INTERNATIONAL

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Standard Specification for Performance of Aircraft[1]

This standard is issued under the fixed designation F3179/F3179M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε^1 NOTE—A correction was made in 8.2 editorially in February 2022.

1. Scope

1.1 This specification covers the airworthiness design standards associated with general aeroplane performance. The material was developed through open consensus of international experts in general aviation. This information was created by focusing on Normal Category aeroplanes. The content may be more broadly applicable; it is the responsibility of the Applicant to substantiate broader applicability as a specific means of compliance. The topics covered within this specification are: Stalling, Takeoff and Landing Speeds; Takeoff Performance, Distances and Path; Climb; Landing Performance and Distances; Balked Landing.

1.2 An applicant intending to propose this information as Means of Compliance for a design approval must seek guidance from their respective oversight authority (for example, published guidance from applicable civil aviation authorities (CAAs)) concerning the acceptable use and application thereof. For information on which oversight authorities have accepted this standard (in whole or in part) as an acceptable Means of Compliance to their regulatory requirements (hereinafter "the Rules"), refer to ASTM Committee F44 webpage (www.astm.org/COMMITTEE/F44.htm).

1.3 *Units*—This specification may present information in either SI units, English Engineering units, or both. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F3060 Terminology for Aircraft

F3064/F3064M Specification for Aircraft Powerplant Control, Operation, and Indication

F3083/F3083M Specification for Emergency Conditions, Occupant Safety and Accommodations

F3173/F3173M Specification for Aircraft Handling Characteristics

F3174/F3174M Specification for Establishing Operating Limitations and Information for Aeroplanes

3. Terminology

3.1 Refer to Terminology F3060.

3.2 In addition, the following definitions apply only in the context of this standard:

3.2.1 *loss of thrust*—for conventional aeroplanes (reciprocating or turbine engine-powered), loss of thrust means one engine inoperative. For other aeroplanes, the amount of thrust loss shall be proposed by the applicant and accepted by the CAA.

3.2.2 V_R—rotation speed is the speed at which the pilot makes a control input with the intention of lifting the aeroplane out of contact with the runway or water surface.

4. Performance Data

4.1 Unless otherwise prescribed, the performance requirements of this specification shall be met for still air and standard atmosphere; and

4.1.1 **For Level 1 and 2 high-speed aeroplanes and all Level 3 and 4 aeroplanes**, ambient atmospheric conditions within the operating envelope.

[1] This specification is under the jurisdiction of ASTM Committee F44 on General Aviation Aircraft and is the direct responsibility of Subcommittee F44.20 on Flight.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

4.2 **For all aeroplanes, except for aeroplanes with $V_{S0} \leq$ 45 KCAS**, performance data shall be determined over not less than the following conditions:

4.2.1 Airport altitude from sea level to 3048 m [10 000 ft];

4.2.2 The temperature from standard (ISA) to 30 °C [54 °F] above standard (ISA +30 °C [ISA +54 °F]) or the maximum ambient atmospheric temperature at which compliance with the cooling provisions of Specification F3064/F3064M is shown, if lower;

4.2.3 Any temperature lower than standard (ISA) and within the operating limitations established for the aeroplane at which takeoff or landing speeds or distances are higher, or climb gradients are lower, than at standard (ISA).

4.3 Performance data shall be determined with any means for controlling the engine cooling air supply (for example, cowl flaps) in the position used in the engine cooling tests;

4.4 The available propulsive thrust shall correspond to engine power, not exceeding the approved power, less:

4.4.1 Installation losses.

4.4.2 The power absorbed by the accessories and services appropriate to the particular ambient atmospheric conditions and the particular flight condition.

4.5 The performance, as affected by engine power or thrust, shall be based on a relative humidity:

4.5.1 Of 80 % at and below standard temperature.

4.5.2 From 80 % at the standard temperature (ISA), varying linearly down to 34 % at 28 °C [50 °F] above standard (ISA +28 °C [ISA +50 °F]).

4.6 Unless otherwise prescribed in determining the takeoff and landing distances, changes in the aeroplane's configuration, speed, and power shall be made in accordance with procedures established by the applicant for operation in service. These procedures shall be able to be executed consistently by pilots of average skill in atmospheric conditions reasonably expected to be encountered in service.

4.7 Takeoff and landing distances, takeoff run, and accelerate-stop distances, as applicable, shall be determined on a smooth, dry, hard-surfaced runway.

4.7.1 The effect on these distances of operation on other types of surfaces (for example, grass and gravel) when dry, may be determined or derived, and these surfaces listed in the aeroplane flight manual in accordance with Specification F3174/F3174M.

4.8 **For Level 3 and Level 4 high-speed multiengine aeroplanes**, the following also apply:

4.8.1 Unless otherwise prescribed, the applicant shall select the takeoff, en route, approach, and landing configurations for the aeroplane;

4.8.2 The aeroplane configuration may vary with weight, altitude, and temperature to the extent they are compatible with the operating procedures required by 4.8.3;

4.8.3 Unless otherwise prescribed, in determining the takeoff performance, takeoff flight path, and the accelerate-stop distance, all with a critical loss of thrust, changes in the aeroplane configuration, speed, and power shall be made in accordance with procedures established by the applicant for operation in service;

4.8.4 Procedures for the execution of discontinued approaches and balked landings associated with the conditions prescribed in 7.3.3.4 and 7.4.3 shall be established;

4.8.5 The procedures established under 4.8.3 and 4.8.4 shall:

4.8.5.1 Be able to be consistently executed by a crew of average skill in atmospheric conditions reasonably expected to be encountered in service,

4.8.5.2 Use methods or devices that are safe and reliable;

4.8.5.3 Include allowance for any reasonably expected time delays in the execution of the procedures.

5. Stall Speed

5.1 V_{S0} and V_{S1} are the stalling speeds or the minimum steady flight speeds in knots (KCAS) at which the aeroplane is controllable with:

5.1.1 The propulsive thrust not greater than zero at the stalling speed, or, if the resultant thrust has no appreciable effect on the stalling speed, with engine(s) at minimum flight thrust and throttle(s) closed with:

5.1.1.1 The propeller(s) in the takeoff position;

5.1.1.2 The aeroplane in the configuration existing in the test, in which V_{S0} and V_{S1} are being used;

5.1.1.3 The center of gravity in the position that results in the highest value of V_{S0} and V_{S1};

5.1.1.4 The weight used when V_{S0} or V_{S1} are being used as a factor to determine compliance with a required performance standard.

5.2 V_{S0} and V_{S1} shall be determined by flight tests using the procedure and meeting the flight characteristics specified in the appropriate stall handling characteristics testing.

6. Takeoff Performance

6.1 *Takeoff Speeds* (see Table 1):

6.1.1 **For single-engine aeroplanes and Levels 1, 2, and 3 low-speed multiengine aeroplanes**, the following apply to rotation speed, V_R:

6.1.1.1 For Levels 1, 2, and 3 low-speed multiengine landplanes, V_R shall not be less than the greater of 1.05 V_{MC}, determined under Specification F3173/F3173M, or 1.10 V_{S1}.

6.1.1.2 For single-engine landplanes, V_R shall not be less than V_{S1}.

6.1.1.3 For seaplanes and amphibians taking off from water, V_R shall be any speed that is shown to be safe under all reasonably expected conditions, including turbulence and a critical loss of thrust.

6.1.2 **For single-engine aeroplanes and Levels 1, 2, and 3 low-speed multiengine aeroplanes**, the speed at 15 m [50 ft] above the takeoff surface level shall not be less than:

6.1.2.1 For Level 1 single-engine aeroplanes with $V_{S0} \leq 45$ knots, not less than 1.3 V_{S1};

6.1.2.2 For Levels 1, 2, and 3 low-speed multiengine aeroplanes, the highest of:

TABLE 1 Sections with Speed Definitions Applicable for Each Aeroplane

Level	Engines	Speed	V_R	Speed at 50 ft	V_{EF}	V_1	V_2
1	Single	Low	6.1.1.2	$V_{S0} \leq 45$ knots: 6.1.2.1 $V_{S0} > 45$ knots: 6.1.2.3	...	...	...
		High	6.1.1.2	$V_{S0} \leq 45$ knots: 6.1.2.1 $V_{S0} > 45$ knots: 6.1.2.3	...	...	...
	Multi	Low	6.1.1.1	6.1.2.2	...	...	...
		High	6.1.3.4	...	6.1.3.2	6.1.3.3	6.1.3.6
2	Single	Low	6.1.1.2	6.1.2.3	...	...	...
		High	6.1.1.2	6.1.2.3	...	...	...
	Multi	Low	6.1.1.1	6.1.2.2	...	...	...
		High	6.1.3.4	...	6.1.3.2	6.1.3.3	6.1.3.6
3	Single	Low	6.1.1.2	6.1.2.3	...	...	...
		High	6.1.1.2	6.1.2.3	...	...	...
	Multi	Low	6.1.1.1	6.1.2.2	...	...	...
		High	6.1.3.4	...	6.1.3.2	6.1.3.3	6.1.3.6
4	Single	Low	6.1.1.2	6.1.2.3	...	...	...
		High	6.1.1.2	6.1.2.3	...	...	...
	Multi	...	6.1.3.4	...	6.1.3.2	6.1.3.3	6.1.3.6

(a) A speed that is shown to be safe for continued flight (or emergency landing, if applicable) under all reasonable expected conditions, including turbulence and a critical loss of thrust;

(b) 1.10 V_{MC} determined under Specification F3173/F3173M; or

(c) 1.20 V_{S1}.

6.1.2.3 For Level 1 single-engine aeroplanes with a $V_{S0} >$ 45 knots and all Levels 2, 3, and 4 single-engine aeroplanes, the higher of:

(a) A speed that is shown to be safe under all reasonably expected conditions, including turbulence and a critical loss of thrust, or

(b) 1.20 V_{S1}.

6.1.3 **For Levels 1, 2, and 3 high-speed multiengine aeroplanes, and all Level 4 multiengine aeroplanes**, the following apply:

6.1.3.1 The value, V_1, shall be established in relation to V_{EF} in accordance with 6.1.3.2 and 6.1.3.3:

6.1.3.2 The value, V_{EF}, is the calibrated airspeed at which the critical loss of thrust is assumed to occur. The value, V_{EF}, shall be selected by the applicant but shall not be less than 1.05 V_{MC} determined under Specification F3173/F3173M or, at the option of the applicant, not less than V_{MCG} determined under Specification F3173/F3173M.

6.1.3.3 The takeoff decision speed, V_1, is the calibrated airspeed on the ground at which, as a result of a critical loss of thrust or other reasons, the pilot is assumed to have made a decision to continue or discontinue the takeoff. The takeoff decision speed, V_1, shall be selected by the applicant but shall not be less than V_{EF} plus the speed gained with the critical loss of thrust during the time interval between the instant at which the critical loss occurs and the instant at which the pilot recognizes and reacts to the thrust loss, as indicated by the pilot's application of the first retarding means during the accelerate-stop determination of 6.3.

6.1.3.4 The rotation speed, V_R, in terms of calibrated airspeed, shall be selected by the applicant and shall not be less than the greatest of the following:

(a) V_1;

(b) 1.05 V_{MC} determined under Specification F3173/F3173M;

(c) 1.10 V_{S1}; or

(d) The speed that allows attaining the initial climb-out speed, V_2, before reaching a height of 11 m [35 ft] above the takeoff surface in accordance with 6.4.1.3(b).

6.1.3.5 For any given set of conditions, such as weight, altitude, temperature, and configuration, a single value of V_R shall be used to show compliance with both the takeoff after a critical loss of thrust and all-engines-operating takeoff requirements.

6.1.3.6 The takeoff safety speed, V_2, in terms of calibrated airspeed, shall be selected by the applicant so as to allow the gradient of climb required in 7.3 but shall not be less than:

(a) 1.10 V_{MC} determined under Specification F3173/F3173M; or

(b) 1.20 V_{S1}.

6.2 The takeoff performance shall be determined as follows:

6.2.1 **For Level 1 low-speed single-engine aeroplanes with $V_{S0} \leq 45$ knots**, the distance required to takeoff from a dry, level, hard surface and climb over a 15 m [50 ft] obstacle shall not exceed 500 m [1640 ft] in still air, and a standard atmosphere using speeds determined in accordance with 6.1.1 and 6.1.2 at sea level with:

6.2.1.1 The engine(s) operating within approved operating limitations;

6.2.1.2 Any means for controlling the engine cooling air supply (for example, cowl flaps) in the normal takeoff position.

6.2.2 **For all other single-engine aeroplanes and Levels 1, 2, and 3 low-speed multiengine aeroplanes**, the distance that is required to takeoff and climb to a height of 15 m [50 ft] above the takeoff surface shall be determined for each weight, altitude, and temperature within the operational limits established for takeoff using speeds determined in accordance with 6.1.1 and 6.1.2 with:

6.2.2.1 Takeoff power on each engine;

6.2.2.2 Wing flaps in the takeoff position(s);

6.2.2.3 Landing gear extended.

6.2.3 **For Levels 1, 2, and 3 high-speed multiengine aeroplanes and all Level 4 multiengine aeroplanes**, takeoff performance includes the Accelerate-Stop Distance (6.3), Takeoff Path (6.4), and the Takeoff Distance and Takeoff Run (6.5) and shall be determined with the operating engine(s) within approved operating limitations.

6.2.4 **For Levels 1, 2, and 3 high-speed multiengine aeroplanes and all Level 4 multiengine aeroplanes**, the takeoff distance after a critical loss of thrust, using a normal rotation rate at a speed 5 knots less than V_R, established in accordance with 6.1.3.4, shall be shown not to exceed the corresponding takeoff distance after a critical loss of thrust, determined in accordance with 6.4 and 6.5, using the established V_R. The takeoff, otherwise performed in accordance with 6.4, shall be continued safely from the point at which the aeroplane is 11 m [35 ft] above the takeoff surface and at a speed not less than the established V_2 minus 5 knots.

6.2.5 **For Levels 1, 2, and 3 high-speed multiengine aeroplanes and all Level 4 aeroplanes**, the applicant shall show, with all engines operating, that marked increases in the scheduled takeoff distances, determined in accordance with 6.5, do not result from over-rotation of the aeroplane or out-of-trim conditions.

6.3 *Accelerate-Stop Distance:*

6.3.1 **For Levels 1, 2, and 3 high-speed multiengine aeroplanes and all Level 4 multiengine aeroplanes**, the accelerate-stop distance shall be determined as follows:

6.3.1.1 The accelerate-stop distance is the sum of the distances necessary to:

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

(b) Accelerate the aeroplane from V_{EF} to V_1, assuming a critical loss of thrust at V_{EF};

(c) Come to a full stop from the point at which V_1 is reached.

6.3.1.2 Means other than wheel brakes may be used to determine the accelerate-stop distances if that means it is:

(a) Safe and reliable,

(b) Used so that consistent results can be expected under normal operating conditions,

(c) Such that exceptional skill is not required to control the aeroplane.

6.4 *Takeoff Path:*

6.4.1 **For Levels 1, 2, and 3 high-speed multiengine aeroplanes and all Level 4 multiengine aeroplanes**, the takeoff path is as follows:

6.4.1.1 The takeoff path extends from a standing start to a point in the takeoff at which the aeroplane is 457 m [1500 ft] above the takeoff surface at or below which height the transition from the takeoff to the en-route configuration shall be completed.

(a) The takeoff path shall be based on the procedures prescribed in Section 4;

(b) The aeroplane shall be accelerated on the ground to V_{EF} at which point the critical loss of thrust occurs and remains lost for the rest of the takeoff;

(c) After reaching V_{EF}, the aeroplane shall be accelerated to V_2.

6.4.1.2 During the acceleration to speed, V_2, the nose gear may be raised off the ground at a speed not less than V_R. However, landing gear retraction shall not be initiated until the aeroplane is airborne.

6.4.1.3 During the takeoff path determination, in accordance with 6.4.1.1 and 6.4.1.2:

(a) The slope of the airborne part of the takeoff path shall not be negative at any point;

(b) The aeroplane shall reach V_2 before it is 11 m [35 ft] above the takeoff surface and shall continue at a speed as close as practical to, but not less than V_2, until it is 122 m [400 ft] above the takeoff surface;

(c) At each point along the takeoff path, starting at the point at which the aeroplane reaches 122 m [400 ft] above the takeoff surface, the available gradient of climb must not be less than 1.2 %;

(d) Except for gear retraction and automatic propeller feathering, the aeroplane configuration shall not be changed, and no change in power that requires action by the pilot shall be made, until the aeroplane is 122 m [400 ft] above the takeoff surface.

6.4.1.4 The takeoff path to 11 m [35 ft] above the takeoff surface shall be determined by a continuous demonstrated takeoff.

6.4.1.5 The takeoff path from 11 m [35 ft] above the takeoff surface shall be determined by synthesis from segments.

(a) The segments shall be clearly defined and related to distinct changes in configuration, power, and speed;

(b) The weight of the aeroplane, the configuration, and the power shall be assumed constant throughout each segment and shall correspond to the most critical condition prevailing in the segment;

(c) The takeoff flight path shall be based on the aeroplane's performance without using ground effect.

6.5 *Takeoff Distance and Takeoff Run:*

6.5.1 **For Levels 1, 2, and 3 high-speed multi-engine aeroplanes and all Level 4 multiengine aeroplanes**, the takeoff distance and, at the option of the applicant, the takeoff run, shall be determined.

6.5.1.1 Takeoff distance is the greater of:

(a) The horizontal distance along the takeoff path from the start of the takeoff to the point at which the aeroplane is 11 m [35 ft] above the takeoff surface as determined under 6.4, or

(b) With all engines operating, 115 % of the horizontal distance from the start of the takeoff to the point at which the aeroplane is 11 m [35 ft] above the takeoff surface determined by a procedure consistent with 6.4.

6.5.1.2 If the takeoff distance includes a clearway, the takeoff run is the greater of:

(a) The horizontal distance along the takeoff path from the start of the takeoff to a point equidistant between the liftoff point and the point at which the aeroplane is 11 m [35 ft] above the takeoff surface as determined under 6.4, or

(b) With all engines operating, 115 % of the horizontal distance from the start of the takeoff to a point equidistant between the liftoff point and the point at which the aeroplane

is 11 m [35 ft] above the takeoff surface determined by a procedure consistent with 6.4.

6.6 *Takeoff Flight Path:*

6.6.1 **For Levels 1, 2, and 3 high-speed multiengine and all Level 4 multiengine aeroplanes**, the takeoff flight path shall be determined as follows:

6.6.1.1 The takeoff flight path begins 11 m [35 ft] above the takeoff surface at the end of the takeoff distance determined in accordance with 6.5.

6.6.1.2 The net takeoff flight path data shall be determined so that they represent the actual takeoff flight paths as determined in accordance with 6.4 and with 6.6.1.1 reduced at each point by a gradient of climb equal to 0.8 %.

6.6.1.3 The prescribed reduction in climb gradient may be applied as an equivalent reduction in acceleration along that part of the takeoff flight path at which the aeroplane is accelerated in level flight.

7. Climb Requirements

7.1 Unless otherwise specified, compliance with the climb requirements shall be shown:

7.1.1 Out-of-ground effect;

7.1.2 At speeds that are not less than those at which compliance with the powerplant cooling requirements has been demonstrated.

7.1.3 With critical loss of thrust at a bank angle not exceeding 5°.

7.1.4 **For Level 1 and 2 low-speed aeroplanes**, at maximum takeoff or landing weight, as appropriate, in a standard atmosphere.

7.1.5 **For Level 1 and 2 high-speed aeroplanes and all Level 3 and 4 aeroplanes**, weights as a function of airport altitude and ambient temperature within the operational limits established for takeoff and landing, respectively.

7.2 Climb with all engines operating.

7.2.1 **Level 1 low-speed aeroplanes with a $V_{S0} \leq 45$ knots** shall meet a climb gradient of at least 8.3 % at sea level for landplanes and 6.7 % for seaplanes and amphibians with:

7.2.1.1 Not more than takeoff power;

7.2.1.2 Landing gear retracted;

7.2.1.3 Wing flaps in the takeoff position(s);

7.2.1.4 Any means for controlling the engine cooling air supply (for example, cowl flaps) in the position used in the cooling tests.

7.2.2 **Level 1 low-speed aeroplanes with a $V_{S0} > 45$ knots and Level 2 low-speed aeroplanes** shall meet a climb gradient of at least 8.3 % at sea level for landplanes and 6.7 % for seaplanes and amphibians with:

7.2.2.1 Not more than maximum continuous power on each engine;

7.2.2.2 The landing gear retracted;

7.2.2.3 The wing flaps in the takeoff position(s);

7.2.2.4 A climb speed not less than the greater of 1.1 V_{MC}, determined under Specification F3173/F3173M, and 1.2 V_{S1} for multiengine aeroplanes and not less than 1.2 V_{S1} for single-engine aeroplanes.

7.2.3 **Level 1 and 2 high-speed aeroplanes, all Level 3 aeroplanes, and Level 4 single-engine aeroplanes** shall have a steady gradient of climb after takeoff of at least 4 % with:

7.2.3.1 Takeoff power on each engine;

7.2.3.2 The landing gear extended, except that if the landing gear can be retracted in not more than 7 s, the test may be conducted with the gear retracted;

7.2.3.3 The wing flaps in the takeoff position(s);

7.2.3.4 A climb speed as specified in 7.2.2.4.

7.3 *Climb after Partial Loss of Thrust:*

7.3.1 **For Levels 1 and 2 low-speed multiengine aeroplanes**, the following apply:

7.3.1.1 Aeroplanes that do not meet single-engine crashworthiness requirements, in accordance with Specification F3083/F3083M, shall be able to maintain a steady climb gradient of at least 1.5 % at a pressure altitude of 1524 m [5000 ft] with the:

(a) Critical loss of thrust including any propulsive drag changes that are rapidly assumed, if applicable;

(b) Remaining engine(s) at not more than maximum continuous power;

(c) Landing gear retracted;

(d) Wing flaps retracted;

(e) Climb speed not less than 1.2 V_{S1}.

7.3.1.2 For aeroplanes that meet single-engine crashworthiness requirements, in accordance with Specification F3083/F3083M, the steady gradient of climb or descent at a pressure altitude of 1524 m [5000 ft] shall be determined with the:

(a) Critical loss of thrust including any propulsive drag changes that are rapidly assumed, if applicable;

(b) Remaining engine(s) at not more than maximum continuous power;

(c) Landing gear retracted;

(d) Wing flaps retracted;

(e) Climb speed not less than 1.2 V_{S1}.

7.3.2 **For Levels 1 and 2 high-speed multiengine aeroplanes and Level 3 low-speed multiengine aeroplanes**:

7.3.2.1 The steady gradient of climb at an altitude of 122 m [400 ft] above the takeoff shall be no less than 1 % with the:

(a) Critical loss of thrust including any propulsive drag changes that are rapidly assumed, if applicable;

(b) Remaining engine(s) at takeoff power;

(c) Landing gear retracted;

(d) Wing flaps in the takeoff position(s);

(e) Climb speed equal to that achieved at 15 m [50 ft] in the demonstration of 6.4.

7.3.2.2 The steady gradient of climb shall not be less than 0.75 % at an altitude of 457 m [1500 ft] above the takeoff surface or landing surface, as appropriate, with the:

(a) Critical loss of thrust including any propulsive drag changes that are rapidly assumed, if applicable;

(b) Remaining engine(s) at not more than maximum continuous power

(c) Landing gear retracted;

(d) Wing flaps retracted;

(e) Climb speed not less than 1.2 V_{S1}.

7.3.3 **For Level 3 high-speed multiengine aeroplanes and all Level 4 multiengine aeroplanes**, the following apply:

7.3.3.1 *Takeoff—Landing Gear Extended*—The steady gradient of climb at the altitude of the takeoff surface shall be measurably positive with:

(a) The critical loss of thrust including any propulsive drag changes that are rapidly and automatically assumed, if applicable;

(b) The remaining engine(s) at takeoff power;

(c) The landing gear extended and all landing gear doors open;

(d) The wing flaps in the takeoff position(s);

(e) The wings level;

(f) A climb speed equal to V_2.

7.3.3.2 *Takeoff—Landing Gear Retracted*—The steady gradient of climb at an altitude of 122 m [400 ft] above the takeoff surface shall not be less than 2.0 % with:

(a) The critical loss of thrust including any propulsive drag changes that are rapidly and automatically assumed, if applicable;

(b) The remaining engine(s) at takeoff power;

(c) The landing gear retracted;

(d) The wing flaps in the takeoff position(s);

(e) A climb speed equal to V_2.

7.3.3.3 *En Route*—The steady gradient of climb at an altitude of 457 m [1500 ft] above the takeoff or landing surface, as appropriate, shall be not less than 1.2 % with:

(a) The critical loss of thrust including any propulsive drag changes that are rapidly assumed, if applicable;

(b) The remaining engine(s) at not more than maximum continuous power;

(c) The landing gear retracted;

(d) The wing flaps retracted;

(e) A climb speed not less than 1.2 V_{S1}.

7.3.3.4 *Discontinued Approach*—The steady gradient of climb at an altitude of 122 m [400 ft] above the landing surface shall be no less than 2.1 % with:

(a) The critical loss of thrust including any propulsive drag changes that are rapidly assumed, if applicable;

(b) The remaining engine(s) at takeoff power;

(c) Landing gear retracted;

(d) Wing flaps in the approach position(s) in which V_{S1} for these position(s) does not exceed 110 % of the V_{S1} for the related all-engines-operating landing position(s);

(e) A climb speed established in connection with normal landing procedures but not exceeding 1.5 V_{S1}.

7.4 *Balked Landing:*

7.4.1 **Level 1 and 2 low-speed aeroplanes with $V_{SO} \leq$ 45 knots** shall be able to maintain either:

7.4.1.1 A steady climb gradient at sea level of at least 3.0 % with:

(a) Takeoff power;

(b) Landing gear extended;

(c) Wing flaps in the landing position, except that if the flaps may be safely retracted in 2 s or less, without loss of altitude and without sudden changes of angle of attack or exceptional piloting skill, they may be retracted;

(d) A climb speed equal to V_{REF} appropriate for the configuration; or

7.4.1.2 Level flight at an altitude of 915 m [3000 ft] and at a speed at which the balked landing transition has been shown to be safe with:

(a) Takeoff power;

(b) Landing gear extended;

(c) Wing flaps in the landing position, except that if the flaps may be safely retracted in 2 s or less, without loss of altitude and without sudden changes of angle of attack or exceptional piloting skill, they may be retracted.

(d) A climb speed equal to V_{REF} appropriate for the configuration.

7.4.2 **Level 1 and 2 low-speed aeroplanes with V_{S0} > 45 knots** shall be able to maintain a steady gradient of climb at sea level of at least 3.0 % with:

7.4.2.1 Not more than the power that is available on each engine 8 s after initiation of movement of the power controls from the minimum flight idle position;

7.4.2.2 Landing gear extended;

7.4.2.3 Wing flaps in the landing position, except that if the flaps may safely be retracted in 2 s or less without loss of altitude and without sudden changes of angle of attack or exceptional piloting skill, they may be retracted;

7.4.2.4 Climb speed equal to V_{REF} appropriate for the configuration.

7.4.3 **Levels 1 and 2 high-speed aeroplanes and all Levels 3 and 4 aeroplanes** shall be able to maintain a steady gradient of climb of at least 3.0 % with:

7.4.3.1 Not more than the power that is available on each engine 8 s after initiation of movement of the power controls from the minimum flight idle position;

7.4.3.2 The landing gear extended;

7.4.3.3 The wing flaps in the landing position;

7.4.3.4 A climb speed equal to V_{REF} appropriate for the configuration.

8. Climb Information

8.1 The climb performance shall be determined:

8.1.1 **For Level 3 low-speed multiengine aeroplanes**, the steady gradient of climb or descent at each weight, altitude, and ambient temperature within the operational limits established by the applicant with:

8.1.1.1 The critical loss of thrust, including any propulsive drag changes that are rapidly and automatically assumed;

8.1.1.2 The remaining engine(s) at takeoff power;

8.1.1.3 The landing gear extended, except that if the landing gear can be retracted in not more than 7 s, the test may be conducted with the gear retracted;

8.1.1.4 The wing flaps in the takeoff position(s);

8.1.1.5 The wings level;

8.1.1.6 A climb speed equal to that achieved at 15 m [50 ft] in the demonstration of 6.2.

8.2 For the all engines operating condition, the steady gradient and rate of climb shall be determined at each weight, altitude, and ambient temperature within the operational limits established by the applicant with:

8.2.1 Not more than maximum continuous power on each engine;

8.2.2 The landing gear retracted;

8.2.3 The wing flaps retracted;

8.2.4 A climb speed not less than 1.3 V_{S1}.

8.3 **For all multiengine aeroplanes**, for a critical loss of thrust condition, the steady gradient and rate of climb/descent shall be determined at each weight, altitude, and ambient temperature within the operational limits established by the applicant with:

8.3.1 The critical loss of thrust including any propulsive drag changes that are rapidly assumed;

8.3.2 The remaining engine(s) at no more than maximum continuous power,

8.3.3 The landing gear retracted;

8.3.4 The wing flaps retracted;

8.3.5 A climb speed not less than 1.2 V_{S1}.

8.4 **For all single-engine aeroplanes**, the maximum horizontal distance travelled in still air, in kilometres per 1000 m [nautical miles per 1000 ft] of altitude lost in a glide, and the speed necessary to achieve this shall be determined with the engine inoperative and the engine and aeroplane in the best glide configuration.

9. Landing

9.1 The landing distance is the horizontal distance necessary to land and come to a complete stop (or to a speed of approximately 5.6 km/h [3 knots] for water landings of seaplanes and amphibians) from a point 15 m [50 ft] above the landing surface.

9.2 The landing distance shall be determined, for standard temperatures at each weight and altitude within the operational limits established for landing, as follows:

9.2.1 A steady approach at not less than V_{REF}, determined in accordance with 9.3, as appropriate, shall be maintained down to the 15 m [50 ft] height:

9.2.1.1 The steady approach shall be at a gradient of descent not greater than 5.2 % (3°) down to the 15 m [50 ft] height;

9.2.1.2 In addition, an applicant may demonstrate by tests that a maximum steady approach gradient steeper than 5.2 % (3°), down to the 15 m [50 ft] height, is safe. The gradient shall be established as an operating limitation and the information necessary to display the gradient shall be available to the pilot by an appropriate instrument.

9.2.2 A constant configuration shall be maintained throughout the maneuver.

9.2.3 The landing shall be made without excessive vertical acceleration or tendency to bounce, nose over, ground loop, porpoise, or water loop.

9.2.4 It shall be shown that a safe transition to the balked landing conditions of 7.4 can be made from the conditions that exist at the 15 m [50 ft] height, at maximum landing weight, or at the maximum landing weight for altitude and temperature of 7.3 and 7.4, as appropriate.

9.2.5 The brakes shall be used so as to not cause excessive wear of brakes or tires.

9.2.6 Retardation means other than wheel brakes may be used if that means:

9.2.6.1 Is safe and reliable;

9.2.6.2 Is used so that consistent results can be expected in service.

9.2.7 If any device is used that depends on the operation of any engine, and the landing distance would be increased when a landing is made with that engine inoperative, the landing distance shall be determined with that engine inoperative unless the use of other compensating means will result in a landing distance not more than that with each engine operating.

9.3 The Reference Landing Approach Speed, V_{REF}, shall be determined by the applicant.

9.3.1 **For Levels 1 and 2 low-speed aeroplanes**, the reference landing approach speed, V_{REF}, shall not be less than the greater of:

9.3.1.1 V_{MC} with the wing flaps in the most extended takeoff position determined under Specification F3173/F3173M;

9.3.1.2 1.3 V_{S1}.

9.3.2 **For Levels 1 and 2 high-speed aeroplanes and Level 3 low-speed aeroplanes**, the reference landing approach speed, V_{REF}, shall not be less than the greater of:

9.3.2.1 V_{MC} in the landing configuration determined under Specification F3173/F3173M;

9.3.2.2 1.3 V_{S1}.

9.3.3 **For Level 3 high-speed aeroplanes and all Level 4 aeroplanes**, the reference landing approach speed, V_{REF}, shall not be less than the greater of:

9.3.3.1 1.05 V_{MC} in the landing configuration determined under Specification F3173/F3173M;

9.3.3.2 1.3 V_{S1}.

10. Keywords

10.1 aeroplane; aeroplane performance; airworthiness