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Standard Specification for Aeroelasticity Requirements[1]

This standard is issued under the fixed designation F3093/F3093M; 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.

1.2 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 non-conformance with the standard.

1.3 *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]

F3061 Specification for Systems and Equipment in Small Aircraft

F3065/F3065M Specification for Installation and Integration of Propeller Systems

F3115 Specification for Structural Durability for Small Airplanes

2.2 *Federal Aviation Administration (FAA) Document:*[3]

Airframe and Equipment Engineering Report No. 45 (as corrected) "Simplified Flutter Prevention Criteria" 1955

2.3 *Federal Aviation Regulations:*[4]

14 CFR 23 Amendment 62

3. Terminology

3.1 *Definitions:*

3.1.1 *GVT*—ground vibration testing

3.1.2 *V-n*—velocity versus load factor

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 within the limit V-n envelope and at all speeds up to the speed specified for the selected method. In addition:

4.1.1 Adequate tolerances must be established for quantities which affect flutter, including speed, damping, mass balance, and control system stiffness; and

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 Level 1 airplanes with V_D up to 260 kph [140 knots] CAS and maximum gross weight up to 750 kg [1650 lbm].

4.2 Flight flutter tests must be made to show that the airplane is free from flutter, control reversal, and divergence, and to show that:

4.2.1 Proper and adequate attempts to induce flutter have been made within the speed range up to V_D/M_D (or V_{DF}/M_{DF} for jets);

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

4.2.3 A proper margin of damping exists at V_D/M_D (or V_{DF}/M_{DF} for jets); and

4.2.4 As V_D/M_D (or V_{DF}/M_{DF} for jets) is approached, there is no large or rapid reduction in damping.

4.3 Any rational analysis used to predict freedom from flutter, control reversal, and divergence must cover all speeds up to 1.2 V_D/1.2 M_D, limited to Mach 1.0 for subsonic airplanes.

4.4 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:

4.4.1 V_D/M_D for the airplane is less than 480 kph [260 knots] (EAS) and less than Mach 0.5,

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[1] This specification is under the jurisdiction of ASTM Committee F44 on General Aviation Aircraft and is the direct responsibility of Subcommittee F44.30 on Structures.

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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.Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, http://www.access.gpo.gov.

[4] Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, http://www.access.gpo.gov.

4.4.2 The wing and aileron flutter prevention criteria, as represented by the wing torsional stiffness and aileron balance criteria, are limited in use to airplanes without large mass concentrations (such as engines, floats, or fuel tanks in outer wing panels) along the wing span, and

4.4.3 The airplane does not have a T-tail or other unconventional tail configurations, does not have unusual mass distributions or other unconventional design features that affect the applicability of the criteria, and has fixed-fin and fixed-stabilizer surfaces.

4.5 For turbopropeller-powered airplanes, the dynamic evaluation must include:

4.5.1 Whirl mode degree of freedom which takes into account the stability of the plane of rotation of the propeller and significant elastic, inertial, and aerodynamic forces.

4.5.2 Propeller, engine, engine mount, and airplane structure stiffness and damping variations appropriate to the particular configuration.

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

4.6.1 For airplanes that meet the criteria of sections 4.4.1 through 4.4.3 of this section, 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 section 4.6.1 of this section, 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 For airplanes showing compliance with the fail-safe criteria of Specification F3115, the airplane must be shown by analysis to be free from flutter up to V_D/M_D after fatigue failure, or obvious partial failure, of a principal structural element.

4.8 For airplanes showing compliance with the damage tolerance criteria of Specification F3115, the airplane must be shown by analysis to be free from flutter up to V_D/M_D with the extent of damage for which residual strength is demonstrated.

4.9 For modifications to the type design that could affect the flutter characteristics, compliance with 4.1 must be shown, except that analysis based on previously approved data may be used alone to show freedom from flutter, control reversal and divergence, for all speeds up to the speed specified for the selected method.

4.10 Additional flutter requirements are addressed in the following standards:

4.10.1 Tab controls requirements including flutter are defined in Specification F3061.

4.10.2 Spring devices requirements including flutter are defined in Specification F3061.

4.10.3 Propeller requirements including flutter are defined in Specification F3065/F3065M.

4.10.4 Ice protection requirements including flutter are defined in 14 CFR 23.1419.