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Standard Specification for Aeroelasticity Requirements for a Light Sport Airplane[1]

This standard is issued under the fixed designation F3619; 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 addresses the aeroelasticity requirements of the airplane and is applicable to the design of a light sport aircraft/airplane as defined by regulations.

1.2 This specification shall apply to airplanes with V_H greater than 62 m/s (120 KCAS) and with V_{NE} less than or equal to 129 m/s (250 KCAS). The content of this specification may be more broadly applicable. It is the responsibility of the applicant to substantiate broader applicability as a specific means of compliance.

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. It is also noted that the internationally accepted units for altitude and airspeed are feet and knots, respectively. This is the only exception to standard SI units.

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 *FAA Documents:*[2]

Airframe and Equipment Engineering Report No. 45 (as corrected) Simplified Flutter Prevention Criteria

AC 23.629 Means of Compliance with Title 14 CFR, Part 23 Amdt. 63, § 23.629, Flutter

3. Terminology

3.1 *Abbreviations:*

3.1.1 *CAS*—calibrated airspeed (m/s, knots)

3.1.2 *EAS*—equivalent airspeed (m/s, knots)

3.1.3 *EFIS*—electronic flight information system

3.1.4 *GVT*—ground vibration testing

3.1.5 *TAS*—true airspeed (m/s, knots)

3.1.6 *V*—airspeed (m/s, knots)

3.1.7 V_D—design diving speed

3.1.8 V_{DF}—demonstrated flight diving speed

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

3.1.10 V_{NE}—never exceed speed.

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

4. Flutter

4.1 It must be shown by the methods in 4.2, and either 4.3 or 4.4, that the airplane is free from flutter, control reversal, and divergence for any condition of operation for all speeds from V_{S0} up to the speed specified for the selected method. In addition:

NOTE 1—Reference AC 23.629 and Aeroelastic Flutter Prevention in Gliders and Small Aircraft[3] for additional guidance on flutter evaluation.

4.1.1 Adequate tolerances of at least 0.8 to 1.2 must be established for quantities that affect flutter, including speed, damping, mass balance, and control system stiffness.

4.1.2 The natural frequencies of main structural components must be determined by vibration tests or other approved methods. This determination is not required for airplanes with V_D up to 72 m/s (140 KCAS).

4.1.3 The requirements of this specification must also be met with zero fuel in the wings.

[1] This specification is under the jurisdiction of ASTM Committee F37 on Light Sport Aircraft and is the direct responsibility of Subcommittee F37.20 on Airplane.

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[2] Available from Federal Aviation Administration (FAA), 800 Independence Ave., SW, Washington, DC 20591, http://www.faa.gov.

[3] Stender, W., Kießling, F., *Aeroelastic Flutter Prevention in Gliders and Small Aircraft*, Wiss. Berichtswesen der DLR, Köln, 1990.

4.2 *Flight Flutter Tests:*

4.2.1 Flight Flutter Tests must be made to show that:

4.2.2 Proper and adequate attempts to induce flutter have been made up to V_{DF} for modes of interest determined through analysis or vibration testing.

NOTE 2—Common approaches include pilot-induced control surface impulses for modes up to 8 Hz or rotating mass shakers for modes for higher frequency modes.

4.2.3 The vibratory response of the structure during the test indicates freedom from flutter;

4.2.4 A proper margin of damping exists (amplitude of vibration decreases after excitation removed) at V_{DF}.

4.3 *Rational Analysis:*

4.3.1 Any rational analysis used to predict freedom from flutter, control reversal, and divergence must cover all speeds up to 1.2 V_D.

4.3.2 Only analysis methods, which experience has shown to be reliable, may be used.

NOTE 3—A ground vibration test coupled with a low fidelity finite element model is a common method of rational analysis.

4.4 *Report No. 45:*

4.4.1 Compliance with rigidity and mass balance criteria defined in pages 4–12 of FAA's Airframe and Equipment Engineering Report No. 45 may be accomplished to show that the airplane is free from flutter, control reversal, or divergence if:

4.4.2 V_D for the airplane is less than 134 m/s (260 KEAS);

4.4.3 The wing and aileron flutter prevention criteria, as represented by the wing torsional stiffness and aileron balance criteria, are limited in use to airplanes:

4.4.3.1 without a T-tail, boom-tail, V-tail or other unconventional tail configurations;

4.4.3.2 without large mass concentrations (such as engines, floats, or fuel tanks in outer wing panels) along the wingspan;

4.4.3.3 unusual mass distributions or other unconventional design features that affect the applicability of the criteria; and

4.4.3.4 with fixed-fin and fixed-stabilizer surfaces.

4.5 Consideration should be given to structures that include cantilevered concentrated masses or large gyroscopic moments to ensure that the structural stiffness and dampening characteristics do not result in divergent vibrations such as whirl modes. Similarity with proven designs may be used to substantiate this requirement.

4.6 Freedom from flutter, control reversal, and divergence up to V_D must be shown as follows:

4.6.1 For airplanes that meet the criteria of 4.4.2 through 4.4.3.4, after the failure, malfunction, or disconnection of any single element in any tab control system.

4.6.2 For airplanes other than those described in 4.6.1, after the failure, malfunction, or disconnection of any single element in the primary flight control system, any tab control system, or any flutter damper.

4.7 *Tab Controls:*

4.7.1 Tab controls must be irreversible unless the tab is properly balanced and has no unsafe flutter characteristics.

4.7.2 Irreversible tab systems must have adequate rigidity and reliability in the portion of the system from the tab to the attachment of the irreversible unit to the aircraft structure.

4.8 *Spring Devices*—The reliability of any spring device used in the control system must be established by tests simulating service conditions to meet the stated maintenance or inspection interval unless failure of the spring will not cause flutter or unsafe flight characteristics.

4.9 If an EFIS is used to display flight information, warning of exceedance of V_{NE} must be indicated conventionally and by audio warning.

5. Keywords

5.1 flutter; light sport aircraft