For single-engine airplanes, the glide performance determined under §23.71.

(d) In addition to paragraph (a) of this section, for normal, utility, and acrobatic category multiengine jets weighing over 6,000 pounds, and commuter category airplanes, the following information must be furnished—

(1) The accelerate-stop distance determined under §23.55;

(2) The takeoff distance determined under §23.59(a);

(3) At the option of the applicant, the takeoff run determined under §23.59(b);

(4) The effect on accelerate-stop distance, takeoff distance and, if determined, takeoff run, of operation on other than smooth hard surfaces, when dry, determined under §23.45(g);

(5) The effect on accelerate-stop distance, takeoff distance, and if determined, takeoff run, of runway slope and 50 percent of the headwind component and 150 percent of the tailwind component;

(6) The net takeoff flight path determined under §23.61(b);

(7) The enroute gradient of climb/descent with one engine inoperative, determined under §23.69(b);

(8) The effect, on the net takeoff flight path and on the enroute gradient of climb/descent with one engine inoperative, of 50 percent of the headwind component and 150 percent of the tailwind component;

(9) Overweight landing performance information (determined by extrapolation and computed for the range of weights between the maximum landing and maximum takeoff weights) as follows—

(i) The maximum weight for each airport altitude and ambient temperature at which the airplane complies with the climb requirements of §23.63(d)(2); and

(ii) The landing distance determined under §23.75 for each airport altitude and standard temperature.

(10) The relationship between IAS and CAS determined in accordance with §23.1323 (b) and (c).

(11) The altimeter system calibration required by §23.1325(e).

§23.1589 Loading information.

The following loading information must be furnished:

(a) The weight and location of each item of equipment that can be easily removed, relocated, or replaced and that is installed when the airplane was weighed under the requirement of §23.25.

(b) Appropriate loading instructions for each possible loading condition between the maximum and minimum weights established under §23.25, to facilitate the center of gravity remaining within the limits established under §23.23.

APPENDIX A TO PART 23—SIMPLIFIED DESIGN LOAD CRITERIA

A23.1 General.

(a) The design load criteria in this appendix are an approved equivalent of those in §§23.321 through 23.459 of this subchapter for an airplane having a maximum weight of 6,000 pounds or less and the following configuration:

(1) A single engine excluding turbine powerplants;

(2) A main wing located closer to the airplane’s center of gravity than to the aft, fuselage-mounted, empennage;

(3) A main wing that contains a quarter-chord sweep angle of not more than 15 degrees fore or aft;

(4) A main wing that is equipped with trailing-edge controls (ailerons or flaps, or both);

(5) A main wing aspect ratio not greater than 7;

(6) A horizontal tail aspect ratio not greater than 4;

(7) A horizontal tail volume coefficient not less than 0.34;

(8) A vertical tail aspect ratio not greater than 2;

(9) A vertical tail platform area not greater than 10 percent of the wing platform area; and

(10) Symmetrical airfoils must be used in both the horizontal and vertical tail designs.

(b) Appendix A criteria may not be used on any airplane configuration that contains any of the following design features:
(1) Canard, tandem-wing, close-coupled, or tailless arrangements of the lifting surfaces;
(2) Biplane or multiplane wing arrangement;
(3) T-tail, V-tail, or cruciform-tail (+) arrangements;
(4) Highly-swept wing platform (more than 15-degrees of sweep at the quarter-chord), delta planforms, or slatted lifting surfaces; or
(5) Winglets or other wing tip devices, or outboard fins.

A23.3 Special symbols.

\( n_1 = \text{Airplane Positive Maneuvering Limit Load Factor} \)
\( n_2 = \text{Airplane Negative Maneuvering Limit Load Factor} \)
\( n_3 = \text{Airplane Positive Gust Limit Load Factor at} \ V_C \)
\( n_{\text{delta}} = \text{Airplane Negative Gust Limit Load Factor} \) at \( V_C \)
\( n_{\text{micro}} = \text{Airplane Positive Limit Load Factor With Flaps Fully Extended at} \ V_F \)

\( V_F \) min = Minimum Design Flap Speed = \( 11.0\sqrt{C_{\mu}}/W \)
\( V_A \) min = Minimum Design Maneuvering Speed = \( 15.0\sqrt{C_{\mu}}/W \)
\( V_{\text{C min}} = \text{Minimum Design Cruising Speed} = 17.0\sqrt{C_{\mu}}/W \)
\( V_D \) min = Minimum Design Dive Speed = \( 25.0\sqrt{C_{\mu}}/W \)

A23.5 Certification in more than one category.

The criteria in this appendix may be used for certification in the normal, utility, and acrobatic categories, or in any combination of these categories. If certification in more than one category is desired, the design category weights must be selected to make the term \( n_i/W \) constant for all categories or greater for one desired category than for others. The basic fuselage structure need only be investigated for the maximum value of \( n_i/W \), or for the category corresponding to the maximum design weight, where \( n_i/W \) is constant. If the acrobatic category is selected, a special unsymmetrical flight load investigation in accordance with paragraphs A23.9(c)(2) and A23.11(c)(2) of this appendix must be completed. The wing, wing carrythrough, and the horizontal tail structures must be checked for this condition. The basic fuselage structure need only be investigated for the highest load factor design category selected. The local supporting structure for dead weight items need only be designed for the highest load factor imposed when the particular items are installed in the airplane. The engine mount, however, must be designed for a higher side load factor, if certification in the acrobatic category is desired, than that required for certification in the normal and utility categories. When designing for landing loads, the landing gear and the airplane as a whole need only be investigated for the category corresponding to the maximum design weight. These simplifications apply to single-engine aircraft of conventional types for which experience is available, and the Administrator may require additional investigations for aircraft with unusual design features.

A23.7 Flight loads.

(a) Each flight load may be considered independent of altitude and, except for the local supporting structure for dead weight items, only the maximum design weight conditions must be investigated.

(b) Table 1 and figures 3 and 4 of this appendix must be used to determine values of \( n_1, n_2, n_3, \text{and} \ n_{\text{delta}} \) corresponding to the maximum design weights in the desired categories.

(c) Figures 1 and 2 of this appendix must be used to determine values of \( n_1, \) and \( n_{\text{delta}} \) corresponding to the maximum flying weights in the desired categories, and, if these load factors are greater than the load factors at the design weight, the supporting structure for dead weight items must be substantiated for the resulting higher load factors.

(d) Each specified wing and tail loading is independent of the center of gravity range. The applicant, however, must select a c.g. range, and the basic fuselage structure must be investigated for the most adverse dead weight loading conditions for the c.g. range selected.

(e) The following loads and loading conditions are the minimums for which strength must be provided in the structure:
   (1) \textit{Airplane equilibrium}. The aerodynamic wing loads may be considered to act normal to the relative wind, and to have a magnitude of 1.05 times the airplane normal loads (as determined from paragraphs A23.9(b) and (c) of this appendix) for the positive flight conditions and a magnitude equal to the airplane normal loads for the negative conditions. Each chordwise and normal component of this wing load must be considered.
   (2) \textit{Minimum design airspeeds}. The minimum design airspeeds may be chosen by the applicant except that they may not be less than the minimum speeds found by using figure 3 of this appendix. In addition, \( V_{\text{Cmin}} \) need not exceed values of 0.9 \( V_F \) actually obtained at sea level for the lowest design weight category for which certification is desired. In computing these minimum design airspeeds, \( n_i \) may not be less than 3.8.
   (3) \textit{Flight load factor}. The limit flight load factors specified in Table 1 of this appendix
§ 23.1501(c) through 23.1513 and § 23.1519. Operating limitations as specified in the airplane similar to the diagram in figure 4 of this appendix. This diagram must also be used to determine the airplane structural envelope of figure 4 of this appendix. In addition, the following requirements apply:

(i) The design limit flight load factors corresponding to conditions “D” and “E” of figure 4 must be at least as great as those found from figure 3 of this appendix. Where

\[ \Delta_d = \frac{V_d}{V_C} \times \Delta_p \quad \text{and} \quad \Delta_b = 0.5 \frac{V_b}{V_D} \times \Delta_p \]

Where \( \Delta_p \) is the maximum total deflection (sum of both aileron deflections) at \( V_r \) with \( V_C \) and \( V_D \) described in subparagraph (2) of §23.367 of this appendix.

(ii) Compute \( K \) from the formula:

\[ K = \frac{\left( C_m - 0.01 \delta_e \right) V_B^2}{\left( C_m - 0.01 \delta_e \right) V_C^2} \]

where \( \delta_e \) is the down aileron deflection corresponding to \( \Delta d \) and \( \delta_b \) is the down aileron deflection corresponding to \( \Delta b \) as computed in step (i).

(iii) If \( K \) is less than 1.0, \( \Delta d \) and \( \Delta b \) must be used to determine \( \delta_e \) and \( \delta_b \). In this case, \( V_L \) is the critical speed which must be used in computing the wing torsion loads over the aileron span.

(iv) If \( K \) is equal to or greater than 1.0, \( \Delta d \) is the down aileron deflection corresponding to \( \Delta b \) as computed in step (i).

(v) If \( K \) is less than 1.0, \( \Delta d \) and \( \Delta b \) must be used to determine \( \delta_e \) and \( \delta_b \). In this case, \( V_L \) is the critical speed which must be used in computing the wing torsion loads over the aileron span.

(d) Supplementary conditions; rear lift truss; engine torque; side load on engine mount. Each of the following supplementary conditions must be investigated:

(i) In designing the rear lift truss, the special condition specified in §23.389 may be investigated instead of condition “G” of figure
4 of this appendix. If this is done, and if certification in more than one category is desired, the value of \( W/S \) used in the formula appearing in §23.369 must be that for the category corresponding to the maximum gross weight.

(2) Each engine mount and its supporting structures must be designed for the maximum limit torque corresponding to METO power and propeller speed acting simultaneously with the limit loads resulting from the maximum positive maneuvering flight load factor \( n_1 \). The limit torque must be obtained by multiplying the mean torque by a factor of 1.33 for engines with five or more cylinders. For 4, 3, and 2 cylinder engines, the factor must be 2, 3, and 4, respectively.

(3) Each engine mount and its supporting structure must be designed for the loads resulting from a lateral limit load factor of not less than 1.47 for the normal and utility categories, or 2.0 for the acrobatic category.

A23.11 Control surface loads.

(a) General. Each control surface load must be determined using the criteria of paragraph (b) of this section and must lie within the simplified loadings of paragraph (c) of this section.

(b) Limit pilot forces. In each control surface loading condition described in paragraphs (c) through (e) of this section, the airloads on the movable surfaces and the corresponding deflections need not exceed those which could be obtained in flight by employing the maximum limit pilot forces specified in the table in §23.397(b). If the surface loads are limited by these maximum limit pilot forces, the tabs must either be considered to be deflected to their maximum travel in the direction which would assist the pilot or the deflection must correspond to the maximum degree of “out of trim” expected at the speed for the condition under consideration. The tab load, however, need not exceed the value specified in Table 2 of this appendix.

(c) Surface loading conditions. Each surface loading condition must be investigated as follows:

1. The distribution of load along the span of the surface, irrespective of the chordwise load distribution, must be assumed proportional to the total chord, except on horn balance surfaces.

2. The load on the stabilizer and elevator, and the load on fin and rudder, must be distributed chordwise as shown in figure 7 of this appendix.

3. In order to ensure adequate torsional strength and to account for maneuvers and gusts, the most severe loads must be considered in association with every center of pressure position between the leading edge and the half chord of the mean chord of the surface (stabilizer and elevator, or fin and rudder).

4. To ensure adequate strength under high leading edge loads, the most severe stabilizer and fin loads must be further considered as being increased by 50 percent over the leading 10 percent of the chord with the loads aft of this appropriately decreased to retain the same total load.

5. The most severe elevator and rudder loads should be further considered as being distributed parabolically from three times the mean loading of the surface (stabilizer and elevator, or fin and rudder) at the leading edge of the elevator and rudder, respectively, to zero at the trailing edge according to the equation:

\[
P(x) = 3 \left( \frac{c}{W} \right) \frac{(c - x)^2}{c_f^2}
\]
Where—

\[ P(x) = \text{local pressure at the chordwise stations } x, \]

\[ c = \text{chord length of the tail surface}, \]

\[ c_f = \text{chord length of the elevator and rudder}, \]

\[ \bar{w} = \text{average surface loading as specified in Figure A5}. \]

(vi) The chordwise loading distribution for ailerons, wing flaps, and trim tabs are specified in Table 2 of this appendix.

(2) If certification in the acrobatic category is desired, the horizontal tail must be investigated for an unsymmetrical load of 100 percent \( w \) on one side of the airplane centerline and 50 percent on the other side of the airplane centerline.

(d) Outboard fins. Outboard fins must meet the requirements of §23.445.

(e) Special devices. Special devices must meet the requirements of §23.459.

A23.13 Control system loads.

(a) Primary flight controls and systems. Each primary flight control and system must be designed as follows:

(1) The flight control system and its supporting structure must be designed for loads corresponding to 125 percent of the computed hinge moments of the movable control surface in the conditions prescribed in A23.11 of this appendix. In addition—

(i) The system limit loads need not exceed those that could be produced by the pilot and automatic devices operating the controls; and

(ii) The design must provide a rugged system for service use, including jamming, ground gusts, taxiing downwind, control inertia, and friction.

(2) Acceptable maximum and minimum limit pilot forces for elevator, aileron, and rudder controls are shown in the table in §23.397(b). These pilots loads must be assumed to act at the appropriate control grips or pads as they would under flight conditions, and to be reacted at the attachments of the control system to the control surface horn.

(b) Dual controls. If there are dual controls, the systems must be designed for pilots operating in opposition, using individual pilot loads equal to 75 percent of those obtained in accordance with paragraph (a) of this section, except that individual pilot loads may not be less than the minimum limit pilot forces shown in the table in §23.397(b).

(c) Ground gust conditions. Ground gust conditions must meet the requirements of §23.415.

(d) Secondary controls and systems. Secondary controls and systems must meet the requirements of §23.405.

### TABLE 1—LIMIT FLIGHT LOAD FACTORS

<table>
<thead>
<tr>
<th>Flight load factors</th>
<th>Normal category</th>
<th>Utility category</th>
<th>Acrobatic category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flaps up:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( n_1 )</td>
<td>3.0</td>
<td>4.4</td>
<td>6.0</td>
</tr>
<tr>
<td>( n_2 )</td>
<td>-0.5 ( n_1 )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( n_3 )</td>
<td>(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( n_4 )</td>
<td>(2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flaps down:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( n ) flap</td>
<td>0.5 ( n_1 )</td>
<td>( ^* \text{Zero} )</td>
<td></td>
</tr>
</tbody>
</table>

*Find \( n \) from Fig. 1.
14 CFR Ch. I (1–1–13 Edition)

Find n, from Fig. 2.

Vertical wing load may be assumed equal to zero and only
the flap part of the wing need be checked for this condition.

<table>
<thead>
<tr>
<th>SURFACE</th>
<th>DIRECTION OF LOADING</th>
<th>MAGNITUDE OF LOADING</th>
<th>CHORDWISE DISTRIBUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal Tail I</td>
<td>a) Up and Down</td>
<td>Figure A5 Curve [2]</td>
<td>See Figure A7</td>
</tr>
<tr>
<td></td>
<td>b) Unsymmetrical</td>
<td>100% W on one side of airplane ξ,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>65% W on other side of airplane ξ, for normal and</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>utility categories. For aeroelastic category</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>see A2.11(c)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Right and Left</td>
<td>Figure A5 Curve [1]</td>
<td>Same as above</td>
</tr>
<tr>
<td>Alenon III</td>
<td>a) Up and Down</td>
<td>Figure A6 Curve [5]</td>
<td></td>
</tr>
<tr>
<td>Wing Flap IV</td>
<td>a) Up</td>
<td>Figure A6 Curve [4]</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>.25 x Up Load [a]</td>
<td></td>
</tr>
<tr>
<td>Trim Tab V</td>
<td>a) Up and Down</td>
<td>Figure A6 Curve [3]</td>
<td>Same as [D] above</td>
</tr>
</tbody>
</table>

Table 2 - Average limit control surface loading

NOTE: The surface loading I, II, III, and V above are based on speeds $V_A\,\text{min}$ and $V_C\,\text{min}$.

The loading of IV is based on $V_C\,\text{min}$.

If values of speed greater than these minimums are selected for design, the appropriate surface loadings must be multiplied by the ratio $\left(\frac{V}{V_{\text{min}}}\right)^2$.

For conditions I, II, III, and V the multiplying factor used must be the higher of $\frac{(V_A\,\text{sel.})^2}{(V_A\,\text{min.})}$ or $\frac{(V_C\,\text{sel.})^2}{(V_C\,\text{min.})}$.
Figure A1—Chart for Finding \( n_3 \) Factor at Speed \( V_c \)

\[ K = \frac{V_{c,sel.}}{V_{c,\text{min.}}} \]

\( V_{c,\text{min.}} \) is found from Figure 3.
FIGURE A3—DETERMINATIONS OF MINIMUM DESIGN SPEEDS—EQUATIONS

SPEEDS ARE IN KNOTS

\[ V_D = \frac{1}{3.8} \sqrt{\frac{W}{S}} \times n_1 \frac{W}{S} \text{ but need not exceed} \]

\[ V_c = \frac{1.4 \sqrt{n_1 \frac{W}{S}}}{W} \text{ in design.} \]

\[ V_r = \frac{1}{3.8} \sqrt{\frac{W}{S}} \text{ but need not exceed} \]

\[ 0.9 \times V_c; \quad V_A = 15.0 \frac{W}{S} \quad \text{but need not exceed} \quad V_c \text{ used} \]

1. Conditions "C" or "F" need only be investigated when \( n_1 \frac{W}{S} \) or \( n_2 \frac{W}{S} \) is greater

2. Condition "G" need not be investigated when the supplementary condition specified in § 23.869 is investigated.
FIGURE A5 - AVERAGE LIMIT CONTROL SURFACE LOADING

1. \( \bar{w} = 3.66 \left( n_1 \frac{W}{S} \right)^{\frac{1}{2}} \) for \( n_1 \frac{W}{S} < 47 \) and \( \text{AR} \leq 2.0 \)

2. \( \bar{w} = 0.534 \left( n_1 \frac{W}{S} \right) \) for \( n_1 \frac{W}{S} > 47 \)

\( \bar{w} = 4.8 + 0.534 \left( n_1 \frac{W}{S} \right) \)

(1) VERTICAL TAIL
(2) HORIZONTAL TAIL (UP & DOWN LOADS)
FIGURE A6 - AVERAGE LIMIT CONTROL SURFACE LOADING

(3) $\frac{W}{S} = 0.78 \frac{W_{\text{max}}}{S} (C_n / 0.80)$

(4) $\frac{W}{S} = 0.64 \frac{W_{\text{max}}}{S} (C_n / 1.6)$

(5) $\frac{W}{S} = 0.46 \frac{W_{\text{max}}}{S}$

Design Maneuvering Wing Loading $\frac{W}{S}$ pounds/sq. ft.
FIGURE A7—CHORDWISE LOAD DISTRIBUTION FOR STABILIZER AND ELEVATOR OR FIN AND RUDDER

\[
P_1 = 2 \left( \frac{w}{E} - 3d' \right) \frac{2 - E - 3d'}{1 - E} \]

\[
P_2 = 2 \left( \frac{w}{E} \right) (3d' + E - 1) \]

where:
- \( w \) = average surface loading (as specified in figure A.5)
- \( E \) = ratio of elevator (or rudder) chord to total stabilizer and elevator (or fin and rudder) chord.
- \( d' \) = ratio of distance of center of pressure of a unit spanwise length of combined stabilizer and elevator (or fin and rudder) chord to the local chord. Sign convention is positive when center of pressure is behind leading edge.
- \( c \) = local chord.

NOTE: Positive values of \( w \), \( P_1 \), and \( P_2 \) are all measured in the same direction.

APPENDIX C TO PART 23—BASIC LANDING CONDITIONS

<table>
<thead>
<tr>
<th>Condition</th>
<th>Tail wheel type</th>
<th>Nose wheel type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level landing</td>
<td>Tail-down land-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ing</td>
</tr>
<tr>
<td></td>
<td>Level landing</td>
<td>Level landing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>with inclined</td>
</tr>
<tr>
<td></td>
<td></td>
<td>reactions</td>
</tr>
<tr>
<td></td>
<td>Level landing</td>
<td>Level landing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>with nose wheel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>just clear of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ground</td>
</tr>
<tr>
<td></td>
<td>Tail-down land-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ing</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reference section</th>
<th>Tail-down landing</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)(1)</td>
<td>23.479</td>
</tr>
<tr>
<td>(a)(2)</td>
<td>23.479</td>
</tr>
<tr>
<td>(a)(2)(i)</td>
<td>23.479</td>
</tr>
<tr>
<td>(a)(2)(ii)</td>
<td>23.479</td>
</tr>
<tr>
<td>(a)(2)(iii)</td>
<td>23.479</td>
</tr>
<tr>
<td>(b)</td>
<td>23.481</td>
</tr>
<tr>
<td>(a)(2)</td>
<td>23.481</td>
</tr>
<tr>
<td>(b)</td>
<td>23.481</td>
</tr>
<tr>
<td>(c)</td>
<td>23.481</td>
</tr>
<tr>
<td>(d)</td>
<td>23.481</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition</th>
<th>Tail wheel type</th>
<th>Nose wheel type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical component at c. g</td>
<td>( nW )</td>
<td>( nW )</td>
</tr>
<tr>
<td>Fore and aft component at c. g</td>
<td>( KnW )</td>
<td>0</td>
</tr>
<tr>
<td>Lateral component in either direction at c. g</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Shock absorber extension (hydraulic shock absorber)</td>
<td>Note (2)</td>
<td>Note (2)</td>
</tr>
<tr>
<td>Shock absorber deflection (rubber or spring shock absorber), percent</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Tire deflection</td>
<td>Static</td>
<td>Static</td>
</tr>
<tr>
<td>Main wheel loads (both wheels) ((V_f))</td>
<td>( (n-L)W )</td>
<td>( (n-L)W )</td>
</tr>
<tr>
<td>Main wheel loads (both wheels) ((D_f))</td>
<td>( KnW )</td>
<td>0</td>
</tr>
</tbody>
</table>

APPENDIX B TO PART 23 [RESERVED]