots per second speed reduction. This suggestion was made by other commenters as well.

The FAA concurs that detailed guidance material may be helpful to ensure an appropriate and consistent demonstration of compliance with the proposed accelerated stall warning requirement. This material will be presented in the proposed revisions to AC 25–7A, which will be published in the **Federal Register** shortly after publication of this final rule.

The purpose of the proposed requirement is to ensure that adequate stall warning exists to prevent an inadvertent stall under the most demanding conditions likely to occur in normal flight. The proposed conditions of 1.5g and a three knots per second entry rate (*i.e.*, airspeed deceleration rate) correspond to the steep turn maneuver prescribed in part 121, Appendices E and F for pilot initial and proficiency training, respectively, plus some margin for error (three degrees more bank and a decreasing airspeed). The elevated load factor will emphasize any adverse stall characteristics, such as wing drop or asymmetric wing flow breakdown, while also investigating Mach and potential aeroelastic effects on available lift. The proposed three knots per second deceleration rate is intended to result in a reasonable penetration beyond the onset of stall warning. A 30-degree banked turn maneuver, as proposed by several of the commenters, produces a load factor of only 1.15g, which the FAA does not consider high enough to evaluate the effect of elevated load factor on the capability to prevent an inadvertent stall.

As noted by one of the commenters, the bank angle used during the maneuver to demonstrate compliance with this proposed requirement may affect the airplane's stall characteristics. However, this aspect is considered secondary to the primary effect of an elevated load factor on the stall warning margin. For this reason, § 25.207(e) is revised from the version published in the NPRM to prescribe a load factor rather than a bank angle. An acceptable means of producing this load factor would be a 48-degree banked turn in level flight.

As adopted, § 25.207(e) requires an airspeed deceleration rate of greater than two knots per second instead of rates up to three knots per second. This change clarifies the intent of achieving a reasonable deceleration rate rather than one specific value, and will result in the intended penetration beyond the onset of stall warning. The FAA anticipates that with typical test techniques, requiring a deceleration rate of greater than two knots per second will result in deceleration rates close to three knots per second. The power and trim conditions are now specified in the rule in order to ensure consistent application of this requirement.

To clarify the meaning of the phrase ''to prevent stalling,'' the parenthetical expression, ''(as defined in § 25.201(d)),'' has been added in the adopted § 25.207(e). Therefore, any of the acceptable indications of a stall applicable to stall demonstration testing is also considered an indication that the airplane has stalled during the accelerated stall warning demonstration. If any of these indications of a stall occur during the accelerated stall warning demonstration, compliance with § 25.207(e) will not have been demonstrated.

Two commenters offered comments relative to subpart C (Structure) of part 25. One of these commenters suggests that the interpretation of the stall speed used in subpart C be undertaken urgently as part of the Harmonization Work Program. The other commenter suggests that either subpart C should be reworked to reflect the introduction of V_{SR} or § 25.103 should introduce definitions of V_{S0} and V_{S1} in terms of V_{SR}.

These comments regarding subpart C of part 25 are beyond the scope of this rulemaking, which is confined to the definition of the stall speed used for airplane performance determination and handling characteristics. This amendment does not affect the stall speeds used in subpart C for structural analysis.

Further consideration by the FAA regarding the proposed revisions to §§ 1.1 (Definition of reference landing speed) and 97.3(b) (Definition of aircraft approach category) has resulted in minor changes in the adopted rule relative to the original proposals. The proposed definition of reference landing speed had used the term ''landing screen height'' to identify the point in the approach at which the reference landing speed is determined. Although this term is defined in the preamble discussion of the rule proposal, it is not defined or used elsewhere within the regulations. The landing distance requirements of § 25.125 specify this height as the 50 foot height, and the adopted definition of reference landing speed in § 1.1 has been changed to be consistent with this requirement.

The preamble discussion references approvals of steep approach operations that use a ''landing screen height'' of less than the 50 foot height prescribed by the § 25.125 landing distance requirements. These types of approvals are not the norm, however, and should be processed as equivalent safety findings, special conditions, or exemptions, whichever is appropriate for the specific case.

In addition to replacing ''landing screen height'' with ''50 foot height,'' the words ''for manual landings'' have been removed from the definition of ''reference landing speed'' since the applicable § 25.125 landing distance requirements make no such distinction. Approval of automatic landing systems, including consideration of associated landing speeds and distances, is addressed in FAA ACs 20–57A, 120–28D, and 120–29.

Further review of the proposed change to § 97.3(b) indicated a potential for confusion with respect to its application to aircraft certificated using V_S, the minimum speed in the stalling maneuver, rather than V_{SR}. There is some concern that the proposed replacement of 1.3 V_{S0} with V_{REF} may introduce terminology which is not well understood by all potential users of the airspace system, and that information provided in some Airplane Flight Manuals may not be consistent with the new terminology. Therefore, as adopted, § 97.3(b) will continue to reference 1.3 V_{S0} for use in those cases where V_{REF} is not specified.

One adverse comment was received on the proposed change to § C36.9(e)(1) of Appendix C to part 36. The commenter notes that the proposed change could result in increasing the speed used to show compliance with the approach noise requirements for those cases where V_{REF} is greater than 1.23 V_{SR0} (or 1.3 V_S for airplanes certificated under the existing stall speed requirements). The commenter states that this increased speed can result in higher certificated noise levels. The commenter objects to the increased stringency and believes it to be an inappropriate consequence of changing to the 1-g stall speed reference. The commenter also notes the importance of arriving at harmonized criteria with the JAA for the approach speed used for noise certifications.

The FAA disagrees with the commenter. The proposed amendment would have replaced the words ''1.3 V_S + 10 knots'' with ''V_{REF} + 10 knots'' and removed the words ''or the speed used in establishing the approved landing distance under the airworthiness regulations constituting the type certification basis of the airplane, whichever speed is greatest.'' The effect of the proposal would have been to require a steady approach speed of V_{REF} + 10 knots over the approach noise measuring point during the flight test measurement of approach noise levels.

The reference to 1.3 V_S in the current § C36.9(e)(1) had been derived from the § 25.125 landing requirements, *i.e.*, 1.3 V_S was interpreted to be the speed at the 50 foot height. Further away from the runway, at the point at which the approach noise is measured (6,562 feet from the runway threshold), the airplane is likely to be at a somewhat higher speed. Higher speeds are used during the approach to provide greater stall and controllability margins, especially in the presence of winds and gusts, with the additional speed being bled off by the time the airplane is at the 50 foot height. As stated in the preamble to the amendment that added part 36 to the FAR, ''The intent of this proposal was to require an airspeed that is highly typical of normal approach airspeeds, so that a realistic approach speed is generated. The speed 1.3 V_S + 10 knots is such an airspeed and is therefore specified * * *'' The ten knot increment applied to 1.3 V_S represents the typical approach speed at the approach noise measuring point.

In a later amendment to part 36 (Amendment 36–5), the FAA recognized that, for various reasons, a speed higher than 1.3 V_S may be used in establishing the landing distance under § 25.125. Amendment 36–5 added the words ''or the speed used in establishing the approved landing distance under the airworthiness regulations constituting the type certification basis of the airplane, whichever speed is greatest'' to the ''1.3 V_S + 10 knots'' speed requirement over the approach noise measuring point.

The additional 10 knot speed increment added to 1.3 V_S was not added to ''the speed used in establishing the approved landing distance under the airworthiness regulations constituting the type certification basis of the airplane.'' The FAA has since determined, however, that the ten knot speed increment should be applied to the speed used to determine the landing distance under § 25.125, regardless of whether that speed is 1.3 V_S or some higher speed. The flightcrew does not know whether the approach speed provided in their manuals is based on 1.3 V_S or some higher speed and will use the same procedures and speed increments in either case.

The FAA's proposal would have set the speed over the approach noise measuring point at V_{REF} +10 knots. Since V_{REF} is the speed used to determine the landing distance, a consistent speed increment would be applied to the speed applicable to the 50 foot height, regardless of whether V_{REF} is determined by stall speed, controllability requirements, or some other parameter.

Subsequent to the publication of Notice 95–17, Working Group 1 (WG1) of the International Civil Aviation Organization (ICAO) Committee on Aviation Environmental Protection (CAEP) recommended to the ICAO CAEP that the noise certification approach reference speed contained in Volume I of Annex 16 to the Convention on International Civil Aviation (the ICAO International Standard and Recommended Practice for Aircraft Noise Certification) be changed to V_{REF} + 10 knots. The WG1 was established by the CAEP to provide technical guidance regarding revisions to Annex 16, Volume 1. The United States is a member of both the ICAO CAEP and WG1. The WG1 did not view the adoption of V_{REF} + 10 knots as having a significant effect on stringency. At its 5th meeting, which was held in January 2001, the ICAO CAEP accepted the WG1 recommendation regarding adoption of V_{REF} + 10 knots. This recommendation was subsequently included in Amendment 7 of Annex 16, Volume 1, which was adopted by the ICAO Council on June 29, 2001.

As a member of the ICAO Council, CAEP and WG1, the FAA supported the conclusion to use V_{REF} + 10 knots. The commenter has provided no support for the expressed effect on stringency. The concern expressed by the commenter regarding the use of harmonized criteria between the FAA and JAA would be eliminated by FAA adoption of the Annex 16, Amendment 7 requirement, considering that Annex 16 is the basis for the JAA noise certification requirements. Accordingly, the FAA adopted the Annex 16, Amendment 7 requirement as part of Amendment 24 to part 36, which was published in the **Federal Register** on July 8, 2002 (67 FR 45193).

Other than the changes noted above, the proposed changes to part 25 are adopted as proposed in Notice No. 95–17.

Paperwork Reduction Act

In accordance with the Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)), there are no requirements for information collection associated with this amendment.

International Compatibility

In keeping with U.S. obligations under the Convention on International Civil Aviation, it is FAA policy to comply with International Civil Aviation Organization (ICAO) Standards and Recommended Practices to the maximum extent practical. The FAA has reviewed the corresponding ICAO Standards and Recommended Practices and the Joint Aviation Authorities regulations, where they exist, and has identified no differences in these amendments and the foreign regulations.

Regulatory Evaluation Summary

Economic Evaluation, Regulatory Flexibility Determination, International Trade Impact Assessment, and Unfunded Mandates Assessment

Changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 directs each Federal agency to propose or adopt a regulation only if the agency makes a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic impact of regulatory changes on small entities. Third, the Trade Agreements Act (19 U.S.C. section 2531–2533) prohibits agencies from setting standards that create unnecessary obstacles to the foreign commerce of the United States. In developing U.S. standards, this Trade Act requires agencies to consider international standards. Where appropriate, agencies are directed to use those international standards as the basis of U.S. standards. And fourth, the Unfunded Mandates Reform Act of 1995 requires agencies to prepare a written assessment of the costs, benefits and other effects of proposed or final rules. This requirement applies only to rules that include a Federal mandate on State, local or tribal governments or the private sector, likely to result in a total expenditure of $100 million or more in any one year (adjusted for inflation.)

In conducting these analyses, the FAA has determined that this final rule: (1) Has benefits that do justify its costs; (2) is not a ''significant rulemaking'' either as defined in the Executive Order or in DOT's Regulatory Policies and Procedures; (3) will not have a significant impact on a substantial number of small entities; (4) will lessen restraints on international trade; and (5) will not contain a significant intergovernmental or private sector mandate.

These analyses, available in the docket, are summarized as follows.

Economic Evaluation

The Benefits Estimate

This rule supports the existing level of safety because type certification for part 25 airplanes based on 1-g criteria is common practice, the FAA having accepted 1-g stall criteria since the mid-80s for most part 25 type certifications, in many cases through the Issue Paper process. This rule establishes the codification of this practice, and thus adds the safety benefit of preventing deviation from this practice. The FAA has not attempted to quantify this benefit.

The FAA also expects this rule will result in added benefits in the form of cost savings to those affected manufacturers that carry out type certification to both FAR and JAR requirements. Historically, U.S. manufacturers that certificate part 25 airplanes to both FAA and JAA requirements using 1-g stall speed criteria have done so by working out separate arrangements with both authorities. The FAA expects compliance with a single harmonized FAA/JAA regulatory standard will be simpler and more direct than compliance through separate arrangements, and that cost savings will result. The FAA has not attempted to quantify this benefit.

The Estimate of Costs and Its Evolution

As noted, the FAA has accepted 1-g stall speed criteria for most part 25 type certification projects since the mid-1980s. The FAA expects this rule will not change the substance of accepted certification practices. Thus, no more than minimal additional certification costs will be associated with this new rule.

However, as certification practices and aviation technology have evolved since the mid-1980s, the costs of certification at 1-g have changed. As these costs have changed, manufacturers' estimates of comparative certification costs have changed; and FAA's estimates of the costs associated with this rule have changed.

This final rule evaluation was begun in 1999. It completes the regulatory evaluation process that began with research pursuant to a 1996 NPRM. Comments to the docket in response to that NPRM were received in 1996. Pursuant to this final rule evaluation, providers of previously received information were asked to review, clarify and update their information as necessary. Their clarifications and updates, together with the previous research and analysis are the basis for the conclusions developed in this final rule evaluation.

While the costs provided in the 1996 comments were much higher than those of the 1996 NPRM, the 1999 clarifications and updates brought the costs developed in this final rule evaluation more into line with those of the NPRM. Cost estimates for typical type certification projects that use 1-g stall speed as the reference datum have evolved as follow:

- In 1996, the NPRM concluded that the costs of 1-g compliance differed depending upon the size of the airplane certified. In then-current dollars, the NPRM estimated compliance costs of $195,000 for a type certification for large part 25 airplanes. For small part 25 airplanes, the NPRM estimate included a one-time cost of $70,000 for each manufacturer and subsequent type certification costs of $250,000. This final rule evaluation concludes that neither regulatory nor practical distinctions between small and large airplanes allow the unambiguous grouping by size category needed to support the level of economic analysis characteristic of final rules.
- In 1996, comments received in response to the NPRM gave additional compliance costs per type certification in then-current dollars that ranged from $331,412 for instrumentation costs plus $35,029 for testing and analysis, to an undifferentiated $1,000,000 per type certification project.
- For this final rule evaluation, the baseline for cost comparisons is the estimate of the current cost of type certification using minimum stall speed as the reference datum for a typical part 25 airplane. Building on the NPRM, the comments to the Docket, and the clarifications and updates, this final rule evaluation estimates typical additional compliance costs of about $130,000 for a type certification program conducted at 1-g for a part 25 airplane, expressed in 1999 dollars.
- During the time the FAA has been accepting certification at 1-g, additional costs of instrumentation have become small to negligible. Falling instrumentation costs and rising instrumentation capability have resulted in acceptable test data being achieved by adding as little additional instrumentation as one accelerometer to the test equipment required for certification at minimum stall speed. (The estimated uninstalled cost of an accelerometer appropriate to this use is the minimal cost of $500 to $2,000, in 1999 dollars. Further, accelerometer and gyroscopic components already present in the inertial navigation systems incorporated on modern transport category airplanes are the fundamental starting point for instrumentation sufficient to measure a 1-g stall speed.)

In summary, for a typical part 25 airplane, the current industry practice of type certification using 1-g stall as the reference datum adds a minor cost ($130,000) for flight-testing and analysis to the costs of the baseline alternative of type certification using minimum speed stall. This practice also is expected to add very minor or no cost for additional instrumentation beyond that required for the type certification baseline.

This final evaluation notes the possibility, also raised in the NPRM and in the 1999 clarifications and updates, that codification of this ongoing practice, and its consequent extension to all U.S. manufacturers and to all part 25 airplanes they will certificate in the future, could have an adverse impact on marketing efforts by manufacturers. (In general, this rule reduces the multiplying factors used to convert reference speed to minimum operational speeds by about 6 percent. When the reduced multiplying factors are applied to the 1-g stall speed, which is generally about 6 percent higher than minimum speed stall, the resulting minimum operating speeds generally will result in the same values produced by using minimum stall speed as the reference datum. However, variation is possible. This possible variation is at the heart of assertions of marketing impact. No such impact is considered in this evaluation, for the reasons that follow:

—The possible differences in operational speeds between type certification using 1-g stall speed and type certification using minimum stall speed are in the low single digits when expressed as speeds
—The very large number of possible combinations of airplane types, operational conditions, operators' services and airport characteristics forestalls practical quantitative consideration of the possible small consequences noted above
—Any operational consequence of certification at 1-g already results from ongoing industry practice and cannot also be considered to result from this rule
—The possible differences in operational speeds between type certification using 1-g stall speed and type certification using minimum stall speed are in the low single digits when expressed as speeds

Benefits/Costs Comparison

The FAA finds that this rule improves the codification of current industry practices that have evolved over a period of about 15 years. These practices already result in the benefits of the current level of safety. With one exception, this rule will add little or nothing to these benefits. The exception is the elimination of the possibility that a future part 25 airplane might not be certificated based on 1-g stall speed criteria. Removing this possibility ensures that the benefits being received cannot be reduced, thus diminishing the current level of safety. The agency has not attempted to quantify either this added benefit or the benefits already being received.

Another additional benefit of improved codification is that type certification to both FAR and JAR requirements will be simpler, more direct and consequently less costly. The agency has not attempted to quantify this harmonization benefit.

Because it is an improvement of the codification of voluntary industry practices, the FAA concludes that this rule will add little or no cost to the industry. The agency estimates that affected manufacturers already voluntarily incur costs of about $130,000 (in 1999 dollars) for each type certification project they base on 1-g stall speed criteria, beyond the costs they would incur in type certification based on minimum stall speed criteria.

The FAA concludes that while this final rule will add little or nothing to the safety benefits and the certification costs that already result from voluntary industry practices, it does add safety and harmonization benefits. Thus, the FAA believes this rule is cost effective.

Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) establishes ''as a principle of regulatory issuance that agencies shall endeavor, consistent with the objective of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the business, organizations, and governmental jurisdictions subject to regulation.'' To achieve that principle, the Act requires agencies to solicit and consider flexible regulatory proposals and to explain the rationale for their actions. The Act covers a wide-range of small entities, including small businesses, not-for-profit organizations and small governmental jurisdictions.

Agencies must perform a review to determine whether a proposed or final rule will have a significant economic impact on a substantial number of small entities. If the determination is that it will, the agency must prepare a regulatory flexibility analysis as described in the Act.

However, if an agency determines that a proposed or final rule is not expected to have a significant economic impact on a substantial number of small entities, section 605(b) of the 1980 act provides that the head of the agency may so certify and a regulatory flexibility analysis is not required. The certification must include a statement providing the factual basis for this determination, and the reasoning should be clear. For aircraft manufacturers, a small entity is one with 1,500 or fewer employees.

Evaluation of this final rule in terms of this standard shows that no current manufacturer of transport category airplanes is a small manufacturer. Although the future entry of a small manufacturer into the business of manufacturing transport category airplanes is possible, such an unusual single entrant could not be construed to equate to a ''substantial number.''

Finally, no regulatory flexibility analysis is required for this rule because it adds little or nothing to the costs that otherwise would be required for type certification of a transport category airplane by a manufacturer of any size. Therefore the impact of this rule would not be significant whether it fell on a large or on a small manufacturer.

In light of these arguments, the FAA certifies that the rule change will not have a significant economic impact on a substantial number of small entities, and a regulatory flexibility analysis is not required.

International Trade Impact Analysis

The Trade Agreement Act of 1979 prohibits Federal agencies from engaging in any standards or related activities that create unnecessary obstacles to the foreign commerce of the United States. Legitimate domestic objectives, such as safety, are not considered unnecessary obstacles. The statute also requires consideration of international standards and where appropriate, that they be the basis for U.S. standards.

Because this rule is a part of a harmonization process that will result in a single FAA/JAA regulatory standard, it reduces a barrier to international trade. Thus, in accordance with the above statute, the FAA has assessed the potential effect of this final rule and has determined that it will support the Act.

Unfunded Mandates Reform Act

The Unfunded Mandates Reform Act of 1995 (the Act), enacted as Public Law 104–4 on March 22, 1995 is intended, among other things, to curb the practice of imposing unfunded Federal mandates on State, local, and tribal governments.

Title II of the Act requires each Federal agency to prepare a written statement assessing the effects of any Federal mandate in a proposed or final agency rule that may result in a $100 million or more expenditure (adjusted annually for inflation) in any one year by State, local, and tribal governments, in the aggregate, or by the private sector; such a mandate is deemed to be a ''significant regulatory action.'' This final rule does not contain such a mandate. Therefore, the assessment requirements of Title II of the Unfunded Mandates Reform Act of 1995 do not apply.

Executive Order 3132, Federalism

The FAA has analyzed this final rule under the principles and criteria of Executive Order 13132, Federalism. We determined that this action will not have a substantial direct effect on the State, or the relationship between the national Government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, we determined that this final rule does not have federalism implications.

Regulations Affecting Interstate Aviation in Alaska

Section 1205 of the FAA Reauthorization Act of 1996 (110 Stat. 3213) requires the Administrator, when modifying regulations in Title 14 of the CFR in a manner affecting interstate aviation in Alaska, to consider the extent to which Alaska is not served by transportation modes other than aviation, and to establish such regulatory distinctions as he or she considers appropriate. Because this rule would apply to the certification of future designs of transport category airplanes and their subsequent operation, it could, if adopted, affect interstate aviation in Alaska.

Environmental Analysis

FAA Order 1050.1D defines FAA actions that may be categorically excluded from presentation of a National Environmental Policy Act (NEPA) environmental impact statement. In accordance with FAA Order 1050.1D, appendix 4, paragraph 4(j), this rulemaking action qualifies for a categorical exclusion.

Energy Impact

The energy impact of this amendment has been assessed in accordance with the Energy Policy and Conservation Act (EPCA) Public Law 94–163, as amended (42 U.S.C. 6362) and FAA Order 1053.1. It has been determined that the final rule is not a major regulatory action under the provisions of the EPCA.

List of Subjects

14 CFR Part 1

Air transportation.

14 CFR Part 25

Aircraft, Aviation safety, Reporting and recordkeeping requirements.

14 CFR Part 97

Air traffic control, Airports, Navigation (air), Weather.

The Amendments

In consideration of the foregoing, the Federal Aviation Administration (FAA) amends Chapter I of Title 14 Code of Federal Regulations (CFR) parts 1, 25, and 97 as follows:

PART 1—DEFINITIONS AND ABBREVIATIONS

1. The authority citation for part 1 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701.

2. Section 1.1 is amended by adding new definitions in alphabetical order to read as follows:

§ 1.1 General definitions.

* * * * *

Final takeoff speed means the speed of the airplane that exists at the end of the takeoff path in the en route configuration with one engine inoperative.

* * * * *

Reference landing speed means the speed of the airplane, in a specified landing configuration, at the point where it descends through the 50 foot height in the determination of the landing distance.

* * * * *

3. Section 1.2 is amended by adding new abbreviations in alphabetical order to read as follows:

§ 1.2 Abbreviations and symbols.

* * * * *

V_{FTO} means final takeoff speed.

* * * * *

V_{REF} means reference landing speed.

* * * * *

V_{SR} means reference stall speed.

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

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

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

* * * * *

PART 25—AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY AIRPLANES

4. The authority citation for part 25 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

5. Section 25.103 is revised to read as follows:

§ 25.103 Stall speed.

(a) The reference stall speed, $V_{SR,}$ is a calibrated airspeed defined by the applicant. V_{SR} may not be less than a 1-g stall speed. V_{SR} is expressed as:

$$V_{SR} \geq \frac{V_{CL_{MAX}}}{\sqrt{n_{ZW}}}$$

where:

$V_{CL_{MAX}}$ = Calibrated airspeed obtained when the load factor-corrected lift coefficient

$$\left(\frac{n_{ZW}W}{qS}\right)$$

is first a maximum during the maneuver prescribed in paragraph (c) of this section. In addition, when the maneuver is limited by a device that abruptly pushes the nose down at a selected angle of attack (*e.g.*, a stick pusher), $V_{CL_{MAX}}$ may not be less than the speed existing at the instant the device operates;

n_{ZW} = Load factor normal to the flight path at $V_{CL_{MAX}}$

W = Airplane gross weight;

S = Aerodynamic reference wing area; and

q = Dynamic pressure.

(b) V_{CLMAX} is determined with:

(1) Engines idling, or, if that resultant thrust causes an appreciable decrease in stall speed, not more than zero thrust at the stall speed;

(2) Propeller pitch controls (if applicable) in the takeoff position;

(3) The airplane in other respects (such as flaps and landing gear) in the condition existing in the test or performance standard in which V_{SR} is being used;

(4) The weight used when V_{SR} is being used as a factor to determine compliance with a required performance standard;

(5) The center of gravity position that results in the highest value of reference stall speed; and

(6) The airplane trimmed for straight flight at a speed selected by the applicant, but not less than $1.13V_{SR}$ and not greater than $1.3V_{SR}$.

(c) Starting from the stabilized trim condition, apply the longitudinal control to decelerate the airplane so that the speed reduction does not exceed one knot per second.

(d) In addition to the requirements of paragraph (a) of this section, when a device that abruptly pushes the nose down at a selected angle of attack (*e.g.*, a stick pusher) is installed, the reference stall speed, V_{SR}, may not be less than 2 knots or 2 percent, whichever is greater, above the speed at which the device operates.

6. Section 25.107 is amended by revising paragraphs (b)(1) introductory text, b(1)(ii), (b)(2) introductory text, b(2)(ii), (c)(1) and (c)(2), and by adding new paragraphs (c)(3) and (g) to read as follows:

§ 25.107 Takeoff speeds.

* * * * *

(b) * * *

(1) $1.13V_{SR}$ for—

* * * * *

(ii) Turbojet powered airplanes without provisions for obtaining a significant reduction in the one-engine-inoperative power-on stall speed;

(2) $1.08V_{SR}$ for—

* * * * *

(ii) Turbojet powered airplanes with provisions for obtaining a significant reduction in the one-engine-inoperative power-on stall speed; and

* * * * *

(c)* * *

(1) V_{2MIN};

(2) V_R plus the speed increment attained (in accordance with § 25.111(c)(2)) before reaching a height of 35 feet above the takeoff surface; and

(3) A speed that provides the maneuvering capability specified in § 25.143(g).

* * * * *

(g) V_{FTO}, in terms of calibrated airspeed, must be selected by the applicant to provide at least the gradient of climb required by § 25.121(c), but may not be less than—

(1) 1.18 V_{SR}; and

(2) A speed that provides the maneuvering capability specified in § 25.143(g).

7. Section 25.111 is amended by revising paragraph (a) introductory text to read as follows:

§ 25.111 Takeoff path.

(a) The takeoff path extends from a standing start to a point in the takeoff at which the airplane is 1,500 feet above the takeoff surface, or at which the transition from the takeoff to the en route configuration is completed and V_{FTO} is reached, whichever point is higher. In addition—

* * * * *

8. Section 25.119 is amended by revising paragraph (b) to read as follows:

§ 25.119 Landing climb: All-engines-operating.

* * * * *

(b) A climb speed of not more than V_{REF}.

9. Section 25.121 is amended by revising paragraphs (c) introductory text, (d) introductory text, (d)(2) and (d)(3), and by adding paragraph (d)(4) to read as follows:

§ 25.121 Climb: One-engine-inoperative.

* * * * *

(c) *Final takeoff.* In the en route configuration at the end of the takeoff path determined in accordance with § 25.111, the steady gradient of climb may not be less than 1.2 percent for two-engine airplanes, 1.5 percent for three-engine airplanes and 1.7 percent for four-engine airplanes, at V_{FTO} and with

* * * * *

(d) *Approach.* In a configuration corresponding to the normal all-engines-operating procedure in which V_{SR} for this configuration does not exceed 110 percent of the V_{SR} for the related all-engines-operating landing configuration, the steady gradient of climb may not be less than 2.1 percent for two-engine airplanes, 2.4 percent for three-engine airplanes, and 2.7 percent for four engine airplanes, with

* * * * *

(2) The maximum landing weight;

(3) A climb speed established in connection with normal landing procedures, but not more than 1.4 V_{SR}; and

(4) Landing gear retracted.

10. Section 25.125 is amended by revising paragraph (a)(2) to read as follows:

§ 25.125 Landing.

(a) * * *

(2) A stabilized approach, with a calibrated airspeed of V_{REF}, must be maintained down to the 50 foot height. V_{REF} may not be less than

(i) 1.23 V_{SR0};

(ii) V_{MCL} established under § 25.149(f); and

(iii) A speed that provides the maneuvering capability specified in § 25.143(g).

* * * * *

11. Section 25.143 is amended by adding a new paragraph (g) to read as follows:

§ 25.143 General.

* * * * *

(g) The maneuvering capabilities in a constant speed coordinated turn at forward center of gravity, as specified in the following table, must be free of stall warning or other characteristics that might interfere with normal maneuvering:

Configuration	Speed	Maneuvering bank angle in a coordinated turn	Thrust power setting
Takeoff	V_2	30°	Asymmetric WAT-Limited.[1]
Takeoff	[2]V_2 + XX	40°	All-engines-operating climb.[3]
En route	V_{FTO}	40°	Asymmetric WAT-Limited.[1]
Landing	V_{REF}	40°	Symmetric for −3° flight path angle.

[1] A combination of weight, altitude, and temperature (WAT) such that the thrust or power setting produces the minimum climb gradient specified in § 25.121 for the flight condition.

[2] Airspeed approved for all-engines-operating initial climb.

[3] That thrust or power setting which, in the event of failure of the critical engine and without any crew action to adjust the thrust or power of the remaining engines, would result in the thrust or power specified for the takeoff condition at V_2, or any lesser thrust or power setting that is used for all-engines-operating initial climb procedures.

12. Section 25.145 is amended by revising paragraphs (a) introductory text, (a)(1), (b)(1), (b)(4), (b)(6), and (c) introductory text to read as follows:

§ 25.145 Longitudinal control.

(a) It must be possible, at any point between the trim speed prescribed in § 25.103(b)(6) and stall identification (as defined in § 25.201(d)), to pitch the nose downward so that the acceleration to this selected trim speed is prompt with

(1) The airplane trimmed at the trim speed prescribed in § 25.103(b)(6);

* * * * *

(b) * * *

(1) With power off, flaps retracted, and the airplane trimmed at 1.3 V_{SR1}, extend the flaps as rapidly as possible while maintaining the airspeed at approximately 30 percent above the reference stall speed existing at each instant throughout the maneuver.

* * * * *

(4) With power off, flaps retracted, and the airplane trimmed at 1.3 V_{SR1}, rapidly set go-around power or thrust while maintaining the same airspeed.

* * * * *

(6) With power off, flaps extended, and the airplane trimmed at 1.3 V_{SR1}, obtain and maintain airspeeds between V_{SW} and either 1.6 V_{SR1} or V_{FE}, whichever is lower.

(c) It must be possible, without exceptional piloting skill, to prevent loss of altitude when complete retraction of the high lift devices from any position is begun during steady, straight, level flight at 1.08 V_{SR1} for propeller powered airplanes, or 1.13 V_{SR1} for turbojet powered airplanes, with—

* * * * *

§ 25.147 [Amended]

13. Section 25.147 is amended in paragraphs (a) introductory text, (a)(2), (c) introductory text, and (d) by revising the expression ''1.4 V_{S1}'' to read ''1.3 V_SR1.''

§ 25.149 [Amended]

14. Section 25.149 is amended in paragraph (c) introductory text by revising the expression ''1.2 V_S'' to read ''1.13 V_{SR}.''

§ 25.161 [Amended]

15. Section 25.161 is amended in paragraphs (b), (c)(1), (c)(2), (c)(3) and (d) introductory text by revising the expression ''1.4 V_{S1}'' to read ''1.3 V_{SR1}''; and in paragraph (e)(3) by revising the expression ''0.013 V_{S0}^2'' to read ''0.013 V_{SR0}^2.''

§ 25.175 [Amended]

16. Section 25.175 is amended: a. In paragraphs (a)(2), (b)(1) introductory text, (b)(2) introductory text, (b)(3) introductory text and (c)(4) by revising the expression ''1.4 V_{S1}'' to read ''1.3 V_{SR1}'';

b. In paragraph (b)(2)(ii) by revising the expression ''V_{MO} + 1.4 V_{S1}/2'' to read ''(V_{MO} + 1.3 V_{SR1})/2'';

c. In paragraph (c) introductory text by revising the expressions ''1.1 V_{S1}'' to read ''V_{SW}'' and ''1.8 V_{S1}'' to read ''1.7 V_{SR1}'';

d. In paragraph (d) introductory text by revising the expressions ''1.1 V_{SO}'' to read ''V_{SW}'' and ''1.3 V_{S0}'' to read ''1.7 V_{SR0}''; and

e. In paragraph (d)(5) by revising the expression ''1.4 V_{S0}'' to read ''1.3 V_{SR0}.''

§ 25.177 [Amended]

17. Section 25.177 is amended in paragraph (c) by revising the expression ''1.2 V_{S1}'' to read ''1.13 V_{SR1}.''

§ 25.181 [Amended]

18. Section 25.181 is amended in paragraphs (a) introductory text and (b) by revising the reference to ''1.2 V_S'' to read ''1.13 V_{SR}.''

19. Section 25.201 is amended by revising paragraphs (a)(2) and (b)(4) to read as follows:

§ 25.201 Stall demonstration.

(a) * * *

(2) The power necessary to maintain level flight at 1.5 V_{SR1} (where V_{SR1} corresponds to the reference stall speed at maximum landing weight with flaps in the approach position and the landing gear retracted).

(b) * * *

(4) The airplane trimmed for straight flight at the speed prescribed in § 25.103(b)(6).

* * * * *

20. Section 25.207 is amended by revising paragraphs (b) and (c), and by adding new paragraphs (d), (e), and (f) to read as follows:

§ 25.207 Stall warning.

* * * * *

(b) The warning must be furnished either through the inherent aerodynamic qualities of the airplane or by a device that will give clearly distinguishable indications under expected conditions of flight. However, a visual stall warning device that requires the attention of the crew within the cockpit is not acceptable by itself. If a warning device is used, it must provide a warning in each of the airplane configurations prescribed in paragraph (a) of this section at the speed prescribed in paragraphs (c) and (d) of this section.

(c) When the speed is reduced at rates not exceeding one knot per second, stall warning must begin, in each normal configuration, at a speed, V_{SW}, exceeding the speed at which the stall is identified in accordance with § 25.201(d) by not less than five knots or five percent CAS, whichever is greater. Once initiated, stall warning must continue until the angle of attack is reduced to approximately that at which stall warning began.

(d) In addition to the requirement of paragraph (c) of this section, when the speed is reduced at rates not exceeding one knot per second, in straight flight with engines idling and at the center-of-gravity position specified in § 25.103(b)(5), V_{SW}, in each normal configuration, must exceed V_{SR} by not less than three knots or three percent CAS, whichever is greater.

(e) The stall warning margin must be sufficient to allow the pilot to prevent stalling (as defined in § 25.201(d)) when recovery is initiated not less than one second after the onset of stall warning in slow-down turns with at least 1.5g load factor normal to the flight path and airspeed deceleration rates of at least 2 knots per second, with the flaps and landing gear in any normal position, with the airplane trimmed for straight flight at a speed of 1.3 V_{SR}, and with the power or thrust necessary to maintain level flight at 1.3 V_{SR}.

(f) Stall warning must also be provided in each abnormal configuration of the high lift devices that is likely to be used in flight following system failures (including all configurations covered by Airplane Flight Manual procedures).

§ 25.231 [Amended]

21. Section 25.231 is amended in paragraph (a)(2) by revising the word ''altitude'' to read ''attitude'' and by revising the expression ''80 percent of V_{S1}'' to read ''75 percent of V_{SR1}.''

§ 25.233 [Amended]

22. Section 25.233 is amended in paragraph (a) by revising the reference ''0.2 V_{S0}'' to read ''0.2 V_{SR0}.''

§ 25.237 [Amended]

23. Section 25.237 is amended in paragraphs (a), (b)(1), and (b)(2) by revising the reference ''0.2 V_{S0}'' to read ''0.2 V_{SR0}.''

24. Section 25.735 is amended by revising paragraphs (f)(2) and (g) to read as follows:

§ 25.735 Brakes and braking systems.

* * * * *

(f) * * *

(2) Instead of a rational analysis, the kinetic energy absorption requirements for each main wheel-brake assembly may be derived from the following formula, which must be modified in cases of designed unequal braking distributions.

$$KE = \frac{0.0443WV^2}{N}$$

where—

KE = Kinetic energy per wheel (ft.-lb.);

W = Design landing weight (lb.);

V = V_{REF}/1.3

VREF = Airplane steady landing approach speed, in knots, at the maximum design landing weight and in the landing configuration at sea level; and

N = Number of main wheels with brakes.

* * * * *

(g) In the landing case, the minimum speed rating of each main wheel-brake assembly (that is, the initial speed used in the dynamometer tests) may not be more than the V used in the determination of kinetic energy in accordance with paragraph (f) of this section, assuming that the test procedures for wheel-brake assemblies involve a specified rate of deceleration, and, therefore, for the same amount of kinetic energy, the rate of energy absorption (the power absorbing ability of the brake) varies inversely with the initial speed.

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§ 25.773 [Amended]

25. Section 25.773 is amended in paragraph (b)(1)(i) by revising the expression ''1.6 V_{S1}'' to read ''1.5 V_{SR1}.''

§ 25.1001 [Amended]

26. Section 25.1001 is amended in paragraphs (c)(1) and (c)(3) by revising the expression ''1.4 V_{S1}'' to read ''1.3 V_{SR1}.''

§ 25.1323 [Amended]

27. Section 25.1323 is amended in paragraph (c)(1) by revising the expression ''1.3 V_{S1}'' to read ''1.23 V_{SR1}'' and in paragraph (c)(2) by revising the expression ''1.3 V_{S0}'' to read ''1.23 V_{SR0}.''

§ 25.1325 [Amended]

28. Section 25.1325 is amended in paragraph (e) by revising the expressions ''1.3 V_{S0}'' and ''1.8 V_{S1}'' to read ''1.23 V_{SR0}'' and ''1.7 V_{SR1},'' respectively.

§ 25.1587 [Amended]

29. Section 25.1587 is amended by in paragraph (b)(2) by revising the expression ''V_S'' to read ''V_{SR}.''

PART 97—STANDARD INSTRUMENT APPROACH PROCEDURES

30. The authority citation for part 97 is revised to read as follows:

Authority: 49 U.S.C. 106(g), 40103, 40106, 40113, 40114, 40120, 44502, 44514, 44701, 44719, 44721–44722.

31. Section 97.3 is amended by revising the first two sentences of paragraph (b) introductory text to read as follows:

§ 97.3 Symbols and terms used in procedures.

* * * * *

(b) Aircraft approach category means a grouping of aircraft based on a speed of V_{REF}, if specified, or if V_{REF} is not specified, 1.3 V_{S0} at the maximum certificated landing weight. V_{REF}, V_{S0}, and the maximum certificated landing weight are those values as established for the aircraft by the certification authority of the country of registry. * * *

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Issued in Washington, DC on November 14, 2002.

Marion C. Blakey,

Administrator.

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