§ 23.303 Factor of safety.

Unless otherwise provided, a factor of safety of 1.5 must be used.

§ 23.305 Strength and deformation.

(a) The structure must be able to support limit loads without detrimental, permanent deformation. At any load up to limit loads, the deformation may not interfere with safe operation.

(b) The structure must be able to support ultimate loads without failure for at least three seconds, except local failures or structural instabilities between limit and ultimate load are acceptable only if the structure can sustain the required ultimate load for at least three seconds. However when proof of strength is shown by dynamic tests simulating actual load conditions, the three second limit does not apply.

§ 23.307 Proof of structure.

(a) Compliance with the strength and deformation requirements of §23.306 must be shown for each critical load condition. Structural analysis may be used only if the structure conforms to those for which experience has shown this method to be reliable. In other cases, substantiating load tests must be made. Dynamic tests, including structural flight tests, are acceptable if the design load conditions have been simulated.

(b) Certain parts of the structure must be tested as specified in Subpart D of this part.

FLIGHT LOADS

§ 23.321 General.

(a) Flight load factors represent the ratio of the aerodynamic force component (acting normal to the assumed longitudinal axis of the airplane) to the weight of the airplane. A positive flight load factor is one in which the aerodynamic force acts upward, with respect to the airplane.

(b) Compliance with the flight load requirements of this subpart must be shown:

1. At each critical altitude within the range in which the airplane may be expected to operate;

2. At each weight from the design minimum weight to the design maximum weight; and

3. For each required altitude and weight, for any practicable distribution of disposable load within the operating limitations specified in §§23.1583 through 23.1589.

(c) When significant, the effects of compressibility must be taken into account.

§ 23.331 Symmetrical flight conditions.

(a) The appropriate balancing horizontal tail load must be accounted for in a rational or conservative manner when determining the wing loads and linear inertia loads corresponding to any of the symmetrical flight conditions specified in §§23.333 through 23.341.

(b) The incremental horizontal tail loads due to maneuvering and gusts must be reacted by the angular inertia of the airplane in a rational or conservative manner.

(c) Mutual influence of the aerodynamic surfaces must be taken into account when determining flight loads.

§ 23.333 Flight envelope.

(a) General. Compliance with the strength requirements of this subpart must be shown at any combination of airspeed and load factor on and within the boundaries of a flight envelope (similar to the one in paragraph (d) of this section) that represents the envelope of the flight loading conditions specified by the maneuvering and gust criteria of paragraphs (b) and (c) of this section respectively.
(b) **Maneuvering envelope.** Except where limited by maximum (static) lift coefficients, the airplane is assumed to be subjected to symmetrical maneuvers resulting in the following limit load factors:

1. The positive maneuvering load factor specified in §23.337 at speeds up to $V_D$;
2. The negative maneuvering load factor specified in §23.337 at $V_C$; and
3. Factors varying linearly with speed from the specified value at $V_C$ to 0.0 at $V_D$ for the normal and commuter category, and −1.0 at $V_D$ for the acrobatic and utility categories.

(c) **Gust envelope.** (1) The airplane is assumed to be subjected to symmetrical vertical gusts in level flight. The resulting limit load factors must correspond to the conditions determined as follows:

   i. Positive (up) and negative (down) gusts of 50 f.p.s. at $V_C$ must be considered at altitudes between sea level and 20,000 feet. The gust velocity may be reduced linearly from 50 f.p.s. at 20,000 feet to 25 f.p.s. at 50,000 feet.
   ii. Positive and negative gusts of 25 f.p.s. at $V_D$ must be considered at altitudes between sea level and 20,000 feet. The gust velocity may be reduced linearly from 25 f.p.s. at 20,000 feet to 12.5 f.p.s. at 50,000 feet.

   (iii) In addition, for commuter category airplanes, positive (up) and negative (down) rough air gusts of 66 f.p.s. at $V_B$ must be considered at altitudes between sea level and 20,000 feet. The gust velocity may be reduced linearly from 66 f.p.s. at 20,000 feet to 38 f.p.s. at 50,000 feet.

   (2) The following assumptions must be made:

   i. The shape of the gust is:

   $$U = \frac{U_{de}}{2} \left(1 - \cos \left(\frac{2\pi s}{25C}\right)\right)$$

   Where—
   - $s=$ Distance penetrated into gust (ft.);
   - $C=$ Mean geometric chord of wing (ft.); and
   - $U_{de}=$ Derived gust velocity referred to in subparagraph (1) of this section.

   (ii) Gust load factors vary linearly with speed between $V_C$ and $V_D$.

(d) **Flight envelope.**