

**§ 25.473 Landing load conditions and assumptions.**

(a) For the landing conditions specified in § 25.479 to § 25.485 the airplane is assumed to contact the ground—

(1) In the attitudes defined in § 25.479 and § 25.481;

(2) With a limit descent velocity of 10 fps at the design landing weight (the maximum weight for landing conditions at maximum descent velocity); and

(3) With a limit descent velocity of 6 fps at the design take-off weight (the maximum weight for landing conditions at a reduced descent velocity).

(4) The prescribed descent velocities may be modified if it is shown that the airplane has design features that make it impossible to develop these velocities.

(b) Airplane lift, not exceeding airplane weight, may be assumed unless the presence of systems or procedures significantly affects the lift.

(c) The method of analysis of airplane and landing gear loads must take into account at least the following elements:

(1) Landing gear dynamic characteristics.

(2) Spin-up and springback.

(3) Rigid body response.

(4) Structural dynamic response of the airframe, if significant.

(d) The landing gear dynamic characteristics must be validated by tests as defined in § 25.723(a).

(e) The coefficient of friction between the tires and the ground may be established by considering the effects of skidding velocity and tire pressure. However, this coefficient of friction need not be more than 0.8.

[Amdt. 25-91, 62 FR 40705, July 29, 1997; Amdt. 25-91, 62 FR 45481, Aug. 27, 1997; Amdt. 25-103, 66 FR 27394, May 16, 2001]

**§ 25.477 Landing gear arrangement.**

Sections 25.479 through 25.485 apply to airplanes with conventional arrangements of main and nose gears, or main and tail gears, when normal operating techniques are used.

**§ 25.479 Level landing conditions.**

(a) In the level attitude, the airplane is assumed to contact the ground at forward velocity components, ranging

from  $V_{L1}$  to  $1.25 V_{L2}$  parallel to the ground under the conditions prescribed in § 25.473 with—

(1)  $V_{L1}$  equal to  $V_{S0}$  (TAS) at the appropriate landing weight and in standard sea level conditions; and

(2)  $V_{L2}$  equal to  $V_{S0}$  (TAS) at the appropriate landing weight and altitudes in a hot day temperature of 41 degrees F. above standard.

(3) The effects of increased contact speed must be investigated if approval of downwind landings exceeding 10 knots is requested.

(b) For the level landing attitude for airplanes with tail wheels, the conditions specified in this section must be investigated with the airplane horizontal reference line horizontal in accordance with Figure 2 of Appendix A of this part.

(c) For the level landing attitude for airplanes with nose wheels, shown in Figure 2 of Appendix A of this part, the conditions specified in this section must be investigated assuming the following attitudes:

(1) An attitude in which the main wheels are assumed to contact the ground with the nose wheel just clear of the ground; and

(2) If reasonably attainable at the specified descent and forward velocities, an attitude in which the nose and main wheels are assumed to contact the ground simultaneously.

(d) In addition to the loading conditions prescribed in paragraph (a) of this section, but with maximum vertical ground reactions calculated from paragraph (a), the following apply:

(1) The landing gear and directly affected attaching structure must be designed for the maximum vertical ground reaction combined with an aft acting drag component of not less than 25% of this maximum vertical ground reaction.

(2) The most severe combination of loads that are likely to arise during a lateral drift landing must be taken into account. In absence of a more rational analysis of this condition, the following must be investigated:

(i) A vertical load equal to 75% of the maximum ground reaction of § 25.473 must be considered in combination with a drag and side load of 40% and 25% respectively of that vertical load.

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(ii) The shock absorber and tire deflections must be assumed to be 75% of the deflection corresponding to the maximum ground reaction of § 25.473(a)(2). This load case need not be considered in combination with flat tires.

(3) The combination of vertical and drag components is considered to be acting at the wheel axle centerline.

[Amdt. 25-91, 62 FR 40705, July 29, 1997; Amdt. 25-91, 62 FR 45481, Aug. 27, 1997]

### § 25.481 Tail-down landing conditions.

(a) In the tail-down attitude, the airplane is assumed to contact the ground at forward velocity components, ranging from  $V_{L1}$  to  $V_{L2}$  parallel to the ground under the conditions prescribed in § 25.473 with—

(1)  $V_{L1}$  equal to  $V_{SO}$  (TAS) at the appropriate landing weight and in standard sea level conditions; and

(2)  $V_{L2}$  equal to  $V_{SO}$  (TAS) at the appropriate landing weight and altitudes in a hot day temperature of 41 degrees F. above standard.

(3) The combination of vertical and drag components considered to be acting at the main wheel axle centerline.

(b) For the tail-down landing condition for airplanes with tail wheels, the main and tail wheels are assumed to contact the ground simultaneously, in accordance with figure 3 of appendix A. Ground reaction conditions on the tail wheel are assumed to act—

(1) Vertically; and

(2) Up and aft through the axle at 45 degrees to the ground line.

(c) For the tail-down landing condition for airplanes with nose wheels, the airplane is assumed to be at an attitude corresponding to either the stalling angle or the maximum angle allowing clearance with the ground by each part of the airplane other than the main wheels, in accordance with figure 3 of appendix A, whichever is less.

[Doc. No. 5066, 29 FR 18291, Dec. 24, 1964, as amended by Amdt. 25-91, 62 FR 40705, July 29, 1997; Amdt. 25-94, 63 FR 8848, Feb. 23, 1998]

### § 25.483 One-gear landing conditions.

For the one-gear landing conditions, the airplane is assumed to be in the level attitude and to contact the ground on one main landing gear, in

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accordance with Figure 4 of Appendix A of this part. In this attitude—

(a) The ground reactions must be the same as those obtained on that side under § 25.479(d)(1), and

(b) Each unbalanced external load must be reacted by airplane inertia in a rational or conservative manner.

[Doc. No. 5066, 29 FR 18291, Dec. 24, 1964, as amended by Amdt. 25-91, 62 FR 40705, July 29, 1997]

### § 25.485 Side load conditions.

In addition to § 25.479(d)(2) the following conditions must be considered:

(a) For the side load condition, the airplane is assumed to be in the level attitude with only the main wheels contacting the ground, in accordance with figure 5 of appendix A.

(b) Side loads of 0.8 of the vertical reaction (on one side) acting inward and 0.6 of the vertical reaction (on the other side) acting outward must be combined with one-half of the maximum vertical ground reactions obtained in the level landing conditions. These loads are assumed to be applied at the ground contact point and to be resisted by the inertia of the airplane. The drag loads may be assumed to be zero.

[Doc. No. 5066, 29 FR 18291, Dec. 24, 1964, as amended by Amdt. 25-91, 62 FR 40705, July 29, 1997]

### § 25.487 Rebound landing condition.

(a) The landing gear and its supporting structure must be investigated for the loads occurring during rebound of the airplane from the landing surface.

(b) With the landing gear fully extended and not in contact with the ground, a load factor of 20.0 must act on the unsprung weights of the landing gear. This load factor must act in the direction of motion of the unsprung weights as they reach their limiting positions in extending with relation to the sprung parts of the landing gear.

### § 25.489 Ground handling conditions.

Unless otherwise prescribed, the landing gear and airplane structure must be investigated for the conditions in §§ 25.491 through 25.509 with the airplane at the design ramp weight (the