UDC 629·13 : 629·11·012·551·3 : 620·1

(Reaffirmed 1995)

Indian Standard

SPECIFICATION FOR HIGH SPEED TUBELESS TYRES FOR CIVIL AIRCRAFT

PART 3 QUALIFICATION TESTS

Aircraft and Space Vehicles Sectional Committee, EDC 74; Panel for Aircraft Tyres and Their Associated Accessories, EDC 74/P-4 [Ref : Doc : EDC 74 (3934)]

1. Scope — In this part, the various qualification tests for new, high speed, tubeless tyres for main/ nose applications of civil aircraft whose ground speeds are greater than 192 km/h (120 mp/h) are covered. The design and performance requirements for these types of tyres are covered in Parts 1 and 2.

2. Test Requirements — The tests are broadly classified as follows:

a) Static tests
b) Dynamometer tests

3. Static Tests — Shall consist of the following:

a) Tyre dimensions
b) Over-pressure (pressure-proof test)
c) Bead seating pressure
d) Air-retention
e) Load deflection

3.1 *Tyre Dimensions* — The tyre dimensions shall be checked in accordance with **3.1.1**.

3.1.1 Mount the tyre on the specified rim, inflate it to its maximum rated inflation pressure and allow it to stand for a minimum of 12 h at normal room temperature. After this lapse of time, re-adjust the inflation to the original value.

3.1.2 Following the pressure adjustment, measure and record the following tyre dimensions:

Overall diameter, overall width, shoulder diameter and shoulder width.

3.1.3 When a tyre does not have readily identifiable shoulder point, measure the shoulder width at the maximum specified shoulder diameter.

3.2 *Over-Pressure (Pressure-Proof Test)* — Shall be checked as follows.

3.2.1 Mount the tyre on a test wheel of adequate strength and gradually inflate it hydraulically at a slow rate to minimum of 4 times the rated inflation pressure at ambient temperature. Pressure testing of tubeless tyres may be conducted with an inner tube fitted.

The tyre shall withstand this pressure for a minimum of three seconds.

3.3 *Bead Seating Pressure* — Is determined by the following test methods:

a) Carbon paper
b) Electrical

3.3.1 *Carbon paper method* — The bead seating pressure is determined by placing a sheet of carbon paper between two sheets of thin paper and placing these sheets between the flanges of the wheel and the bead of the tyre. The tyre is inflated and the pressure at which the heel of the bead touches the vertical face of the rim flange, as shown on the thin paper, is considered as the bead seat pressure.

3.3.2 *Electrical method* — Shall comprise of an arrangement shown in Fig. 1.

3.3.2.1 The test procedure is as given below:

The contact area of the wheel is cleaned to expose the metal surface. Three pieces of skim copper or steel, 120° from each other, are fixed to one tyre bead. The skims are held in place with light gauge non-conducting adhesive tape. The tape insulates the skims from the top of the rim flange. The procedure calls for the use of a battery, fitted with two leads, one of which is a fixed lead containing a lamp or ohm-meter and the other lead being used as the probe lead. The fixed lead is clipped to the wheel, and the probe lead is used to make contact with the three skims in turn.

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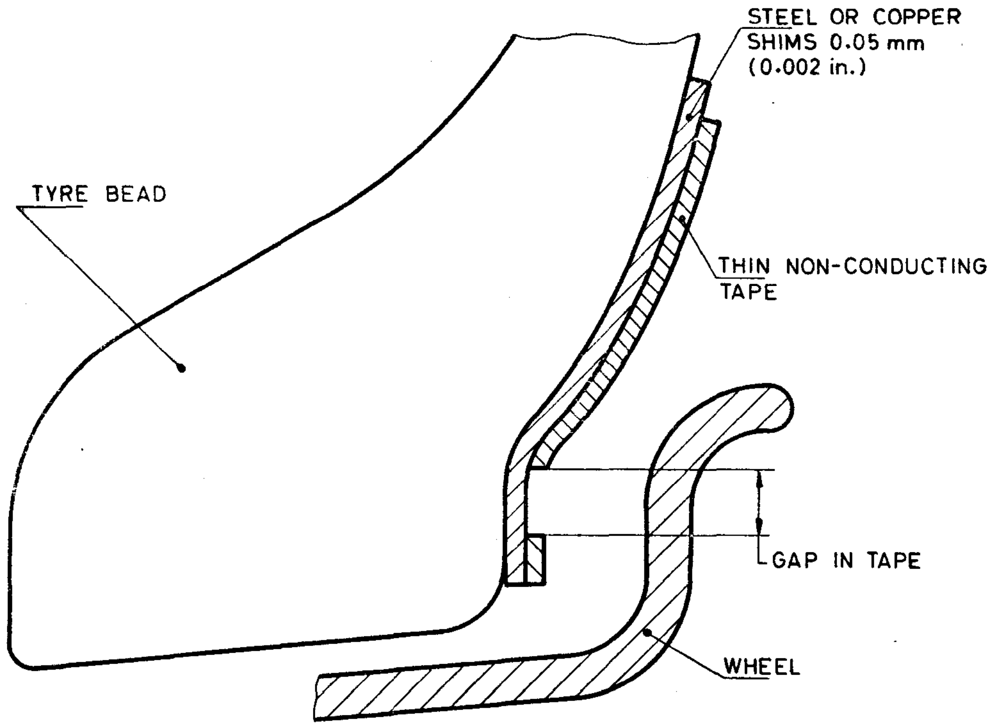


FIG. 1 BEAD SEATING PRESSURE-ELECTRICAL METHOD.

The tyre is inflated in increments, and after each increment, the probe lead is placed on the skims in turn. When the lamp lights or the ohm-meter reading is zero, at all three skim locations, the bead is considered to be fully seated on the wheel at the recorded inflation pressure, and that pressure is considered to be the bead seating pressure.

3.3.3 Any other procedures other than **3.3.1** and **3.3.2** may be used if these are recognized and approved by the Certifying Authorities. In all procedures the test shall be conducted without the use of lubricant on the tyre bead or rim.

3.4 *Air Retention Test* — The test is carried out as follows.

3.4.1 Inflate the tyre to the maximum rated inflation pressure and allow it to stand for a minimum period of 12 hours after which time, make good the pressure reduction due to tyre stretch. Then allow the tyre to stand for a further period of 24 hours, at the same ambient temperature, after which time, measure the pressure and determine the pressure drop. The pressure drop shall not exceed five percent of the rated inflation pressure.

3.5 *Load Deflection Test*

3.5.1 After the tyre has been mounted and inflated as specified in **3.1** the tyre and wheel are installed in a testing machine where deflection can be accurately measured. The assembly between wheel, axle and bushings shall be strong and free from vibrations so that the zero point can be accurately determined. The tyre is loaded three times at three different locations to a deflection greater than 50 percent, but not 'bottomed'. Measure and record the tyre overall diameter for each curve. To obtain the zero load and deflection point, move the tyre until it barely touches the flat plate. There shall be no pre-loading. Run the testing machine at the following point, move the tyre until it barely touches the flat plate. There shall be no pre-loading. Run the testing machine at the following crosshead speeds for plotting the load-deflection curve:

7·6 mm/min (*Max*) for tyres up to 762 mm diameter.
25·4 mm/min (*Max*) for tyres up to 762 mm diameter.

Load the tyre until 'bottoming' starts.

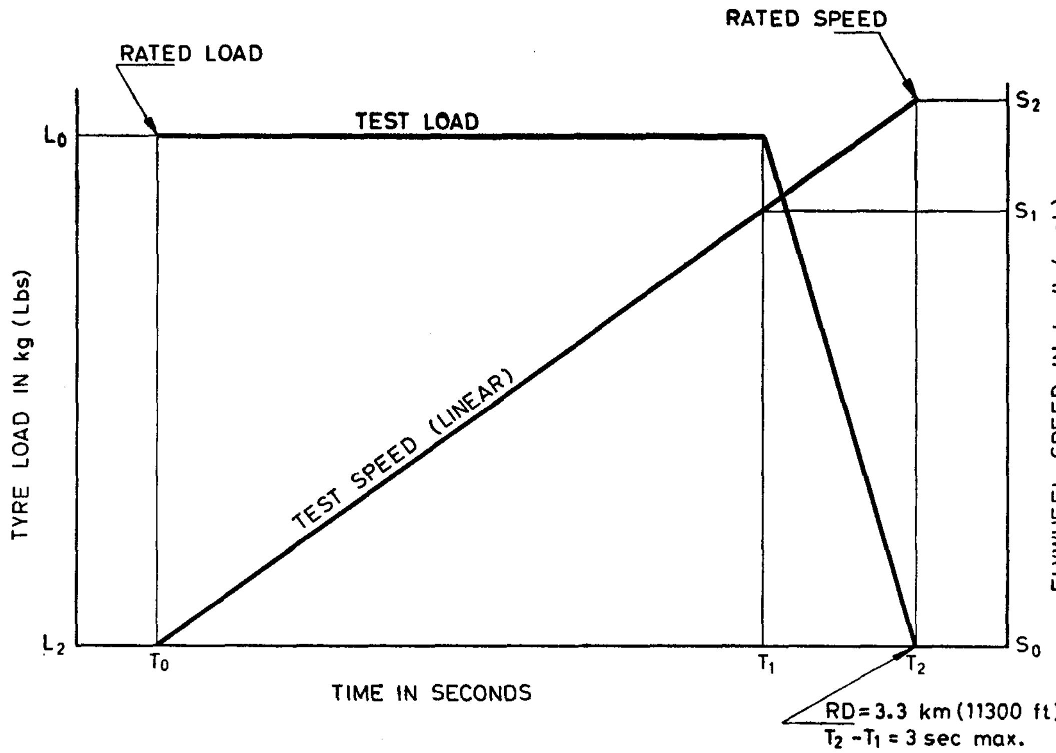
Obtain the load-deflection curves by starting at the lowest inflation pressure first, and allow 10 minutes between each curve run at a different inflation pressure including the rated inflation pressure. There shall be no pause at rated loads to determine data points.

Note 1 — A load-deflection curve at loads up to 1·5 times load rating of the tyre shall be obtained.

Note 2 — The nominal (static) loaded radius and nominal deflection are to be measured at rated load and inflation pressure.

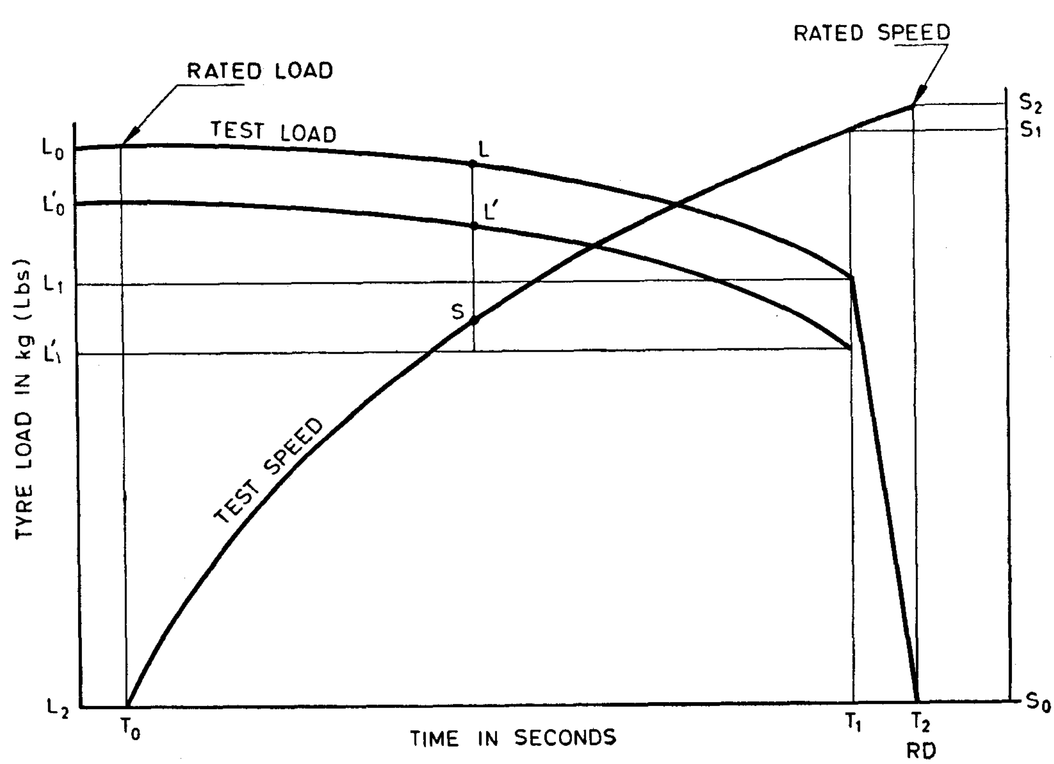
4. Dynamometer Tests — A single tyre specimen shall be used for the tests. The data compiled by the aircraft designer of representative load, speed time and distance shall be the basis for establishing the dynamometer test conditions. The dynamometer test conditions of load-speed temperatures shall comply with **4.1**, **4.2** and **4.3**.

4.1 *Dynamometer Test Loads* — The load at the start of the test shall be equal to the rated load of the tyre. The load at any time during the test shall be equal to the load shown on the established curve at that speed times the rated load of the tyre divided by the initial load-speed-time curve load of the tyre. Typical load-speed-time curves are shown in Fig. 2A and 2B.



Note — Test load at L_0 shall be equal to or greater than the rated load of tyre. Test speed at S_2 shall be equal to or greater than rated speed of the tyre.

FIG. 2A GRAPHIC REPRESENTATION OF A UNIVERSAL LOAD-SPEED-TIME TEST CYCLE



Note 1 — Operational load L' for most critical take-off conditions.

Note 2 — Test load at L_0 shall be equal to or greater than rated load of tyre. Test speed at S_2 shall be equal to or greater than rated speed of the tyre.

Note 3 — Test load L at any speed S shall be equal to or greater than operational load $L_1' \times \frac{L_0}{L_0'}$.

FIG. 2B GRAPHIC REPRESENTATION OF STANDARD LOAD-SPEED-TIME TEST CYCLE

Symbol Definitions for Test Curves

The numerical values which are used for the following symbols shall be determined from the applicable aircraft load-speed-time data.

L_0 = tyre load at start of take-off (not less than rated load),

L_1 = tyre load at rotation,

L_2 = zero tyre load (lift-off),

S_0 = zero tyre speed,

S_1 = tyre speed at rotation,

S_2 = tyre speed at lift-off (not less than speed rating),

T_0 = start of take-off,

T_1 = time to rotation,

T_2 = time to lift-off, and

RD = roll distance.

4.2 *Speeds* — The applicable dynamometer test speeds for corresponding maximum ground speeds are as follows:

Maximum Ground Speed of Aircraft km/h (mph)		Speed Rating of Tyre km/h (mph)	Minimum Dynamometer Speed at S_2 km/h (mph)
Over	Not Over		
192(120)	256(160)	256(160)	256(160)
256(160)	304(190)	304(190)	304(190)
304(190)	336(210)	336(210)	336(210)
336(210)	360(225)	360(225)	360(225)
360(225)	376(235)	376(235)	376(235)
376(235)	392(245)	392(245)	392(245)

For ground speeds over 392 km/h, the tyre shall be tested to the maximum applicable load-speed-time requirements and appropriately identified with proper speed ratings.

4.3 *Temperatures* — The temperature of the air contained in the tyre or of the carcass measured at the hottest point of the tyre shall not be lower than 49°C at the start of at least 90 percent of the test cycles specified in **4.6.3** and at least 40·5°C at the start of the overload test in **4.6.2** and of at least 90 percent of the tests specified in **4.6.1** and **4.6.3**. For the remaining 10 percent of each group of cycles the contained air or carcass temperature shall not be lower than 26·5°C at the start of each cycle.

Rolling of the tyre on the dynamometer is acceptable for obtaining the minimum starting temperature.

4.4 *Tyre Test Loads* — The tyre shall be forced against the dynamometer flywheel at not less than the rated load of the tyre during the entire roll distance of the test.

4.5 *Inflation Pressure*

4.5.1 *Test inflation pressure* — In order to compensate for the curvature of the flywheel, the inflation test pressure shall be adjusted in accordance with one of the following:

a) The test inflation pressure shall be the pressure required at an identified ambient temperature to obtain the same loaded radius against the flywheel of the dynamometer as the loaded radius for a flat surface.

b) By adjustment of the rated inflation pressure by application of the appropriate ratio obtained from Fig. 3 or 4. Adjustment of the test inflation pressure may not be made to compensate for increase due to temperature rise occurring during the tests.

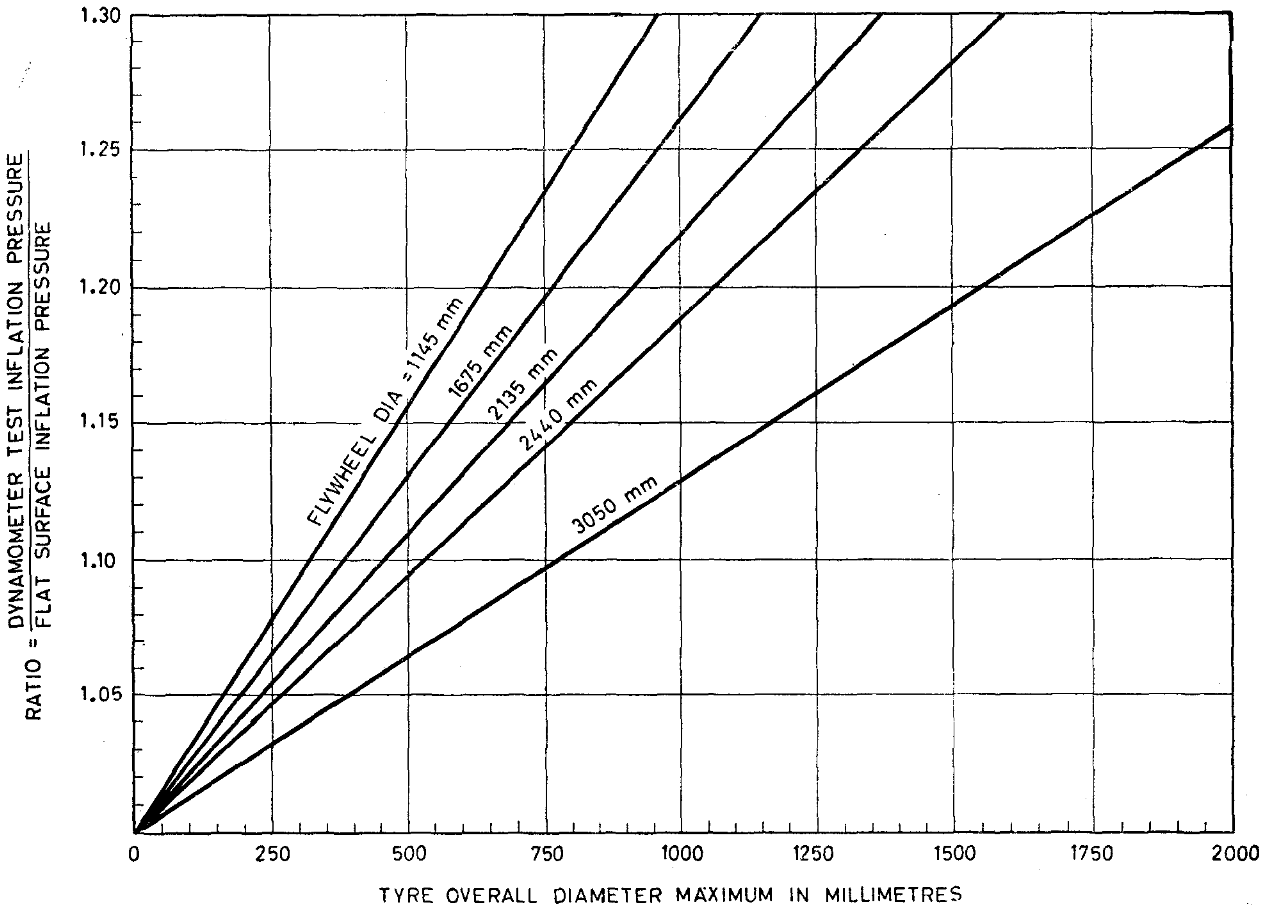


FIG. 3 CHART FOR ADJUSTING AIRCRAFT TYRE TEST INFLATION PRESSURE FOR FLYWHEEL CURVATURE, VALUES IN MILLIMETRES

4.6 *Test Cycles* — The test tyre shall withstand the following cycles during dynamometer testing:

a) 50-take-off cycles at rated load.

b) 1-overload take-off cycle at 1·5 times rated load.

c) 8 taxi cycles at rated load.

d) 2-overload taxi cycles at 1·2 times rated load.

The sequence of the cycles is, however, optional.

4.6.1 *Take-off cycles* — The dynamometer test cycles shall realistically simulate actual aircraft take-off performance on the runway.

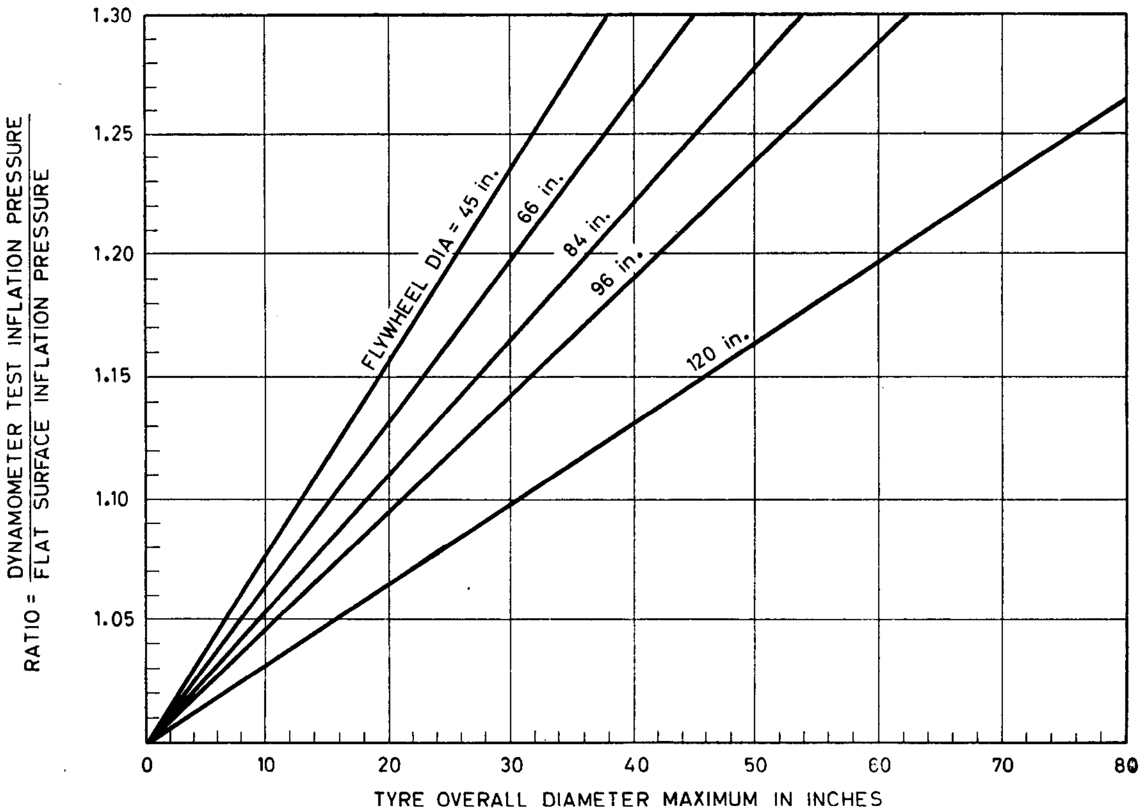


FIG. 4 CHART FOR ADJUSTING AIRCRAFT TYRE TEST INFLATION PRESSURE FOR FLYWHEEL CURVATURE VALUES IN INCHES

The specified load, speed, time and distance schedule are adopted wherein the dynamometer flywheel is accelerated to the applicable conditions as shown in Fig. 2A and 2B.

Fig. 2A defines a test cycle generally applicable to any aircraft.

Fig. 2B defines a test cycle, where the load, speed and distance shall be selected based on established design with the most critical take-off conditions.

4.6.2 *Overload take-off cycles* — The cycle shall duplicate the cycles specified in **4.6.1** except that the tyre load through the cycle shall be increased by a factor of at least 1·5. Upon completion of the overload take-off cycle the tyre shall be capable of retaining air pressure with the loss of pressure not exceeding 10 percent in 24 h from the initial test pressure. However, the degradation is permissible.

4.6.3 *Taxi cycles* — The tyre shall withstand at least 10 taxi cycles on a dynamometer under the following test conditions:

Number of Test Cycles	*Minimum Tyre Load*	*Minimum Peripheral Speed*	*Minimum Roll Distance*
	kg	km/h (mph)	*km (Feet)*
8	rated load	64 (40)	10·5 (35 000)
2	1·2 × rated load	64 (40)	10·5 (35 000)

Note — Nose wheel tyres do not require 7 percent factor on load but shall cover loads as specified for nose wheel tyres, *see* IS : 10992 (Part 2)-1984 'Specification for high speed tubeless tyres for civil aircraft : Part 2 'Performance requirements'.

Overload take-off and overload taxi (at 1·2 times rated load) tests are required if operating speeds are in excess of 192 km/h (120 mph) using the aircraft manufacturer's curve.

EXPLANATORY NOTE

The specification for high speed tubeless tyres for civil aircraft are covered in the following three parts:

Part 1 Design requirements
Part 2 Performance requirements
Part 3 Qualification tests

While preparing this part of the specification considerable assistance has been derived from the following publications:

ISO 3324 (Part 1)-1976 Aircraft tyres and rims: Part 1 Specifications. International Organization for Standardization.

ISO 3324 (Part 2)-1979 Aircraft tyres and rims: Part 2 Methods of test.

C 62 C TSO Technical standard order of Federal Aviation Administration, USA.

BS M 45-1974 Aircraft tyres — Aerospace series, British Standards Institution.

Wherever applicable, reference has been made to FPS system as the industry is still to change-over entirely to metric system. The conversion factors are given in Part 1 of this specification.

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