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

This standard is issued under the fixed designation F2245; 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 covers airworthiness requirements for the design of powered fixed wing light sport aircraft, an "airplane."

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

1.3 *Units*—The values given in this standard are in SI units and are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound (or other) units that are provided for information only and are not considered standard. The values stated in each system may not be exact equivalents. Where it may not be clear, some equations provide the units of the result directly following the equation.

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 requirements 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]

D910 Specification for Leaded Aviation Gasolines
D4814 Specification for Automotive Spark-Ignition Engine Fuel
D7547 Specification for Hydrocarbon Unleaded Aviation Gasoline
F2316 Specification for Airframe Emergency Parachutes
F2339 Practice for Design and Manufacture of Reciprocating Spark Ignition Engines for Light Sport Aircraft
F2483 Practice for Maintenance and the Development of Maintenance Manuals for Light Sport Aircraft
F2506 Specification for Design and Testing of Light Sport Aircraft Propellers
F2538 Practice for Design and Manufacture of Reciprocating Compression Ignition Engines for Light Sport Aircraft
F2564 Specification for Design and Performance of a Light Sport Glider
F2746 Specification for Pilot's Operating Handbook (POH) for Light Sport Airplane
F2840 Practice for Design and Manufacture of Electric Propulsion Units for Light Sport Aircraft

2.2 *Federal Aviation Regulations and Advisory Circulars:*[3]

14 CFR Part 33 Airworthiness Standards: Aircraft Engines
14 CFR Part 35 Airworthiness Standards: Propellers
AC 23 Powerplant Guide for Certification of Part 23 Airplanes and Airships
AC 23.1521-2 Type Certification of Oxygenates and Oxygenated Gasoline Fuels in Part 23 Airplanes with Reciprocating Engines

2.3 *EASA Requirements:*[4]

CS-22 Sailplanes and Powered Sailplanes
CS-E Engines
CS-P Propellers

2.4 *Other Standards:*

EN 228 Automotive Fuels - Unleaded Petrol - Requirements and Test Methods[5]
GAMA Specification No. 1 Specification for Pilot's Operating Handbook[6]

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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 Federal Aviation Administration (FAA), 800 Independence Ave., SW, Washington, DC 20591, http://www.faa.gov or http://www.gpo.gov.

[4] Available from EASA European Aviation Safety Agency, Postfach 10 12 53, D-50452 Cologne, Germany, http://easa.europa.eu.

[5] Available from Deutsches Institut für Normung e.V.(DIN), Am DIN-Platz, Burggrafenstrasse 6, 10787 Berlin, Germany, http://www.din.de.

[6] Available from the General Aviation Manufacturers Association (GAMA), 1400 K Street NW, Suite 801, Washington, DC 20005-2485, http://www.gama.aero/.

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 *flaps*—any movable high lift device.

3.1.4 *maximum empty weight,* W_E (N)—largest empty weight of the airplane, including all operational equipment that is installed in the airplane: weight of the airframe, powerplant, Energy Storage Device (ESD) as part of an Electric Propulsion Unit (EPU), 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: $W_E = W - W_U$.

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

3.1.6 *night*—hours between the end of evening civil twilight and the beginning of morning civil twilight.

3.1.6.1 *Discussion*—Civil twilight ends in the evening when the center of the sun's disc is 6° below the horizon, and begins in the morning when the center of the sun's disc is 6° below the horizon.

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

3.1.8 The term "engine idle," 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.

3.1.9 The term "vapor lock," when used in reference to liquid fuel systems, shall mean that the liquid fuel, while still in the fuel delivery system, changes state from liquid to gas (that is, vaporizes), that either causes fuel feed pressure to the propulsion unit to decrease below manufacturers' specifications, transient loss of power, or complete stalling of the propulsion unit.

3.2 *Abbreviations:*

3.2.1 *AR*—aspect ratio $= \frac{b^2}{S}$

3.2.2 *b*—wing span (m)

3.2.3 *c*—chord (m)

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

3.2.5 C_L—lift coefficient of the airplane

3.2.6 C_D—drag coefficient of the airplane

3.2.7 *CG*—center of gravity

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

3.2.9 C_{MO}—zero lift moment coefficient

3.2.10 C_n—normal coefficient

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

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

3.2.13 *ICAO*—International Civil Aviation Organization

3.2.14 *LSA*—Light Sport Aircraft

3.2.15 *MAC*—mean aerodynamic chord (m)

3.2.16 *n*—load factor

3.2.17 n_1—airplane positive maneuvering limit load factor

3.2.18 n_2—airplane negative maneuvering limit load factor

3.2.19 n_3—load factor on wheels

3.2.20 *P*—power, (kW)

3.2.21 ρ—air density (kg/m^3) = 1.225 at sea level standard conditions

3.2.22 *POH*—Pilot Operating Handbook

3.2.23 *q*—dynamic pressure $(\mathrm{N/m^2}) = \frac{1}{2}\rho V^2$

3.2.24 *RC*—climb rate (m/s)

3.2.25 *S*—wing area (m^2)

3.2.26 *V*—airspeed (m/s)

3.2.26.1 V_A—design maneuvering speed

3.2.26.2 V_C—design cruising speed

3.2.26.3 V_D—design diving speed

3.2.26.4 V_{DF}—demonstrated flight diving speed

3.2.26.5 V_F—design flap speed

3.2.26.6 V_{FE}—maximum flap extended speed

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

3.2.26.8 V_{NE}—never exceed speed

3.2.26.9 V_O—operating maneuvering speed

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

3.2.26.11 V_{S1}—stalling speed or minimum steady flight speed at which the aircraft is controllable in a specific configuration

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

3.2.26.13 V_R—ground gust speed

3.2.26.14 V_X—speed for best angle of climb

3.2.26.15 V_Y—speed for best rate of climb

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

3.2.28 *W*—maximum takeoff or maximum design weight (N)

3.2.29 W_E—maximum empty airplane weight (N)

3.2.30 W_U—minimum useful load (N)

3.2.31 W_{ZWF}—maximum zero wing fuel weight (N)

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} may be less than or equal to V_D.

4.1.1.2 V_{NE} must be less than or equal to $0.9V_{DF}$ and greater than or equal to $1.1V_C$. In addition, V_{NE} must be greater than or equal to V_H.

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 *Load Distribution Limits:*

4.2.1 The minimum useful load, W_U, shall be equal to or greater than the sum of:

4.2.1.1 An occupant weight of 845 N (190 lbf) for each occupant seat in aircraft, plus

4.2.1.2 The weight of consumable substances, such as fuel, as required for a 1 h flight at V_h. Consumption rates must be based on test results for the specific application.

4.2.2 The minimum flying weight shall be determined.

4.2.3 Empty CG, most forward, and most rearward CG shall be determined.

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

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

4.3 *Propeller Speed and Pitch Limits*—Propeller configuration shall not allow the engine to exceed safe operating limits established by the engine manufacturer under normal conditions.

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

4.4 *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.

4.4.1 *Stalling Speeds*—Wing level stalling speeds V_{SO} and V_S shall be determined by flight test at a rate of speed decrease of 0.5 m/s^2(m/s per second) (1 kt/s) or less, throttle closed, with maximum takeoff weight, and most unfavorable CG.

4.4.2 *Takeoff*—With the airplane at maximum takeoff weight, full throttle, the following shall be measured using normal takeoff procedures:

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

4.4.2.1 Ground roll distance to takeoff on a runway with minimal grade.

4.4.2.2 Distance to clear a 15 m (50 ft) obstacle at a climb speed of at least $1.3V_{S1}$.

4.4.3 *Climb*—At maximum takeoff weight, flaps in the position specified for climb within the POH, and full throttle:

4.4.3.1 Rate of climb at V_Y shall exceed 1.6 m/s (315 ft/min).

4.4.3.2 Climb gradient at V_X shall exceed 1⁄12 .

TABLE 1 Pilot Force

Pilot force as applied to the controls	Pitch, N (lbf)	Roll, N (lbf)	Yaw, N (lbf)
For temporary application (less than 2 min):			
Stick	200 (45)	100 (22.5)	...
Wheel (applied to rim)	200 (45)	100 (22.5)	...
Rudder pedal	...	...	400 (90)
For prolonged application:	23 (5.2)	23 (5.2)	110 (24.7)

4.4.4 *Landing*—For landing with throttle closed and flaps extended, the following shall be determined:

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

4.4.4.2 Ground roll distance with reasonable braking if so equipped.

4.4.5 *Balked Landing*—The airplane shall demonstrate a full-throttle climb gradient at 1.3 V_{SO} which shall exceed 1⁄30 within 5 s of power application from aborted landing. If the flaps may be promptly and safely retracted without loss of altitude and without sudden changes in attitude, they may be retracted.

4.4.5.1 *Airplanes with EPU*—Balked landing performance shall be demonstrated considering minimum remaining available ESD power.

4.5 *Controllability and Maneuverability:*

4.5.1 *General:*

4.5.1.1 The airplane shall be safely controllable and maneuverable during takeoff, climb, level flight (cruise), dive to V_{DF} or the maximum allowable speed for the configuration being investigated, approach, and landing (power off and on, flaps retracted and extended) through the normal use of primary controls.

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

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

4.5.1.4 Lateral, directional, and longitudinal control shall be possible down to V_{SO}.

4.5.2 *Longitudinal Control:*

4.5.2.1 With the airplane trimmed as closely as possible for steady flight at $1.3V_{S1}$, it must be possible at any speed between $1.1V_{S1}$ and $1.3V_{S1}$ to pitch the nose downward so that a speed not less than $1.3V_{S1}$ can be reached promptly. This must be shown with the airplane in all possible configurations, with simultaneous application of full power and nose down pitch control, and with power at idle.

4.5.2.2 Longitudinal control forces shall increase with increasing load factor.

4.5.2.3 The control force to achieve the positive limit maneuvering load factor (n_1) shall not be less than 70 N in the clean configuration at the aft center of gravity limit. The control force increase is to be measured in flight from an initial n=1 trimmed flight condition at a minimum airspeed of two times the calibrated maximum flaps up stall speed.

4.5.2.4 If flight tests are unable to demonstrate a maneuvering load factor of n_1, then the minimum control force shall be proportional to the maximum demonstrated load factor, n_{1D}, as follows: