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Standard Specification for Weights and Centers of Gravity of Aircraft¹

This standard is issued under the fixed designation F3082/F3082M; 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 establishes the airworthiness design standards associated with aeroplane weight and center of gravity.

1.2 The term “aeroplane” is utilized in this specification as it was originally conceived for normal category fixed wing aircraft with a maximum certificated weight of 19 000 lb or less and a passenger seating configuration up to 19 as defined in the Rules. However, these standards may be more broadly applicable and their usage should not be unnecessarily limited.

1.3 The applicant for a design approval shall seek the individual guidance of their respective civil aviation authority (CAA) body concerning the use of this specification as part of a certification plan. For information on which CAA regulatory bodies have accepted this specification (in whole or in part) as a means of compliance to their small aircraft airworthiness regulations (hereinafter referred to as “the Rules”), refer to ASTM Committee F44 webpage (www.astm.org/COMMITTEE/F44.htm), which includes CAA website links.

1.4 *Units*—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.

1.5 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *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

F3060 Terminology for Aircraft

F3061 Specification for Systems and Equipment in Aircraft

F3063/F3063M Specification for Aircraft Fuel Storage and Delivery

F3174/F3174M Specification for Establishing Operating Limitations and Information for Aeroplanes

F3120 Specification for Ice Protection for General Aviation Aircraft

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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. Terminology

3.1 See Terminology **F3060** for definitions and abbreviations.

4. General Weight and CG Limits

~~4.1 *Weight and Center of Gravity*—The applicant must determine limits for weights and centers of gravity that provide for the safe operation of the airplane.~~

~~4.1.1 Each of the Flight Standards shall be met at critical combinations of weight and center of gravity within the range of loading conditions for which certification is requested. This shall be shown by:~~

~~4.1.1.1 Tests upon an aeroplane of the type for which certification is requested or by calculations based on, and equal in accuracy to, the results of testing, and~~

~~4.1.1.2 Systematic investigation of each probable combination of weight and center of gravity, if compliance cannot be reasonably inferred from combinations investigated.~~

~~4.1.2 The general tolerances in **Table 1** are allowed during flight testing. However, greater tolerances may be allowed in particular tests, if properly justified.~~

~~4.1 *Load Distribution Limits: Limits*—The applicant must determine limits for weights and centers of gravity that provide for the safe operation of the airplane.~~

~~4.1.1 Ranges of weights and centers of gravity within which the aeroplane may be safely operated shall be established. If a weight and center of gravity combination is allowable only within certain lateral load distribution limits that could be inadvertently exceeded, these limits shall be established for the corresponding weight and center of gravity combinations.~~

~~4.1.2 The load distribution limits shall not exceed any of the following:~~

- ~~(1) The selected limits,~~
- ~~(2) The limits at which the structure is proven, or~~
- ~~(3) The limits at which compliance with each applicable flight requirement is shown.~~

~~4.2 *Removable Ballast*—Removable ballast may be used in showing compliance with the flight requirements if:~~

~~4.2.1 The place for carrying ballast is properly designed and easily accessible to enable, during pre-flight inspection, that the ballast is properly installed.~~

TABLE 1 General Tolerances

Item	Tolerance
Weight	+5 %, -10 %
Critical items affected by weight	+5 %, -1 %
C.G.	±7 % total travel

4.2.2 Instructions are included in the aeroplane flight manual, approved manual material, or markings and placards for the proper placement of the removable ballast under each loading condition for which removable ballast is necessary.

4.3 *Weight Limits:*

4.3.1 *Maximum Weight*—The maximum weight is the highest weight at which compliance with each applicable requirement (other than those complied with at the design landing weight) is shown. The maximum weight shall be established so that it is:

4.3.1.1 Not more than the least of:

- (1) The highest weight selected by the applicant;
- (2) The design maximum weight, which is the highest weight at which compliance with each applicable structural loading condition (other than those complied with at the design landing weight) is shown;
- (3) The highest weight at which compliance with each applicable flight requirement is shown, and

4.3.1.2 Not less than the weight with:

- (1) Each seat occupied, assuming a weight of 77 kg [~~170 lb~~][170 lb] for each occupant or 86 kg [190 lb] for Level 1 aeroplanes with a stall speed of 45 kts or lower and for aeroplanes approved for aerobatics except that seats other than pilot seats may be placarded for a lesser weight, and
 - (a) Oil at full capacity,
 - (b) At least enough fuel for maximum continuous power operation of ~~at least 30 min for day-VFR approved aeroplanes and at least 45 min for night-VFR and IFR approved aeroplanes or for Level 1 aeroplanes with a stall speed of 45 kts or less enough fuel for 1 h of operation at maximum continuous power, or for:~~
 - (1) 30 min for day-VFR-approved aeroplanes, and
 - (2) 45 min for night-VFR- and IFR-approved aeroplanes, or
 - (3) Level 1 aeroplanes with a stall speed of 45 kts or less enough fuel for 1 h of operation, or
- (2) The required minimum crew, and fuel and oil to full capacity.

4.3.2 *Minimum Weight*—The minimum weight (the lowest weight at which compliance with each applicable requirement is shown) shall be established so that it is not more than the sum of:

4.3.2.1 The empty weight determined under Section 4.46,

4.3.2.2 The weight of the required minimum crew (assuming a weight of 77 kg [170 lb] for each crewmember), or for Level 1 aeroplanes with a stall speed of 45 kts or less a weight of 55 kg [120 lb], and

4.3.2.3 For turbojet powered aeroplanes, 5 % of the total fuel capacity of that particular fuel tank arrangement under investigation.

4.3.2.4 For other aeroplanes, the weight of the fuel necessary for 30 min of operation at maximum continuous power.

4.4 *Empty Weight and Corresponding Center of Gravity:*

4.4.1 ~~The empty weight and corresponding center of gravity shall be determined by weighing the aeroplane with:~~

4.4.1.1 ~~Fixed ballast,~~

4.4.1.2 ~~Unusable fuel determined under Specification F3063/F3063M, and~~

4.4.1.3 ~~Full operating fluids including:~~

- (1) ~~Oil,~~
- (2) ~~Hydraulic fluid, and~~
- (3) ~~Other fluids required for normal operation of aeroplane systems, except potable water, lavatory precharge water, and water intended for injection in the engines.~~

4.4.2 ~~The condition of the aeroplane at the time of determining empty weight shall be one that is well defined and can be easily repeated.~~

~~4.5 Removable Ballast—Removable ballast may be used in showing compliance with the flight requirements if:~~

~~4.5.1 The place for carrying ballast is properly designed and easily accessible to enable, during pre-flight inspection, that the ballast is properly installed.~~

~~4.5.2 Instructions are included in the aeroplane flight manual, approved manual material, or markings and placards for the proper placement of the removable ballast under each loading condition for which removable ballast is necessary.~~

5. Requirements Compliance

5.1 Each of the Flight Standards shall be met at critical combinations of weight and center of gravity within the range of loading conditions for which certification is requested. This shall be shown by:

5.1.1 Tests upon an aeroplane of the type for which certification is requested or by calculations based on, and equal in accuracy to, the results of testing, and

5.1.2 Systematic investigation of each probable combination of weight and center of gravity, if compliance cannot be reasonably inferred from combinations investigated.

5.2 The general tolerances in **Table 1** are allowed during flight testing. However, greater tolerances may be allowed in particular tests, if properly justified.

6. Empty Weight and CG Condition

6.1 The condition of the aeroplane at the time of determining empty weight shall be one that is well defined and can be easily repeated.

6.2 Empty Weight and Corresponding Center of Gravity:

6.2.1 The empty weight and corresponding center of gravity shall be determined by weighing the aeroplane with:

6.2.1.1 Fixed ballast,

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6.2.1.2 Unusable fuel determined under Specification **F3063/F3063M**, and

6.2.1.3 Full operating fluids including:

(1) Oil,

(2) Hydraulic fluid, and

(3) Other fluids required for normal operation of aeroplane systems, except potable water, lavatory precharge water, and water intended for injection in the engines.

7. Keywords

7.1 aircraft; airworthiness; design; flight; general aviation; operational limitations; performance