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Standard Specification for Low-Speed Flight Characteristics of Aeroplanes[1]

This standard is issued under the fixed designation F3180/F3180M; 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.

1. Scope

1.1 This specification will cover the flight characteristics of aeroplanes at low speed and provide standards for departure characteristics, spinning, and stall warning.

1.2 This specification establishes the airworthiness design requirements associated with low-speed aeroplane flight characteristics.

1.3 The applicant for a design approval shall seek the individual guidance to their respective civil aviation authority (CAA) body concerning the use of this specification as part of a certification plan. For information on which CAA regulatory bodies have accepted this specification (in whole or in part) as a means of compliance to their small aircraft airworthiness regulations (hereinafter referred to as "the Rules"), refer to ASTM Committee F44 webpage (www.astm.org/COMMITTEE/F44.htm), which includes CAA website links.

1.4 This specification is applicable to small aeroplanes.

1.5 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

1.6 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F3060 Terminology for Aircraft

F3173/F3173M Specification for Handling Characteristics of Aeroplanes

F3179/F3179M Specification for Performance of Aeroplanes

3. Terminology

3.1 See Terminology F3060 for more definitions and abbreviations.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *ball width*—a displacement on a standardized slip-skip indicator that corresponds to a lateral acceleration of tan $(4\pi/180) = 0.07$ G = 0.7 m/s^2 [2.3 ft/s^2].

3.2.2 *directional control*—cockpit control that is intended for, but not necessarily limited to, generation of aircraft yaw motion.

3.2.3 *lateral control*—cockpit control that is intended for, but not necessarily limited to, generation of aircraft roll motion.

3.2.4 *longitudinal control*—cockpit control that is intended for, but not necessarily limited to, generation of aircraft pitch motion.

4. Low-Speed Characteristics

4.1 *Stall:*

4.1.1 *Wings-Level Stall:*

4.1.1.1 *Primary Flight Control Behavior:*

(1) For single engine low-speed Level 1 aeroplanes with $V_{S0} \leq 45$ knots that have interconnected lateral and directional controls, it shall be possible to produce and correct roll by unreversed use of the lateral control without producing excessive yaw, up to the time the aeroplane stalls.

(2) For all other Level 1 aeroplanes, and all Level 2, 3, and 4 aeroplanes, it shall be possible to produce and correct roll by unreversed use of the lateral control and to produce and correct yaw by unreversed use of the directional control up to the time the aeroplane stalls.

4.1.1.2 The wings-level stall characteristics shall be demonstrated in flight as follows. Starting from a speed at least 18.5 km/h [10 knots] above the stall speed, the longitudinal control shall be pulled back so that the rate of speed reduction will not exceed 1.9 (km/h)/s [1 knot/s] until a stall is produced, as shown by either:

(1) An uncontrollable downward pitching motion of the aeroplane,

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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.

(2) A downward pitching motion of the aeroplane that results from the activation of a stall avoidance device (for example, stick pusher activation), or

(3) The longitudinal control reaching the stop.

4.1.1.3 Normal use of longitudinal control for recovery is allowed after the downward pitching motion from 4.1.1.2(*1*) or 4.1.1.2(*2*) has unmistakably been produced, or the longitudinal control has been held against the stop for not less than the longer of 2 s or the time used in the minimum steady flight speed determination discussed in Specification F3179/F3179M.

4.1.1.4 During the entry into and the recovery from stalls performed below 7620 m [25 000 ft], it shall be possible to prevent more than 15° of roll or yaw by the normal use of controls.

4.1.1.5 For aeroplanes approved for a maximum operating altitude at or above 7620 m [25 000 ft], during the entry into and the recovery from stalls performed at or above 7620 m [25 000 ft], it shall be possible to prevent more than 25° of roll or yaw by the normal use of controls.

4.1.1.6 Compliance with these requirements shall be shown under the following conditions:

(1) Wing Flaps—Retracted, fully extended, and each intermediate normal operating position as appropriate for the phase of flight;

(2) Landing Gear—Retracted and extended as appropriate for the phase of flight and altitude;

(3) Cowl Flaps—Appropriate to configuration;

(4) Spoilers/Speed Brakes—Retracted and extended unless they have no measurable effect at low speeds, or in their appropriate position if they are automatically actuated as part of normal operations;

(5) Power/thrust idle;

(6) Power/Thrust On—Depending on engine type, one of the following applies:

(a) For Reciprocating Engine Powered Aeroplanes—Seventy-five percent of maximum continuous power. However, if the power-to-weight ratio at 75 % of maximum continuous power results in nose-high attitudes exceeding 30°, the test may be carried out with the power required for level flight in the landing configuration at maximum landing weight and a speed of 1.4 V_{S0}, except that the power may not be less than 50 % of maximum continuous power; or

(b) For Turbine Engine Powered Aeroplanes—At maximum engine thrust, except that it need not exceed the thrust necessary to maintain level flight at 1.5 V_{S1} (where V_{S1} corresponds to the stalling speed with flaps in the approach position, the landing gear retracted, and maximum landing weight);

(7) Trim—The aeroplane trimmed at 1.5 V_{S1} or the minimum trim speed, whichever is higher; and

(8) Propeller—Full increase revolutions per minute (rpm) position for the idle condition.

4.1.2 *Turning Flight and Accelerated Turning Stalls:*

4.1.2.1 Turning flight and accelerated turning stalls shall be demonstrated by establishing and maintaining a coordinated turn in a 30° bank. The speed should be steadily reduced while progressively tightening the turn with the longitudinal control until the aeroplane is stalled. The rate of speed reduction shall be constant and:

(1) For a turning flight stall, may not exceed 1.9 (km/h)/s [1 knot/s], and

(2) For an accelerated turning stall, 5.6 to 9.3 (km/h)/s [3 to 5 knots/s] with steadily increasing normal acceleration.

4.1.2.2 After the aeroplane has stalled, as defined in 4.1.1.2, it shall be possible to regain wings-level flight by normal use of the flight controls but without increasing power and without:

(1) Excessive loss of altitude,

(2) Undue pitch-up,

(3) Uncontrollable tendency to spin,

(4) Exceeding a bank angle of 60° in the original direction of the turn or 30° in the opposite direction in the case of turning flight stalls,

(5) Exceeding a bank angle of 90° in the original direction of the turn or 60° in the opposite direction in the case of accelerated turning stalls, and

(6) Exceeding the maximum permissible speed or allowable limit load factor.

4.1.2.3 Compliance with 4.1.2 shall be shown under the following conditions:

(1) Wing Flaps—Retracted, fully extended, and each intermediate normal operating position as appropriate for the phase of flight.

(2) Landing Gear—Retracted and extended as appropriate for the phase of flight and altitude;

(3) Cowl Flaps—Appropriate to configuration;

(4) Spoilers/Speed Brakes—Retracted and extended unless they have no measurable effect at low speeds, or in their appropriate position if they are automatically actuated as part of normal operations;

(5) Power/thrust idle;

(6) Power/Thrust On—Depending on engine type, one of the following applies:

(a) For Reciprocating Engine Powered Aeroplanes—Seventy-five percent of maximum continuous power. However, if the power-to-weight ratio at 75 % of maximum continuous power results in nose-high attitudes exceeding 30°, the test may be carried out with the power required for level flight in the landing configuration at maximum landing weight and a speed of 1.4 V_{S0}, except that the power may not be less than 50 % of maximum continuous power; or

(b) For Turbine Engine Powered Aeroplanes—At maximum engine thrust, except that it need not exceed the thrust necessary to maintain level flight at 1.5 V_{S1} (where V_{S1} corresponds to the stalling speed with flaps in the approach position, the landing gear retracted, and maximum landing weight);

(7) Trim—The aeroplane trimmed at 1.5 V_{S1} or the minimum trim speed, whichever is higher; and

(8) Propeller—Full increase rpm position for the idle condition.

4.2 *Departure Characteristics*—All Level 1, all Level 2, and single engine Level 3 aeroplanes that are not approved for spinning shall meet one of the following alternatives. In all cases, maneuvers can be discontinued, and a normal recovery

initiated, after a downward pitching motion of the aeroplane commences due to the activation of a stall avoidance device (for example, stick pusher activation).

4.2.1 *Alternative 1:*

4.2.1.1 During the stall maneuver contained in 4.1.1, the longitudinal control shall be pulled back and held against the stop. Then, using lateral and directional controls in the proper direction, it shall be possible to maintain wings-level flight within 15° of bank and to roll the aeroplane from a 30° bank in one direction to a 30° bank in the other direction.

4.2.1.2 Reduce the aeroplane speed using the longitudinal control at a rate of approximately 1.9 (km/h)/s [1 knot/s] until the longitudinal control reaches the stop.

(1) With the longitudinal control pulled back and held against the stop, apply full directional control until whichever of the following conditions occurs first:

(a) Seven seconds, or

(b) Through a 360° heading change, which shall take no fewer than 4 s.

(2) At the end of the maneuver, the aeroplane shall respond immediately and normally to primary flight controls applied to regain coordinated, unstalled flight without reversal of control effect and without exceeding the temporary control forces specified by Specification F3173/F3173M.

(3) The following control positions and configurations shall be used during the maneuver discussed in 4.2.1.2(*1*):

(a) Full right and full left directional control,

(b) Lateral control:

(1) Neutral, and

(2) Fully deflected opposite of the direction of the turn; and

(c) Power and aeroplane configuration set in accordance with 4.1.1.6 without change during the maneuver.

4.2.1.3 Compliance with 4.1.1 and 4.1.2 shall be demonstrated with the aeroplane in uncoordinated flight, corresponding to one ball-width displacement on a slip-skid indicator, unless one ball-width displacement cannot be obtained with full directional control, in which case the demonstration shall be with full directional control applied.

4.2.2 *Alternative 2:*

4.2.2.1 At their discretion, the applicant shall utilize an approach acceptable to the local CAA that may utilize aerodynamic design characteristics, systems-based protection features, or a combination thereof to lower the probability of departure from controlled flight to an acceptable level.

NOTE 1—Several proposals are in development for alternate means of compliance to the parent requirement in 4.2. Future revisions of this specification will include those alternate approaches under this (and potentially other) requirements.

4.2.3 *Alternative 3*—Single engine low-speed Level 1 aeroplanes with $V_{S0} \leq 45$ knots may comply with 4.2 as follows:

4.2.3.1 The aeroplane shall fly a series of maneuvers according to the entry procedures described in 4.1.1.2 and 4.1.2.1.

4.2.3.2 The aeroplane shall be configured as per 4.1.1.6 for the wings-level entries, and as per 4.1.2.3 for the banked and accelerated entries, except that the configurations will be modified as follows:

(1) The aeroplane weight shall be 5 % more than the highest weight for which approval is requested;

(2) The aeroplane center of gravity shall be at least 3 % of the mean aerodynamic chord aft of the rearmost position for which approval is requested;

(3) The available longitudinal control up-travel is set 4° in excess of that to which the longitudinal control travel is to be limited for approval; and

(4) For aeroplanes that have independent lateral and directional controls, the lateral control travel set 7° in both directions, in excess of that to which the lateral control travel is to be limited for approval, or

(5) For aeroplanes with interconnected lateral and directional controls, the lateral-directional control travel set 7° in both directions, in excess of that to which the lateral-directional control travel is to be limited for approval.

4.2.3.3 The maneuvers specified in 4.2.3.1 shall continue until the longitudinal control reaches the aft stop. The aft stop shall be held for a period of 4 s with the following additional control inputs:

(1) For aeroplanes with independent lateral and directional controls:

(a) Lateral control neutral,

(b) Directional control full left and right; or

(2) For aeroplanes with interconnected lateral and directional controls, the lateral-directional control full left and full right, though the control may be neutralized if the aircraft exceeds 60° of bank.

4.2.3.4 After the conditions of 4.2.3.3 have been met, it must be possible to regain wings-level flight according to the criteria in 4.1.2.2.

4.3 *Spinning*—Aeroplanes shall meet the following spin recovery requirements in each configuration for which approval for spinning is requested:

4.3.1 The aeroplane shall recover from any point in a spin up to and including six turns, or any greater number of turns for which certification is requested, in not more than one-and-one-half additional turns after initiation of the first control action for recovery. However, beyond three turns, the spin may be discontinued if spiral characteristics appear;

4.3.2 The applicable airspeed limits and limit maneuvering load factors shall not be exceeded. For flaps-extended configurations for which approval is requested, the flaps shall not be retracted during the recovery;

4.3.3 It shall be impossible to obtain unrecoverable spins with any use of the flight or engine power controls either at the entry into or during the spin; and

4.3.4 There shall be no characteristics during the spin (such as excessive rates of rotation or extreme oscillatory motion) that might prevent a successful recovery because of disorientation or incapacitation of the pilot.

4.4 *Stall Warning*—There shall be a clear and distinctive stall warning with the flaps and landing gear in any normal position in straight and turning flight.

4.4.1 The stall warning shall give clearly distinguishable indications under expected conditions of flight. The type of warning shall be the same for all normal configurations throughout the flight envelope of the aeroplane.

4.4.1.1 A visual alert that requires the attention of the crew within the cockpit is not acceptable by itself.

4.4.2 When the speed is reduced at rates not exceeding 1.9 km/h [1 knot/s], stall warning shall begin, in each normal configuration, at a speed exceeding the speed at which the stall is identified in accordance with 4.1.1.2 by not less than 9.3 km/h [5 knots] or 5 % calibrated airspeed (CAS), whichever is greater. Once initiated, stall warning shall continue until the angle of attack is reduced to approximately that at which stall warning began.

NOTE 2—For the purpose of compliance with this specification, angle of attack can be measured directly or inferred through other measurements.

4.4.2.1 For Level 1 aeroplanes, a voice warning such as "STALL STALL" or an aural horn or tone is acceptable. If an aural horn or tone is utilized, it must be the only aural tone or horn in the cockpit.

4.4.2.2 For Level 2, 3, and 4 aeroplanes, the stall warning shall consist of either:

(1) An aural warning in combination with a system that provides tactile feedback through the pilot's controls to deter the pilot from further reducing airspeed or increasing angle of attack, or

(2) A voice warning such as "STALL STALL" along with an additional voice callout that occurs prior to the stall warning.

(a) The additional voice callout shall be provided no less than 4 s in advance of the stall warning callout assuming a steady deceleration in straight or turning flight for the maneuvers specified in 4.1, and

(b) Must not overlap or conflict with the stall warning.

4.4.3 For all aeroplanes other than single engine low-speed Level 1 aeroplanes with $V_{S0} \leq 45$ knots, when following aeroplane flight manual (AFM) procedures, stall warning shall not occur during:

(1) Takeoff with all engines operating,

(2) Takeoff continued with one engine inoperative, and

(3) Approach to landing.

4.4.4 During turning and accelerated turning stalls required by 4.1.2.1(*2*), the stall warning shall begin sufficiently in advance of the stall for the stall to be averted by pilot action taken after the stall warning first occurs.

4.4.5 For aeroplanes approved for aerobatics, an artificial stall warning may be mutable provided that it is armed automatically during takeoff and rearmed automatically in the approach configuration.

5. Keywords

5.1 airworthiness; flight; general aviation