Designation: ~~F3093/F3093M – 20~~ F3093/F3093M – 21

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 covers the aeroelasticity requirements of the aeroplane. The material was developed through open consensus of international experts in general aviation. This information was created by focusing on Level 1, 2, 3, and 4 Normal Category aeroplanes. The content may be more broadly applicable; it is the responsibility of the Applicant to substantiate broader applicability as a specific means of compliance. The topics covered within this document are: 2. Referenced Documents, 3. Terminology, 4. Flutter.

1.2 An applicant intending to propose this information as Means of Compliance for a design approval must seek guidance from their respective oversight authority (for example, published guidance from applicable CAAs) concerning the acceptable use and application thereof. For information on which oversight authorities have accepted this standard (in whole or in part) as an acceptable Means of Compliance to their regulatory requirements (hereinafter "the Rules"), refer to the ASTM Committee F44 web page (www.astm.org/COMMITTEE/F44.htm). Annex A1 maps the Means of Compliance described in this specification to the rules of EASA CS-23, amendment 5, or later, and FAA 14 CFR Part 23, amendment 64, or later.

1.3 *Units*—This document may present information in either SI units, English Engineering units, or both. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

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 *ASTM Standards:*[2]

F3061/F3061M Specification for Systems and Equipment in Small Aircraft
F3115/F3115M Specification for Structural Durability for Small Aeroplanes
F3120/F3120M Specification for Ice Protection for General Aviation Aircraft

2.2 *European Union Aviation Safety Agency (EASA) Standard:*[3]

CS-23 Certification Specifications for Normal-Category Aeroplanes

[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 European Union Aviation Safety Agency (EASA), Konrad-Adenauer-Ufer 3, D-50668 Cologne, Germany, https://www.easa.europa.eu/.

2.3 *Federal Aviation Administration (FAA)* ~~*Document:*~~*Documents:*[4]
14 CFR Part 23 Airworthiness Standards: Normal Category Airplanes
Airframe and Equipment Engineering Report No. 45 (as corrected) "Simplified Flutter Prevention Criteria" 1955

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 aeroplane 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 aeroplanes 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 aeroplane 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 aeroplanes.

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 aeroplane is free from flutter, control reversal, or divergence if:

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

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 aeroplanes without large mass concentrations (such as engines, floats, or fuel tanks in outer wing panels) along the wing span, and

4.4.3 The aeroplane 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 aeroplanes, 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.

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

4.5.2 Propeller, engine, engine mount, and aeroplane 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 aeroplanes 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 aeroplanes 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 aeroplanes showing compliance with the fail-safe criteria of Specification F3115/F3115M, the aeroplane 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 aeroplanes showing compliance with the damage tolerance criteria of Specification F3115/F3115M, the aeroplane 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/F3061M.

4.10.2 Spring devices requirements including flutter are defined in Specification F3061/F3061M.

4.10.3 Ice protection requirements including flutter are defined in Specification F3120/F3120M.

ANNEX

(Mandatory Information)

A1. CORRELATION OF STANDARD—CONTENT AND THE RULES

A1.1 Means of Compliance Correlation Sorted by Standard Section

TABLE A1.1 Means of Compliance Correlation Sorted by Standard Section

Specification	Rev	Section	Subpart	14 CFR Part 23	Subpart	CS-23
F3093/F3093M	20	4.1	C	23.2245(a)	C	23.2245(a)
F3093/F3093M	20	4.1.1	C	23.2245(b)	C	23.2245(b)
F3093/F3093M	20	4.2	C	23.2245(a)	C	23.2245(a)
F3093/F3093M	20	4.3	C	23.2245(a)	C	23.2245(a)
F3093/F3093M	20	4.4	C	23.2245(a)	C	23.2245(a)
F3093/F3093M	20	4.5	C	23.2245(a)	C	23.2245(a)
F3093/F3093M	20	4.6	C	23.2245(a)	C	23.2245(a)
F3093/F3093M	20	4.7	C	23.2245(a)	C	23.2245(a)
F3093/F3093M	20	4.8	C	23.2245(a)	C	23.2245(a)
F3093/F3093M	20	4.9	C	23.2245(a)	C	23.2245(a)
F3093/F3093M	20	4.10	C	23.2245(a)	C	23.2245(a)

NOTE A1.1—The specification sections shown in the specification column will be at the highest level at which everything below that level is the same as the level shown.

A1.2 Means of Compliance Correlation Sorted by FAA 14 CFR Rule

TABLE A1.2 Means of Compliance Correlation Sorted by FAA 14 CFR Rule

Subpart	14 CFR Part 23	Specification	Rev	Section
C	23.2245(a)	F3093/F3093M	20	4.1
C		F3093/F3093M	20	4.2
C		F3093/F3093M	20	4.3
C		F3093/F3093M	20	4.4
C		F3093/F3093M	20	4.5
C		F3093/F3093M	20	4.6
C		F3093/F3093M	20	4.7
C		F3093/F3093M	20	4.8
C		F3093/F3093M	20	4.9
C		F3093/F3093M	20	4.10
C	23.2245(b)	F3093/F3093M	20	4.1.1

A1.3 Means of Compliance Correlation Sorted by EASA CS-23 Rule