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Standard Specification for Design and Performance of a Light Sport Glider[1]

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1. Scope

1.1 This specification covers airworthiness requirements for the design of a powered or non-powered fixed wing light sport aircraft, a "glider."

1.2 This specification is applicable to the design of a light sport aircraft glider as defined by regulations and limited to day VFR flight.

1.3 A glider for the purposes of this specification is defined as a heavier than air aircraft that remains airborne through the dynamic reaction of the air with a fixed wing and in which the ability to remain aloft in free flight does not depend on the propulsion from a power plant. A powered glider is defined for the purposes of this specification as a glider equipped with a power plant in which the flight characteristics are those of a glider when the power plant is not in operation.

1.4 The values in SI units are to be regarded as the standard. The values in parenthesis are for information only.

1.5 *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 requirements prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F2295 Practice for Continued Operational Safety Monitoring of a Light Sport Aircraft

F2316 Specification for Airframe Emergency Parachutes

F2339 Practice for Design and Manufacture of Reciprocating Spark Ignition Engines for Light Sport Aircraft

F2840 Practice for Design and Manufacture of Electric Propulsion Units for Light Sport Aircraft

F2972 Specification for Light Sport Aircraft Manufacturer's Quality Assurance System

2.2 *Other Standards:*

CS-22 Subpart H Certification Specifications for Sailplanes and Powered Sailplanes[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *electric propulsion unit, EPU*—any electric motor and all associated devices used to provide thrust for an electric aircraft.

3.1.2 *energy storage device, ESD*—used to store energy as part of a Electric Propulsion Unit (EPU). Typical energy storage devices include but are not limited to batteries, fuel cells or capacitors.

3.1.3 *feathering*—a single action from the cockpit that repositions the propeller blades to low drag configuration when the engine is not operating.

3.1.4 *flaps*—any movable high lift device.

3.1.5 *maximum empty weight, W_E (kg)* —largest empty weight of the glider, including all operational equipment that is installed in the glider: weight of the airframe, powerplant, excluding energy storage device (ESD) for electric propulsion unit when removable, required equipment, optional and specific equipment, fixed ballast, full engine coolant and oil, hydraulic fluid, and the unusable fuel. Hence, the maximum empty weight equals maximum takeoff weight minus minimum useful load: $W_E = W - W_U$.

3.1.6 *minimum useful load, W_U (kg)* —where $W_U = W - W_E$.

3.1.7 The terms "engine" referring to internal combustion engines and "motor" referring to electric motors for propulsion are used interchangeably within this standard.

3.1.8 The term "engine idle" or "throttle closed" when in reference to electric propulsion units shall mean the minimum power or propeller rotational speed condition for the electric motor as defined without electronic braking of the propeller rotational speed.

3.2 *Abbreviations:*

3.2.1 *AOI*—Aircraft Operating Instructions

3.2.2 *AR*—Aspect Ratio = b^2/S

[1] This specification is under the jurisdiction of ASTM Committee F37 on Light Sport Aircraft and is the direct responsibility of Subcommittee F37.10 on Glider.

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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.

[3] Available from European Aviation Safety Agency (EASA), Postfach 10 12 53, D-50452 Koeln, Germany, http://www.easa.eu.int/home.php.

3.2.3 *b*—wing span (m)

3.2.4 *c*—chord (m)

3.2.5 *CAS*—calibrated air speed (m/s, kts)

3.2.6 C_L—lift coefficient of the aircraft

3.2.7 C_D—drag coefficient of the aircraft

3.2.8 *CG*—center of gravity

3.2.9 C_m—moment coefficient (C_m is with respect to *c*/4 point, positive nose up)

3.2.10 C_{MO}—zero lift moment coefficient

3.2.11 C_n—normal coefficient

3.2.12 *g*—acceleration as a result of gravity = 9.81 m/s^2

3.2.13 *IAS*—indicated air speed (m/s, kts)

3.2.14 *ICAO*—International Civil Aviation Organization

3.2.15 *LSA*—light sport aircraft

3.2.16 *n*—load factor

3.2.17 n_1—glider positive maneuvering limit load factor at V_A

3.2.18 n_2—glider positive maneuvering limit load factor at V_D

3.2.19 n_3—glider negative maneuvering limit load factor at V_A

3.2.20 n_4—glider negative maneuvering limit load factor at V_D

3.2.21 *q*—dynamic pressure = 0.004823 V^2 kg/m^2, when *V* is in km/h

3.2.22 *S*—wing area (m^2)

3.2.23 *V*—airspeed (m/s, kts)

3.2.24 V_A—design maneuvering speed

3.2.25 V_C—design cruising speed

3.2.26 V_D—design diving speed

3.2.27 V_{DF}—demonstrated flight diving speed

3.2.28 V_F—design flap speed

3.2.29 V_{FE}—maximum flap extended speed

3.2.30 V_H—maximum speed in level flight with maximum continuous power (corrected for sea level standard conditions)

3.2.31 V_{LO}—maximum speed for landing gear extended

3.2.32 V_{NE}—never exceed speed

3.2.33 V_S—stalling speed or minimum steady flight speed at which the aircraft is controllable (flaps retracted)

3.2.34 V_{S1}—stalling speed, or minimum steady flight speed in a specific configuration

3.2.35 V_{S0}—stalling speed or minimum steady flight speed at which the aircraft is controllable in the landing configuration

3.2.36 V_R—ground gust speed

3.2.37 V_T—maximum aerotow speed

3.2.38 V_W—maximum winch tow speed

3.2.39 V_Y—speed for best rate of climb

3.2.40 *W*—maximum takeoff or maximum design weight (kg)

3.2.41 W_E—maximum empty aircraft weight (kg)

3.2.42 W_U—minimum useful load (kg)

3.2.43 *w*—average design surface load (N/m^2)

4. Flight

4.1 *Proof of Compliance:*

4.1.1 Each of the following requirements shall be met at the most critical weight and CG configuration. Unless otherwise specified, the speed range from stall to V_{DF} or the maximum allowable speed for the configuration being investigated shall be considered.

4.1.1.1 V_{DF} shall be less than or equal to V_D.

4.1.1.2 If V_{DF} chosen is less than V_D, V_{NE} must be less than or equal to 0.9 V_{DF} and greater than or equal to 1.1 V_C.

4.1.2 The following tolerances are acceptable during flight testing:

Weight	+5 %, −10 %
Weight, when critical	+5 %, −1 %
CG	±7 % of total travel

4.2 Compliance must be established for all configurations except as otherwise noted. In demonstrating compliance, the powerplant or propeller, if retractable, must be retracted, except as otherwise noted.

4.3 *Load Distribution Limits:*

4.3.1 The maximum weight shall be determined so that it is:

4.3.1.1 Not more than:

(1) The highest weight selected by the applicant, and

(2) The design maximum weight, which is the highest weight at which compliance with each applicable structural loading condition and all requirements for flight characteristics is shown.

4.3.1.2 Not less than:

(1) For a single-place glider not less than the empty weight of the glider, plus a weight of the occupant of 80 kg, plus the required minimum equipment, plus, for a powered glider, sufficient energy (fuel or other energy storage) for at least 30 min of flight at maximum continuous power.

(2) For a two-place glider not less than the empty weight of the glider, plus a weight of the occupants of 160 kg, plus the required minimum equipment, plus, for a powered glider, sufficient energy (fuel or other energy storage) for at least 30 min of flight at maximum continuous power.

4.3.2 The design empty weight shall be specified by the manufacturer.

4.3.3 *Empty Weight and Center of Gravity Range:*

4.3.3.1 The CG range within which the glider can be safely operated must be specified by the manufacturer.

4.3.3.2 The empty weight, corresponding CG, most forward, and most rearward CG shall be determined with fixed ballast and required minimum equipment.

4.3.3.3 The CG range must not be less than that which corresponds to that of a sole pilot weight of 65 kg up to the maximum weight, always considering the most unfavorable placing of luggage.

4.3.3.4 Fixed or removable ballast, or both, may be used if properly installed and placarded.

4.3.3.5 Multiple ESDs may be used if properly installed and placarded.

4.4 *Propeller Speed and Pitch Limits for a Powered Glider*—The operating limitations shall not allow the engine to exceed safe operating limits established by the engine manufacturer under normal conditions.

4.4.1 Maximum RPM shall not be exceeded with full throttle during takeoff, climb, or flight at 0.9 V_H, and 110 % maximum continuous RPM shall not be exceeded during a glide at V_{NE} with throttle closed.

4.5 *Performance, General*—All performance requirements apply in standard ICAO atmosphere in still air conditions and at sea level. Speeds shall be given in indicated (IAS) and calibrated (CAS) airspeeds.

4.5.1 *Stalling Speeds:*

4.5.1.1 Wing level stalling speeds V_{S0} and V_S shall be determined by flight test at a rate of speed decrease of 1 knot/s or less, throttle closed, with maximum takeoff weight, and most unfavorable CG.

4.5.1.2 For powered gliders, wing level stalling speeds V_{S0} and V_S shall also be determined with the engine idling, propeller in the takeoff position, and the cowl flaps closed.

4.5.1.3 For powered gliders, wings level, level flight top speed V_H shall be determined by flight test at maximum continuous rated RPM or with full throttle, if unable to reach max continuous RPM, at maximum takeoff weight, in cruise configuration.

4.5.2 *Takeoff for a Powered Glider:*

4.5.2.1 With the glider at maximum takeoff weight and full throttle, the distance to clear a 15-m (50-ft) obstacle shall not exceed 600 m (2000 ft).

4.5.2.2 Takeoff must be demonstrated with crosswind components not less than 0.2 V_{S0}.

NOTE 1—The procedure used for normal takeoff, including flap position, shall be specified within the AOI.

4.5.3 *Climb*—At maximum takeoff weight, flaps in the position specified for climb within the AOI, landing gear retracted, and full throttle, the minimum rate of climb shall exceed 1.0 m/s (200 ft/min).

4.5.4 *High Speed Descent*—If so equipped, the glider must not exceed V_{NE} in a dive at a 30° angle to the horizon with airbrakes extended.

4.5.5 *Descent*—If so equipped, the glider must have a glide slope not flatter than one in seven at a speed of 1.3 V_{S0} at maximum weight and with airbrakes extended.

4.5.6 *Landing*—The following shall be determined:

4.5.6.1 Landing distance from 15 m (50 ft) above ground when speed at 15 m (50 ft) is 1.3 V_{S0}.

4.5.6.2 Ground roll distance with braking if so equipped.

4.6 *Controllability and Maneuverability:*

4.6.1 *General:*

4.6.1.1 The glider shall be safely controllable and maneuverable during takeoff, climb, level flight, dive to V_{DF} or the maximum allowable speed for the configuration being investigated, engine extension and retraction, and approach and landing through the normal use of primary controls.

4.6.1.2 Smooth transition between all flight conditions shall be possible without exceeding pilot force as shown in Table 1.

TABLE 1 Pilot Force

Pilot force as applied to the controls	Pitch, N	Roll, N	Yaw, N	Wing flaps, landing gear, air brakes, retraction or extension of engine, two cable release, N
For temporary application: (less than 2 min) Stick	200	150	300	150
For prolonged application:	20	15	100	Not determined

4.6.1.3 Full control shall be maintained when retracting and extending flaps within their normal operating speed range (V_{S0} to V_{FE}).

4.6.1.4 Lateral, directional, and longitudinal control shall be possible down to V_{S0}.

4.6.2 *Longitudinal Control:*

4.6.2.1 At steady flight, or if so equipped, with the aircraft trimmed as closely as possible for steady flight at 1.3 V_{S1}, it must be possible at any speed below 1.3 V_{S1} to pitch the nose downward so that a speed not less than 1.3 V_{S1} can be reached promptly. This must be shown with the aircraft in all possible configurations.

4.6.2.2 Longitudinal control forces shall increase with increasing load factor.

4.6.2.3 Longitudinal control must be maintained:

(1) In towed flight, while extending or retracting flaps.

(2) When retraction or extension of the airbrakes is made at speeds between 1.1 V_{S0} and 1.5 V_{S0}.

(3) For powered gliders, when a change of the wing flap configuration is made during steady horizontal flight at 1.1 V_{S1} with simultaneous application of maximum continuous power.

(4) For powered gliders, when the engine is extended or retracted.

4.6.3 *Directional and Lateral Control:*

4.6.3.1 It must be possible, without significant slip or skid, to reverse the direction of a turn with a 45° bank to the opposite direction within *b*/3 or 4 s, whichever is longer (where *b* is the span of the glider in meters), when the turn is made at a speed of 1.4 V_{S1}, with where applicable, wing flaps, air brakes, and landing gear retracted.

4.6.3.2 With and without flaps deployed, rapid entry into or recovery from a maximum cross-controlled slip shall not result in uncontrollable flight characteristics.

4.6.3.3 Lateral and directional control forces shall not reverse with increased deflection.

4.6.4 *Aerotowing:*

4.6.4.1 If the glider is equipped for aerotowing, aerotows must be demonstrated at speeds up to V_T without:

(1) Difficulty in regaining the normal towing position after the glider has been displaced laterally or vertically.

(2) The released tow cable contacting any part of the glider.

4.6.4.2 Aerotowing must be demonstrated with crosswind components not less than 0.2 V_{S0}.

4.6.4.3 A suitable range of tow cables must be established.

4.6.4.4 Tests must be repeated for each location of the towing release mechanism.

4.6.5 *Winch Launching:*