### Wheels - Passenger Car and Light Truck
### Performance Requirements and Test Procedures

## RATIONALE

This document has been updated to add a reference to SAE J3204.

## 1. SCOPE

This SAE Recommended Practice provides minimum performance requirements and uniform procedures for fatigue testing of wheels intended for normal highway use and temporary use on passenger cars, light trucks, and multipurpose vehicles. For heavy truck wheels and wheels intended to be used as duals, refer to SAE J267. For wheels used on trailers drawn by passenger cars, light trucks, or multipurpose vehicles, refer to SAE J1204. These minimum performance requirements apply only to wheels made of materials included in Tables 1 to 4. The minimum cycles noted in Tables 1 through 4 are to be used on individual test and a sample of tests conducted, with Weibull Statistics using two parameter, median ranks, 50% confidence level, and 90% reliability, typically noted as B10C50.

## 2. REFERENCES

### 2.1 Applicable Publications

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

### 2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J175       Wheels - Lateral Impact Test Procedure - Road Vehicles

SAE J267       Wheels/Rims - Truck and Bus - Performance Requirements and Test Procedures for Radial and Cornering Fatigue

SAE J1204      Wheels - Recreational and Utility Trailer Fatigue Test Procedure and Performance Requirements

SAE J2530      Aftermarket Wheels - Passenger Cars and Light Truck - Performance Requirements and Test Procedures

SAE J3010      Registration and Conformity Assessment Process for Passenger Cars and Light Trucks Wheels

Kinstler, J., "The Science and Methodology of SAE Wheel Fatigue Test Specifications," SAE Technical Paper 2005-01-1826, 2005, https://doi.org/10.4271/2005-01-1826.

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2.1.2    ISO Publications

Copies of these documents are available online at http://webstore.ansi.org/.

ISO 3006          Road Vehicles - Passenger Car Road Wheels - Test Methods

2.2    Related Documents

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1    SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J393          Nomenclature - Wheels, Hubs, and Rims for Commercial Vehicles

SAE J3204         Aftermarket Composite Wheels Made of Matrix Material and Fiber Reinforcement Intended for Normal Highway Use - Test Procedures and Performance Requirements

2.2.2    ISO Publications

Copies of these documents are available online at http://webstore.ansi.org/.

ISO 3911          Wheels/Rims - Nomenclature, Designation, Marking, and Units of Measurement

2.2.3    Tire and Rim Association Publications

Available from The Tire and Rim Association, Inc., 175 Montrose West Avenue, Suite 150, Copley, OH 44321, Tel: 330-666-8121, www.us-tra.org.

Yearbook, The Tire and Rim Association, Inc.

*Table 1 - Test factors and minimum cycle requirements for wheels*
*in normal highway service - dynamic cornering fatigue*

| Wheel Type (Material) | "S" Front | "S" Rear | Minimum Cycles |
|---|---|---|---|
| Ferrous All | 1.6 | 1.45 | 18000 |
| Cold Formed Aluminum 5000 Series[1] | 1.80 | 1.55 | 50000 |
| Aluminum Cast and Forged | 2.0 | 1.75 | 50000 |

[1]    With 3% or less magnesium content.

*Table 2 - Test factors and minimum cycle requirements for wheels*
*in normal highway service - dynamic radial fatigue*

| Wheel Type (Material) | "K" Front | "K" Rear | Minimum Cycles |
|---|---|---|---|
| Ferrous All | 2.25 | 2.0 | 400000 |
| Aluminum All | 2.5 | 2.25 | 600000 |

*Table 3 - Factors and minimum cycle requirements for temporary use wheels - dynamic cornering fatigue*

| Wheel Type (Material) | "S" Front | "S" Rear | Minimum Cycles |
|---|---|---|---|
| Ferrous All | 1.6 | 1.45 | 9000 |
| Cold Formed Aluminum 5000 Series[1] | 1.8 | 1.55 | 25000 |
| Aluminum Cast and Forged | 2.0 | 1.75 | 25000 |

[1]  With 3% or less magnesium content.

*Table 4 - Factors and minimum cycle requirements for temporary use wheels - dynamic radial fatigue*

| Wheel Type (Material) | "K" Front | "K" Rear | Minimum Cycles |
|---|---|---|---|
| Ferrous All | 1.65 | 1.45 | 400000 |
| Aluminum All | 1.80 | 1.60 | 600000 |

3.  DEFINITIONS

3.1   NORMAL HIGHWAY USE

A wheel intended for sustained, all position, use on a motor vehicle on improved surfaces with no special restrictions as to speed or distance traveled.

3.2   TEMPORARY USE

A wheel intended for "temporary use" only as a spare for the life of an original tire. Special speed restrictions may also apply.

4.   DYNAMIC CORNERING FATIGUE

4.1   Equipment

Use a test machine that: (see Figures 1 and 2)

a.   Imparts a constant rotating bending moment to the wheel.

b.   Maintains the test load within ±2.5%.

c.   Monitors and measures the deflection of the system at the point of load application during the test.

NOTE: MOMENT ARM
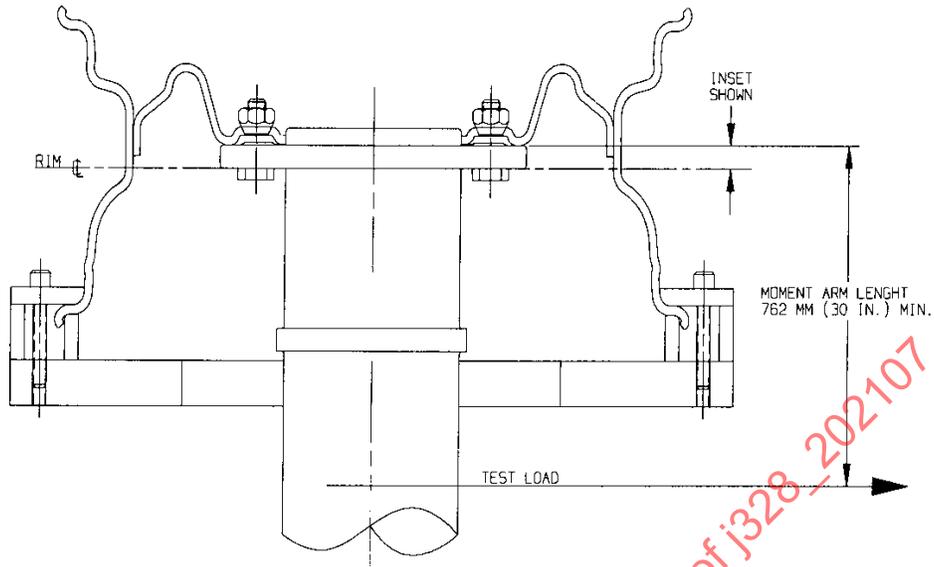MAY EXTEND ABOVE
TABLE INSTEAD OF
BELOW TABLE

INSET
SHOWN

RIM ℄

MOMENT ARM LENGTH
762 MM (30 IN.) MIN.

TEST LOAD

**Figure 1 - Dynamic cornering fatigue (typical set-up)**
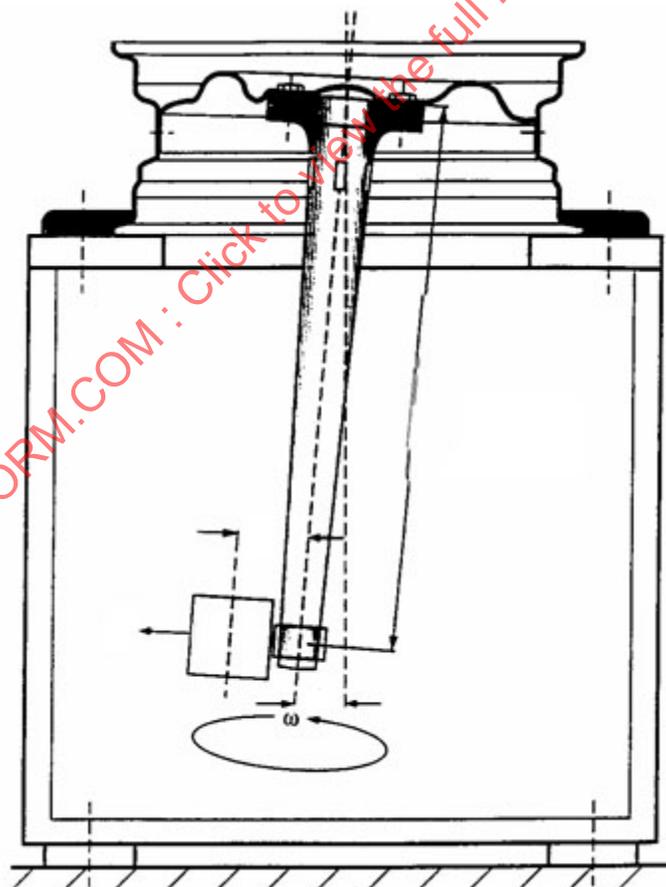
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**Figure 2 - Eccentric mass construction**

4.2    Procedure

a.  Use only fully processed new wheels, which are representative of wheels intended for the vehicle and ready for road use. Separate wheels are to be used for each test.

b.  Use a test adapter, studs, and nuts representative of those specified for the wheel.

c.  Verify the mating surfaces of the wheel and adapter are free of foreign material or excessive wear (wear plate optional).

d.  Attach a rigid load arm shaft and test adapter to the wheel mounting surface.

e.  Tighten the nuts as specified or as follows:

    M12x1.25, M12x1.5, M12x1.75, and 1/2x20   115 N·m ± 7 N·m

    M14x1.5, M14x2, and 9/16x18                          140 N·m ±7 N·m

f.  Clamp the rim securely to the test device.

g.  Adjust the system to be within 0.25 mm total indicator reading normal to the load arm shaft at the point of load application.

h.  Apply the test load parallel to the plane of the rim.

i.  Retightening allowed only when specified by wheel or vehicle manufacturer.

j.  Broken studs or other parts of the test fixture do not require test termination but may result in damage to the wheel and test invalidation. Optionally, all studs may be replaced and the test continued.

k.  Report data with the minimum number of fields noted in Appendix A.

4.3    Bending Moment Test Load Calculation

Calculate the bending moment (Force x Load Arm Length) to be applied to the test wheel as follows in Equation 1:

$$M = W(Ru + d)S \qquad \text{(Eq. 1)}$$

where:

    M = bending moment in N·m

Use M(front) or M(rear), whichever is greater as determined by Equations 2 and 3:

$$M(front) = W(front)(Ru + d)S(front) \qquad \text{(Eq. 2)}$$

and

$$M(rear) = W(rear)(Ru + d)S(rear) \qquad \text{(Eq. 3)}$$

where:

    W = 1/2 of the maximum vertical static load on the axle as specified in newtons by the vehicle manufacturer or the load rating of the wheel as specified by the wheel manufacturer; W(front), W(rear)

    R = static-loaded radius (SLR) of the largest tire specified by the vehicle manufacturer and/or wheel manufacturer; if the SLR is not specified, use the formula listed below: R= (Dr/2) + 0.77((Tire width (mm) x Tire section height ratio) - 17.5) +17.5 (mm)

u = coefficient of friction developed between the tire and the road; use u = 0.7

d = the inset or outset of the wheel in millimeters; use positive sign for inset and negative sign for outset

S = load factor—see Tables 1 or 3; S(front), S(rear)

W(front) = 1/2 of the maximum static load on the front axle or the load rating of the wheel in newtons

W(rear) = 1/2 of the maximum static load on the rear axle in newtons

Dr = nominal rim diameter in inches; needs to be converted to millimeters for use in formula

### 4.4    Test Termination/Suspension

### 4.4.1    Test Termination

Terminate the test when any of the following conditions occur.

a.   Wheel exceeds the initial deflection at point of load application by 20%.

b.   A visually detected crack penetrating through a section of the wheel in the base metal or propagation of any existing fracture/crack resulting in a fatigue crack penetrating through any section of the wheel at the minimum cycle requirement.

c.   Cracking in the wheel finish alone shall not be the basis for finding a test termination.

### 4.4.2    Test Suspension

Test can be suspended at 2x minimum cycle requirement.

### 5.   DYNAMIC RADIAL FATIGUE

### 5.1    Equipment

Use a test machine that: (see Figure 3)

a.   Has a driven rotatable drum which presents a smooth surface wider than the loaded test tire section width.

b.   Has a suggested drum diameter of 1707 mm – 187 revolutions per kilometer (67.23 inches – 300 revolutions per mile).

c.   Imparts a constant load to the test wheel and tire normal to the surface of the drum and in line radially with the center of the test wheel and drum.

d.   Can maintain the test load within ±2.5%.

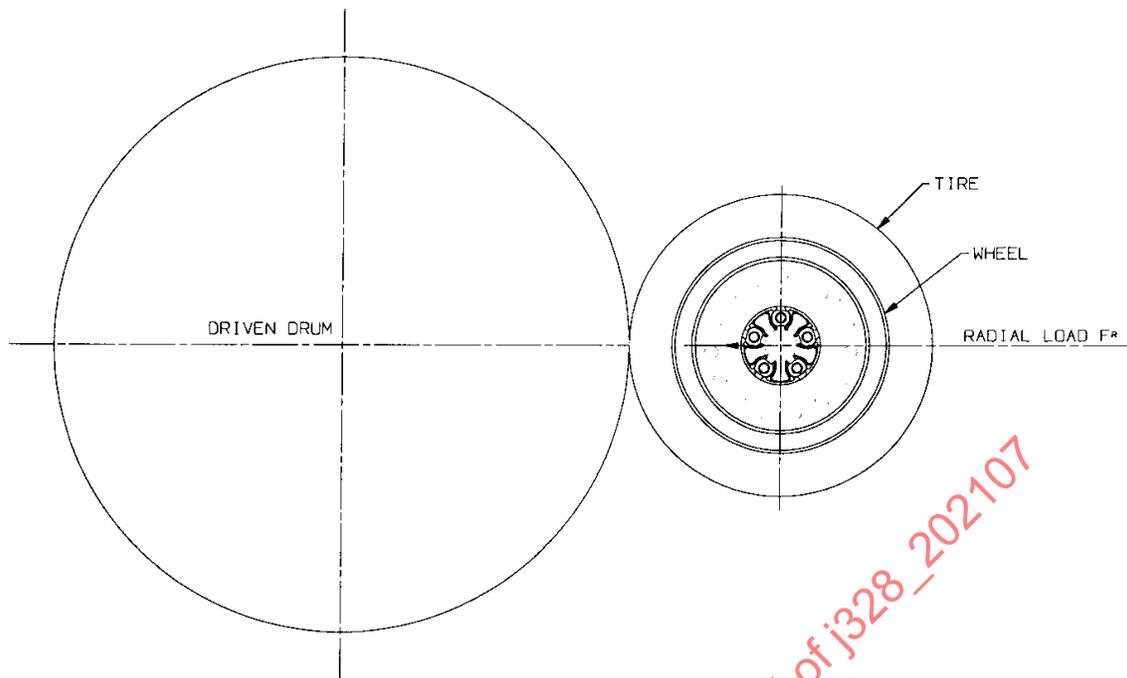e.   The rotational axis of the test wheel and drum are parallel.

*Figure 3 - Radial fatigue (typical set-up)*

5.2    Procedure

a.  Use only fully processed new wheels, which are representative of wheels intended for the vehicle and ready for road use. Separate wheels are to be used for each test.

b.  Select test tires that are representative of the maximum size and type approved by the vehicle or wheel manufacturer for the wheel under test.

c.  Use a test adapter, studs, and nuts that are representative of those specified for the wheel.

d.  Mount and inflate the tire to 448 kPa ± 14 kPa (65 psi ± 2 psi) for tires with usage pressure of 310 kPa (45 psi) or less. For wheels and tires intended for use at higher pressures, use 1.2 times the usage pressure, but not less than 448 kPa ± 14 kPa (65 psi ± 2 psi).

e.  Tighten the nuts as specified or as follows:

M12x1.25, M12x1.5, M12x1.75, and 1/2x20  115 N·m ± 7 N·m

M14x1.5, M14x2, and 9/16x18                      140 N·m ± 7 N·m

f.  There may be an increase in inflation pressure during the test. This is normal, but it is permissible to adjust back to the test pressure.

g.  Use caution as the test tires are severely overloaded and may fail.

h.  Failure of the test tire or other parts of the test fixture does not require test termination, but may result in damage to the wheel and test invalidation. Optionally, the tire may be replaced and the test continued.

i.  Report data with the minimum number of fields noted in Appendix B.

5.3    Radial Test Load Calculation

The radial load to be applied to the wheel shall be determined as follows in Equation 4:

$$F = WK \quad \text{(Eq. 4)}$$

where:

F = radial load (N)

Use F(front) or F(rear), whichever is greater as determined by Equations 5 and 6:

$$F(front) = W(front)*K(front) \quad \text{(Eq. 5)}$$

where:

W(front) = 1/2 of the maximum static load (N) on the front axle or the load rating of the wheel as specified

K(front) = load factor (front); see Tables 2 or 4

$$F(rear) = W(rear)*K(rear) \quad \text{(Eq. 6)}$$

where:

W(rear) = 1/2 of the maximum static load (N) on the rear axle

K(rear) = load factor (rear); see Tables 2 or 4

5.4    Test Termination/Suspension

5.4.1    Terminate the test when any of the following conditions occur:

a.    Inability of the wheel to sustain the test load.

b.    A visually detected crack penetrating through a section of the wheel in the base metal or propagation of any existing fracture/crack resulting in a fatigue crack penetrating through any section of the wheel at the minimum cycle requirement.

c.    Cracking in the wheel coating alone shall not be the basis for finding a test termination.

5.4.2    Test Suspension

Test can be suspended at 2x minimum cycle requirement.

5.5    Acceptance Criteria

The wheel conforms to this test if all elements in Sections 4 and 5 are met, and the B10C50 of cycles at test termination meet or exceed the minimum cycle requirement noted in Tables 1 through 4.