Sec. 37.172 Aircraft wheels and wheel-brake assemblies - TSO-C26c.

(a) Applicability. This Technical Standard Order prescribes the minimum performance standards that aircraft landing wheels and wheel-brake assemblies must meet in order to be identified with the applicable TSO marking. New models of such equipment which are to be so identified and which are manufactured on or after December 31, 1979, must meet the requirements of the Federal Aviation Administration Standard for Aircraft Wheels and Wheel-Brake Assemblies set forth at the end of this section.

(b) Marking. In lieu of the marking requirements of Sec. 37.7, aircraft wheels and wheel-brake assemblies must be legibly and permanently marked with the following information:
(1) Name of the manufacturer responsible for compliance.
(2) Serial number, or date of manufacture, or both.
(3) Part number.
(4) Applicable technical standard order (TSO) number.
(5) Size (this marking applies to wheels only).

All stamped, etched, or embossed markings must be located in noncritical areas.

(c) Data requirements.
(1) In addition to the data specified in Sec. 37.5, the manufacturer must furnish to the Chief, Engineering and Manufacturing Branch, Federal Aviation Administration, in the region in which the manufacturer is located (or, in the case of the Western Region, the Chief, Aircraft Engineering Division), the following technical data:
(i) One copy of the applicable limitations pertaining to installation of wheels and brakes on aircraft, including the weight of the brake assembly, maximum static load rating, maximum limit load rating, maximum accelerate-stop kinetic energy in foot-pounds (KE_{RT}), design landing kinetic energy in foot-pounds (KE_{DL}), accelerate-stop deceleration in feet-second^2, design landing stop deceleration in feet/second^2, applicable speed as specified in paragraph 4.2(a)(1) of the FAA Standard for Aircraft Wheels and Wheel-Brake Assemblies, type of hydraulic fluid used, and the weight of the wheel.
(ii) One copy of the manufacturer's test report.
(2) Upon request of the regional office specified in paragraph (c)(1) of this section, the manufacturer must furnish the applicable maintenance instructions.

(d) Previously approved equipment. Wheels and wheel-brake assemblies approved prior to December 31, 1979, may continue to be manufactured under the provisions of their original approval.

Federal Aviation Administration Standard for Aircraft Wheels and Wheel-Brake Assemblies

1. Purposes.

This document contains minimum performance standards for aircraft landing wheels and wheel-brake assemblies.

2. Design and construction.

(a) Design.
(1) Lubricant retainers. Lubricant retainers must retain the lubricant under all operating conditions, prevent the lubricant from reaching braking surfaces, and prevent foreign matter from entering the bearings.
(2) Removable flanges. All removable flanges must be assembled onto the wheel in a manner that will prevent the removable flange and retaining device from leaving the wheel if a tire should deflate while the wheel is rolling.

(3) Adjustment. When necessary to assure safe performance, the brake mechanism must be equipped with suitable adjustment devices.
(4) Water seal. Wheels intended for use on amphibious aircraft must be sealed to prevent entrance of water into the wheel bearings or other portions of the wheel or brake, unless the design is such that brake action and service life will not be impaired by the presence of sea water or fresh water.
(5) Explosion prevention. Unless determined to be unnecessary, means must be provided to minimize the probability of wheel and tire explosions which result from elevated brake temperatures.

(b) Construction.
(1) Castings. Castings must be of high quality, clean, sound, and free from blowholes, porosity, or surface defects caused by inclusions, except that loose sand or entrapped gases may be allowed when the serviceability of the casting has not been impaired.
(2) Forgings. Forgings must be of uniform condition and free from blisters, fins, folds, seams, laps, cracks, segregation, and other defects. If strength and serviceability are not impaired, imperfections may be removed.
(3) Rim surfaces. For wheels designed for use with a tire and inner tube combination, the surface of the rim between bead seats must be free from defects which would be injurious to the inner tube while mounting the tire or while in service.
(4) Rim joints. For wheels designed for use with a tire and inner tube combination, joints in the rim surface and joints between rim surfaces and demountable flanges must be smooth, close fitting, and noninjurious to the inner tube while mounting the tire or while in service.
(5) Rivets and bolts. When rivets are used, they must be well headed over, and rivets and bolts coming in contact with the casing or tube must be smooth enough not to damage the tube or casing during normal operation.
(6) Bolts and studs. When bolts and studs are used for fastening together sections of a wheel, the length of the threads for the nut extending into and bearing against the sections must be held to a minimum and there must be sufficient unthreaded bearing area to carry the required load.
(7) Steel parts. All steel parts, except braking surfaces and those parts fabricated from corrosion-resistant steel must be cadmium plated or zinc plated or have equivalent protection from corrosion.
(8) Aluminum parts. All aluminum alloy parts must be anodized or have equivalent protection from corrosion. This protection must include protection for fuse plug holes, valve stem holes, and other passages.
(9) Magnesium parts. All magnesium alloy parts must receive a suitable dichromate treatment or have equivalent protection from corrosion. This protection must include protection for fuse plug holes, valve stem holes, and other passages.
(10) Bearing and braking surfaces. The bearings and braking surfaces must be protected during the application of finish to the wheels and brakes.
(11) Fatigue. The construction of the wheel must take into account techniques used to improve fatigue resistance of critical areas of the wheel.

3. Rating.

(a) Each wheel design must be rated for the following:
(1) S=Maximum static load in pounds (ref. Secs. 23.731(b), 25.731(b), 27.731(b), and 29.731(b) of this chapter).
(2) L=Maximum limit load in pounds (ref. Secs. 23.731(c), 25.731(c), 27.731(c), and 29.731(c) of this chapter).

(b) Each wheel-brake assembly design must be rated for the following:
(1) KE_{DL}=Kinetic energy capacity in foot-pounds per wheel-brake assembly at the design landing rate of absorption.

(2) KE_{RT}=Kinetic energy capacity in foot-pounds per wheel-brake assembly at the maximum accelerate-stop rate of absorption for wheel-brake assemblies of airplanes certificated under Part 25 of this chapter only.

4. Qualification tests. The aircraft wheels and wheel-brake assemblies must be tested as follows and the test data included in the applicant's test report required by Sec. 37.172(c)(1)(ii) of this part.

4.1 Wheel tests. To establish the S and L ratings for a wheel, test a standard sample in accordance with he following radial, combined, and static load tests:

(a) Maximum radial load test. Test the wheel for yield and ultimate loads as follows:
(1) Test method. Mount the wheel with a suitable tire of proper fit installed, on its axle, and position it against a flat nondeflecting surface. The wheel axle must have the same angular orientation to the nondeflecting surface that it will have to the runway when it is mounted on the aircraft and is under the maximum limit load. Inflate the tire to the pressure recommended for the S load with air or water. If water inflation is used, the water must be bled off to obtain the same tire deflection that would result if air inflation were used. Water pressure may not exceed the pressure which would develop if air inflation were used and the tire deflected to its maximum extent. Load the wheel through its axle perpendicular to the flat nondeflecting surface. Deflection readings must be taken at suitable points to indicate deflection and permanent set of the wheel rim at the bead seat.
(2) Yield load. Apply to the wheel a load not less than 1.15 times the maximum radial limit load, determined under Secs. 23.471 through 23.511, or Secs. 25.471 through 25.511, or Secs. 27.471 through 27.505, or Secs. 29.471 through 29.511 of this chapter, as appropriate. Apply the load with the wheel positioned against the nondeflecting surface, and the valve hole positioned at 90 degrees with respect to the line between the center of the wheel and the point of contact, then with the valve hole positions 180 degrees, 270 degrees, and 0 degrees from the nondeflecting surface. The 90 degree increments must be altered to other positions if the other positions are more critical. Three successive loadings at the 0 degree position may not cause permanent set increments of increasing magnitude. The permanent set increment caused by the last loading at the 0 degree position may not exceed 5 percent of the deflection caused by that loading or 0.005 inches, whichever is greater. The bearing cups, cones, and rollers used in operation must be used for these loadings. There must be no yielding of the wheel such as would result in loose bearing cups, air, or water leakage through the wheel or past the wheel seal, or interference in any critical areas.
(3) Ultimate load. Apply to the wheel a load, not less than 2 times the maximum radial limit load for castings and 1.5 times the maximum radial limit load for forgings, determined under Secs. 23.471 through 23.511, or Secs. 25.471 through 25.511, or Secs. 27.471 through 27.505, or Secs. 29.471 through 29.511 of this chapter, as appropriate. Apply the load with the same wheel positioned against the nondeflecting surface and the valve hole positioned at 0 degrees with respect to the line between the center of the wheel and the point of contact. The wheel must be able to support the load without failure for at least 3 seconds. The bearing cones may be replaced with conical bushings, but the cups used in operation must be used for this loading. If at a point of loading during the test, it is shown that the tire will not successfully maintain pressure or if bottoming of the tire on the nondeflecting surface occurs, the tire pressure may be increased to no more than 2 times the rated inflation pressure. If bottoming of the tire continues to occurs with this increased pressure, a loading block which fits between the rim flanges and simulates the load transfer of the inflated tire may be used. The arc of wheel supported by the loading block must be no greater than 80 degrees.
(4) If the radial limit load in paragraph 4.1(b) is equal to or greater than the maximum radial limit in paragraph 4.1(a)(2) and (3), the tests specified in paragraphs 4.1(a)(2) and (3) may be omitted.

(b) Combined radial and side load tests. Tests the wheel for the yield and ultimate loads as follows:

(1) Test method. Mount the wheel, with a suitable tire of proper fit installed, on its axle, and position it against a flat nondeflecting surface. The wheel axle must have the same angular orientation to the nondeflecting surface that it will have to the runway when it is mounted on the aircraft and is under the combined radial and side load. Inflate the tire to the pressure recommended for the maximum static load with air or water. If water inflation is used, the water must be bled off to obtain the same tire deflection that would result if air inflation were used. Water pressure may not exceed the pressure which would develop if air inflation were used and the tire deflected to its maximum extent. For the radial load component, load the wheel through its axle perpendicular to the flat nondeflecting surface. For the side load component, load the wheel through its axle parallel to the flat nondeflecting surface. The side load reaction must arise from the friction of the tire or the loading block on the nondeflecting surface. Apply the two loads simultaneously, increasing them either continuously or in increments no longer than 10 percent of the loads to be applied. Alternatively, a resultant load equivalent to the radial and side load may be applied to the axle. Deflection readings must be taken at suitable points to indicate deflection and permanent set of the wheel rim at the bead seat.

(2) Yield load. Apply to the wheel radial and side loads not less than 1.15 times the respective ground loads determined under Secs. 23.485, 23.497, and 23.499, or Secs. 25.485, 25.495, 25.497, and 25.499, or Secs. 27.485 and 27.497, or Secs. 29.485 and 29.497 of this chapter, as appropriate. Apply these loads with the wheel positioned against the nondeflecting surface and the valve hole positioned at 90 degrees with respect to the line between the center of the wheel and the point of contact, then with valve hole positioned at 100 degrees, 270 degrees, and 0 degrees from the nondeflecting surface. The 90 degree increments must be altered to other positions if the other positions are more critical. Three successive loadings at the 0 degree position may not cause permanent set increments of increasing magnitude. The permanent set increment caused by the last loading at the 0 degree position may not exceed 5 percent of the deflection caused by that loading, or 0.005 inch, whichever is greater. The bearing cups, cones, and rollers used in operation must be used in this test. There must be no yielding of the wheel such as would result in loose bearing cups, air or water leakage through the wheel or past the wheel seal, or interference in any critical areas. A tire and tube may be used when testing a tubeless wheel only when it has been demonstrated that pressure will be lost due to the inability of a tire bead to remain properly positioned under the load. The wheel must be tested for the most critical inboard and outboard side loads.
(3) Ultimate load. Apply to the wheel radial and side loads not less than 2 times for castings and 1.5 times for forgings the respective ground loads determined under Secs. 23.485, 23.497, and 23.499, or Secs. 25.485, 25.495, 25.497, and 25.499, or Secs. 27.485 and 27.497, or Secs. 29.485 and 29.497 of this chapter, as appropriate. Apply these loads with the same wheel positioned against the nondeflecting surface and the valve hole positioned at 0 degrees with respect to the center of the wheel and the point of contact. The wheel must be able to support the load without failure for at least 3 seconds. The bearing cones may be replaced with conical bushings, but the cups used in operation must be used for this loading. If, at a point of loading during the test, it is shown that the tire will not successfully maintain pressure or if bottoming of the tire on the nondeflecting surface occurs, the tire pressure may be increased to no more than 2 times the rated inflated pressure. If bottoming of the tire continues to occur with this increased pressure, a loading block which fits between the rim flanges and simulates the load transfer of the inflated tire may be used. The arc of wheel supported by the loading block must be no greater than 80 degrees.

(c) Maximum static load test. Test the wheel for the maximum static load test as follows:
(1) Test method. Mount the wheel, with a suitable tire of proper fit installed, on its axle, and position it against a flat nondeflecting surface or a flywheel. The wheel axle must have the same angular orientation to the load surface that it will have to the runway when it is mounted on the aircraft and is under the maximum static load. Inflate the tire to the pressure recommended for the maximum static load "S". The radial load must be applied to the wheel through the axle and perpendicular to the load surface. The side load, when required, must be applied through the wheel axle and parallel to the load surface. For the side load, the wheel axle must be rotated or

yawed to the angle which will produce a side load component equal to 0.15 "S" while the wheel is being roll tested.
(2) Roll test. The wheel must be tested under the loads and for the distance shown in Table I. At the end of the test there must be no cracks on the wheel and no leakage through the wheel or past the wheel seal, and the bearing cups may not be loosened in the hub.

Table I		
Category of aircraft	Load conditions	Roll distance (miles)
Part 25	Maximum static load, "S".	2000
	Maximum static load, "S" plus 0.15 "S" side load applied in outboard direction.	100
	Maximum static load, "S" plus 0.15 "S" side load applied in inboard direction.	100
Part 23	Maximum static load, "S"	1000
Part 27 and 29	Maximum static load, "S"	250

(3) Roll on Rim Test. The wheel without a tire must be tested at a speed not less than 10 mph under the loads and distance shown in Table II. The test axle angular orientation with the load surface must approximate that of the airplane axle to the runway under maximum static load. At the end of the test there may be cracks but no fragmentation of the wheel. (V_2=takeoff speed in knots)

Table II		
Category of aircraft	Load conditions	Roll distance (feet)
Part 25	Maximum static load "S"	$V_2 2 \times 0.5$

(d) Pressure test. Pressure test the wheel in accordance with the following:
(1) Overpressure test. The wheel must be hydrostatically tested to withstand without failure for at least 3 seconds application of an overpressure factor not less than 4.0 for Part 25 airplanes, 3.5 for Part 23 airplanes, and 3.0 for rotorcraft, times the rate inflation pressure determined by the applicant.
(2) Diffusion test. The tubeless tire and wheel assembly must hold the rated inflation pressure for 24 hours with no greater pressure drop than 5 percent. This test must be performed after the tire growth has stabilized.

4.2 Wheel-brake assembly test. A sample of a wheel-brake assembly design, with a suitable tire of proper fit installed, must meet the following tests to qualify the design for its kinetic energy ratings. The wheel of a wheel-brake assembly must be separately tested under paragraph 4.1. The wheel-brake assembly must be tested with the operating medium specified by the manufacturer.

(a) Dynamic torque tests. Test the wheel-brake assembly on the suitable inertial brake testing machine in accordance with the following:
(1) Speed and weight values. For airplanes, select either Method I or Method II below to calculate the kinetic energy level which a single wheel and wheel-brake assembly will be required to absorb. For rotorcraft, use Method I.

(i) Method I. Calculate the kinetic energy level to be used in the brake testing machine by using the equation:

$KE=0.0443WV^2/N$

Where-

KE=Kinetic energy per wheel-brake assembly (ft.-lbs.);

W=Design landing weight (lbs.);

V=Aircraft speed in knots. V must be not less than V_{20} the poweroff stalling speed of the aircraft at sea level, at the design landing weight, and the landing configuration. For the accelerate-stop tests applicable only to wheel-brake assemblies for airplanes certificated under Part 25 of this chapter, the manufacturer must determine the most critical combination of takeoff weight and speed;

N=Number of wheels with brakes. For rotorcraft, the manufacturer must calculate the most critical combination of takeoff weight and brake application speed to be used in the above equation.

(ii) Method II. The speed and weight values may be determined by other equations based on rational analysis of the sequence of events expected to occur during an accelerate-stop condition or an operational landing at maximum landing weight. The analysis must include rational or conservative values for braking coefficients of friction between the tire and runway, aerodynamic drag, propeller drag, powerplant forward thrust, and, if critical, loss of drag credit for the most adverse single-engine or propeller due to malfunction. Do not consider the decelerating effects of propeller reverse pitch, drag parachutes, and powerplant thrust reversers.

(2) Test requirements. The wheel-brake assembly must bring the inertial testing machine to a stop at the average deceleration, and for the number of repetitions specified in Table III without failure, impairment of operation, or replacement of parts except as permitted in paragraph 4.2(a)(3).

Table III	
Category of aircraft	Test
Parts 23 and 25	KE_{DL}; 100 design landing stops at a deceleration selected by manufacturer but not less than 10 ft./sec.^{2}
Part 25	KE_{RT}; 1 accelerate-stop at a deceleration selected by manufacturer but not less than 6 ft./sec.^{2}
Parts 27 and 29	KE_{DL}; 20 design landing stops at a deceleration selected by manufacturer but not less than 6 ft./sec.^{2}

(3) General conditions.

(i) During landing stop tests (KE_{DL}), one change of brake lining is permissible. The remainder of the brake assembly parts must withstand the 100 KE_{DL} stops without failure or impairment of operation.

(ii) During the accelerate-stop test (KE_{RT}), brake lining and bare disks may be new or used. No less than two landing stop tests must have been completed on the brake prior to this test. The brake must be usable for taxi after the accelerate-stop test to KE_{RT}.

(iii) As used this paragraph, "braking lining" is either individual blocks of wearing material or disks which have wearing material integrally bonded to them. "Bare disks" are plates or drums which do not have wearing material integrally bonded to them.

(d) Brake structural torque test. Apply load S and a torque load specified in paragraph 4.2(b)(1) or (2), as applicable, for at least 3 seconds. Rotation of the wheel must be resisted by a reaction force transmitted through the brake or brakes by an application of at least maximum brake line

pressure or brake cable tension in the case of a nonhydraulic brake. If such pressure or tension is insufficient to prevent rotation, the friction surface may be clamped, bolted, or otherwise restrained while applying the pressure or tension.
(1) For landing gears with only one wheel per landing gear strut, the torque load is 1.2 SR where R is the normal loaded radius of the tire at rated inflation pressure under load S.
(2) For landing gears with multiple wheels per landing gear strut, the torque load is 1.44 SR where R is the normal loaded radius of the tire at rated inflation pressure under load S.

(c) Overpressure-hydraulic brakes. The brake with actuator piston extended to simulate a maximum worn condition must withstand hydraulic pressure for at least 3 seconds, equal to the following:
(1) For Airplanes, 2 times the maximum brake line pressure available to the brakes.
(2) For rotorcraft, 2 times the pressure required to hold the rotorcraft on a 20 degree slope at design takeoff weight.

(d) Endurance tests-hydraulic brakes. The hydraulic brake assembly must be subjected to an endurance test during which the total leakage may not exceed 5cc and no malfunction may occur during or upon completion of the test. Minimum piston travel during the test may not be less than the maximum allowable piston travel in operation. The tests must be conducted by subjecting the hydraulic brake assembly to-
(1) 100,000 cycles for airplanes, and 50,000 cycles for rotorcraft, of application and release of the average hydraulic pressure needed in the KE_{DL} tests specified in paragraph 4.2(a)(2) except that manufacturers using Method II in conducting the tests specified in paragraph 4.2(a)(2) must subject the wheel-brake assembly to the average of the maximum pressures needed in those tests. The piston must be adjusted so that 25,000 cycles for airplanes, and 12,500 cycles for rotorcraft, are performed at each of the four positions where the piston would be at rest when adjusted for 25, 50, 75, and 100 percent of the wear limit; and
(2) 5,000 cycles for airplanes, and 2,500 cycles for rotorcraft at the maximum system pressure available to the brakes.