

## Road traffic

### No. 287 § 30 StVZO (Regulations authorising the use of vehicles for road traffic)

#### here: Guidelines for the testing and inspection of custom wheels for motor vehicles and their trailers

Bonn, November 25, 1998

StV 13/36.25.07-20.01

The minimum technical requirements pertaining to custom wheels, as defined in the "Guidelines for the testing and inspection of custom wheels for passenger cars and motorcycles" of July 27, 1982 (Transport Bulletin 1982, page 276), have been updated to include additional requirements which have in the meantime become evident from experience with the use of these wheels. In addition to test and inspection requirements some of which have been amended, a "mounting test" has been adopted in these guidelines; this means that expert opinions can now include statements regarding any modification to the vehicle's bodywork or chassis that may be necessary.

In view of the wide-range of custom wheels now available on the market the scope of the guidelines has been extended to all types of vehicles.

Now that the criteria to be fulfilled by testing authorities and by alternative test and inspection specifications have been defined, testing authorities outside Germany will also be able to qualify as experts accredited with the Kraftfahrt-Bundesamt (Federal Motor Vehicle Agency in Germany = KBA) and to obtain general type approvals as per § 22 of the StVZO for these custom wheels, or to prepare component expertises according to § 19, Section 3 no 4 of Annex XIX (StVZO).

Manufacturers of custom wheels are now obliged to establish and maintain a quality assurance system in line with international standards.

After approval by the competent state authorities, the guidelines outlined below will be published and applicable with immediate effect.

### Transition periods

For the ident and duplicate wheels defined in these guidelines

- which qualify for the simplified testing and inspection procedure as per Annex 1, and
- the production of which was started prior to December 31, 1998 and is still in progress,

the following transition periods apply:

- a) an application for the issue of a general type approval must be submitted, together with all the necessary documents to the KBA by July 1, 1999 at the latest.
- b) evidence of a quality assurance system conforming to Article 6 of these guidelines must be furnished to the approval authority by July 1, 1999 at the latest.
- c) where wheel manufacturers have appropriate testing and inspection equipment evidence of in-house-tests and inspections carried out by the wheel manufacturers will be recognised until July 1, 1999. The Technical Service may verify the submitted test results by way of random spot checks.
- d) up to September 30, 1999 wheels can still be manufactured on the basis of the "Guidelines for the testing and inspection of custom wheels for passenger cars and motorcycles" of July 27, 1982 (Transport Bulletin 1982, page 276).

On expiry of the transition periods for ident and duplicate wheels, the "Guidelines for the testing and inspection of custom wheels for passenger cars and motorcycles" of July 27, 1982, Transport Bulletin 1982, page 276, amended on October 18, 1991, Transport Bulletin 1991, page 736, will be repealed at the latest by September 30, 1999.

The DIN standards quoted in these guidelines may be ordered from the publishing house Beuth Verlag in 10772 Berlin.

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Construction and Housing  
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**Annex 1: Simplified testing and inspection procedure for ident and duplicate wheels**

Note: The obligations outlined in Council Directive 83/189/EEC of March 28, 1983, which lays down an information procedure in the field of standards and technical specifications (Official EC Journal No. L 109, page 8), last amended by Directive 94/10/EC, passed by the European Parliament and the European Council on March 23, 1994 (Official EC Journal No. L 100, page 30), have been met.

## 1. Scope

These guidelines provide for a standardised assessment procedure for custom wheels. This procedure will serve as a basis for preparing expertises for the general type approval of vehicle components as per § 22 StVZO, for preparing expertises on components as per § 19, Section 3, no 4, Annex XIX StVZO and expertises for individual acceptance tests as per § 21 StVZO.

The individual sections of these guidelines cover the testing and inspection of custom wheels for the following types of vehicles:

- passenger cars and off-road vehicles
- motorcycles
- lorries and omnibuses with tapered bead seat rims, rim diameter code 17.5 to 22.5
- trailers for passenger cars (rim diameter code 12 to 16)
- trailers/semi-trailers for lorries (with tapered bead seat rims, rim diameter code 17.5 to 22.5)

## 2. Definitions

### 2.1 Normal operating conditions

Normal operating conditions are considered to be the use of the vehicle within the technical limits stipulated by StVZO, which will depend on the road conditions in the different EU Member States.

### 2.2 Wire-spoke wheel

Wire-spoke wheels are wheels where the rim is joined to the hub by wire-spokes and fastening nipples.

### 2.3 Triple axis

Bogies of trailers and semi-trailers in accordance with EEC Directive 96/53/EEC.

### 2.4 Dynamic tyre radius

The dynamic tyre radius is the rolling circumferences divided by  $2\pi$  determined in accordance with DIN 70020 at 60 km/h.

### 2.5 Single-piece wheels

Single-piece wheels are wheels the body of which consists of only one piece.

### 2.6 Offset

The offset is the distance from the centre of the rim (half rim width) of the wheel to the wheel attachment face. The offset is considered positive if the wheel attachment face is displaced from the centre of the wheel towards the outside of the wheel (DIN 70020 part 5) and regarded as negative if it is displaced towards the inside of the wheel.

### 2.7 Rim

The rim is the part of the wheel, consisting of the rim flange, bead seat and rim base, which carries the wheel.

### 2.8 Rim width

The rim width is the distance between the insides of the rim flanges. This dimension is either coded or given in mm.

### 2.9 Nominal rim diameter

The nominal rim diameter is the diameter in the bead base of the bead seat. It is mostly not given in mm but represented by a code which is identical to the diameter stated in inches.

### 2.10 Rim base

The rim base is the internal base of the rim

- 2.11 Rim flange**  
The rim flange forms the outer limit of the bead seat in axial direction.
- 2.12 Bead seat**  
The bead seat is the seating face for the tyre bead.
- 2.13 Rim circumference**  
The circumference of a wheel measured with a rim tape measure as per DIN 7838 or DIN 7839.
- 2.14 Off-road vehicle**  
Off-road vehicles within the meaning of these guidelines are those vehicles which conform to the definitions given in Directive 70/156/EEC, version 92/53/EEC, Annex II, A. Number 4.
- 2.15 Number of load cycles**  
Number of load cycles or "overrolls" is the number of complete oscillations of the rotating or, if necessary, alternating test moment.
- 2.16 PCD (Pitch-circle diameter)**  
The PCD is the pitch-circle diameter of the bolt-holes for mounting the wheel on the vehicle hub.
- 2.17 Centering**  
The centering enables the wheel to be centred on the hub flange.
- 2.18 Hub cap**  
The hub cap is a cover over the centre hole area.
- 2.19 Wheel attachment face**  
The wheel attachment face is the flat (inner mating face) surface of the wheel which lies against the hub flange.
- 2.20 Wheel connecting dimensions**  
The wheel connecting dimensions are the dimensions specified by the vehicle manufacturer for mounting the wheel.
- 2.21 Wheel mounting parts**  
The wheel mounting parts are the accessories required for mounting the wheel
- 2.22 Wheel family**  
A wheel family comprises custom wheels with identical cast wheel bodies and with the same contour, whose design differs with respect to PCD, number of holes, offset, centre hole diameter and diameter of the mounting holes.
- 2.23 Wheel load**  
Wheel load is the normal force acting in the contact face of the tyre.
- 2.24 Side force**  
The side force is the horizontal force component, transverse to the direction of travel, which acts on the tyres during cornering, if the wind comes from one side or if the road slopes to one side.
- 2.25 Humps**  
Humps are bead seats in accordance with DIN, ISO or E.T.R.T.O. standard
- 2.26 Disk wheels**  
Disk wheels consist of the rim and a wheel disk (wheel nave) welded, riveted or bolted to it.

**2.27 Custom wheels**

Custom wheels are wheels which, provided they comply with certain requirements, may be used on a vehicle, but are not covered by the vehicle type approval.

**2.27.1 Ident wheels**

Ident wheels are wheels which are manufactured with the same manufacturing equipment as that used for wheels fitted by the vehicle manufacturer during series production. They are covered by the vehicle type approval and differ from standard wheels only by the absence of trademarks and/or the part number of the vehicle manufacturer and the additional identification as per 3.3. Ident wheels can be subjected to the simplified testing and approval procedure (see Annex 1).

**2.27.2 Duplicate wheels**

Duplicate wheels are steel-disk wheels which are replicas of the wheels fitted during series production and approved with the vehicle type approval. With regard to the dimensions, materials and service life, they correspond fully to the wheels fitted in series production. Duplicate wheels can be subjected to the simplified testing and approval procedure (see Annex 1).

**2.28 Taper bead seat rims**

Taper bead seat rims have tyre seating faces with a bead angle of 15°.

**2.29 Technical crack**

A technical crack is a material separation with a propagation of more than 1 mm due to the effect of a dynamic test load.

**2.30 Compound constructions**

Compound wheels are wheels the wheel bodies of which consist of several parts or several different materials.

### **3. Requirements**

#### **3.1 General requirements**

- 3.1.1 These guidelines serve to establish a standardised assessment procedure for custom wheels. They may also be used to assess the wheels of one-off vehicles or small series of vehicles if the manufacturers cannot furnish any evidence of their having the necessary strength and durability for the intended purpose.
- 3.1.2 Since modifications to the vehicle (e.g. to parts of the chassis, steering system or car body) may become necessary, or restrictions with respect to tyres (load-rating restrictions, ABS suitability, suitability for fitting, driving behaviour) may have to be taken into consideration, the effectiveness of custom-wheel approval as per § 22 of the StVZO, paragraph 1 can be made subject to acceptance of the modification by an officially recognised motor-vehicle or traffic expert or inspector or by an employee who fulfils the requirements outlined in Section 7.4 a of Annex VIII to the StVZO.<sup>1</sup>
- 3.1.3 A technical expertise will be needed to confirm that the requirements outlined in these guidelines are satisfied.
- 3.1.4 As per Annex XIX to the StVZO, a Technical Service or Test Authority is a test laboratory recognised in terms of the DIN EN 45001 standard (issue May 1990) or an accredited laboratory for the testing and inspection of vehicle wheels in terms of DIN EN 45001 (issue May 1990) and DIN EN 45002 (issue May 1990) standards. The leading Technical Service responsible for the implementation of these guidelines is TÜV Automotive GmbH, TÜV Süddeutschland Group, Daimlerstraße 11, D-85744 Garching.

Tests and inspections as well as expertises carried out or prepared in line with these or equivalent guidelines by the competent testing authorities of other EU Member States, or third countries in which the agreement on the European Economic Area is valid, are also recognised. "Equivalent" means that the requirements outlined in these guidelines are likewise satisfied on a permanent basis.

Competent test authorities of other EU Member States or third countries in which the agreement on the European Economic Area applies are test authorities which are recognised by the competent local approval authority in line with the DIN EN 45001 (issue May 1990) standard or accredited for the testing and inspection of vehicle wheels in line with the standards DIN EN 45001 (issue May 1990) and DIN EN 45002 (issue May 1990).

- 3.1.5 The following is taken for granted as far as the preparation of expert reports on custom wheels is concerned: manufacturers of such custom wheels must provide evidence that they maintain a quality assurance system for their production process, which is in line with the harmonised standard EN 29 002 (issue December 1987) or an equivalent standard relating to the manufacturing of these parts.

Such evidence can be furnished in the form of a quality assurance system certified and monitored by a notified body as per module D (QA production) of the Council Resolution passed on December 13, 1990 relating to the modules to be used in technical harmonisation directives pertaining to the various stages of conformity evaluation procedure (90/683/EEC) (Official Journal of the EC no L 380 page 13) in line with Section 2 of Annex XIX to StVZO.

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<sup>1</sup> As of December 1, 1999, this regulation will be replaced by no. 4 of Annex VIII b of the StVZO (28th regulation on the amendment of regulations of May 20, 1998)

- 3.1.6 The Technical Services and test authorities agree on the respective measuring and test equipment. Further calibrations are carried out every six months or once a year in accordance with the particular laboratory manuals.

### **3.2 Wheel-specific requirements**

- 3.2.1 The connecting dimensions for mounting the wheel must correspond to the dimensions and tolerances stipulated by the vehicle manufacturer or outlined in the relevant standards.
- 3.2.2 The wheel centring method specified by the vehicle manufacturer must be maintained.
- 3.2.3 The rim shape shall conform to an internationally approved standard. The standard used shall be stated. Where there are deviations in the rim base, appropriate tests and inspections must be carried out to verify that these deviations are not a cause for technical concern. If a rim does not conform to the standard, the tyre manufacturer must confirm that the tyre intended for the rim in question can be used. It must be ensured that the tyre is suitable for all loads that may be encountered during driving, and that it remains firmly seated on the rim.
- 3.2.4 Custom wheels shall also have humps if these are present on the standard wheels.
- 3.2.5 The testing of custom wheels shall include the necessary wheel mounting parts.
- 3.2.6 Only materials with adequate corrosion and ageing resistance shall be used. In cases of doubt, the technical service or approval authority may demand additional tests.

### **3.3 Wheel identification**

Wheels in accordance with these guidelines shall be provided with the following clearly legible and durable identification at a protected point, which must be visible while the wheel is mounted:

- Manufacturer or registered manufacturer's trademark.
- Rim size according to standard.
- Type and/or model designation.
- Date of manufacture (stating at least month and year).
- Type designation after award of general type approval or identification in line with the component expertise or identification in line with expertise as per § 21 StVZO (type mark or identification must be provided on the visible side of the wheel).
- Offset or half dual spacing (for lorries with twin arrangement).

**4. Test procedures to be applied (by vehicle types)****4.1 Passenger cars and off-road vehicles**

	<b>Passenger cars and off-road vehicles</b>				
Restriction	none				
Base material	Aluminium		Magnesium		Steel
Type	single-piece	compound construction	single-piece	compound construction	disk wheel
4.6.1 Bending fatigue test	x	x	x	x	x
4.6.2 Rim rolling test	x <sup>1)</sup>	x	x	x	x
4.6.3 Energy absorption test	--	--	--	--	--
4.6.4 Impact test	x	x	x	x	--
4.6.5 Alternating torsion test	x <sup>2)</sup>	x <sup>2)</sup>	x <sup>2)</sup>	x <sup>2)</sup>	--
4.6.6 Corrosion test	x <sup>3)</sup>	x <sup>3)</sup>	x	x	--
4.6.7 Materials test	x	x	x	x	x
4.6.8 Mounting test	x	x	x	x	x

x = test required

-- = test not required

1) Required on wheels for off-road vehicles and special types of wheels.

2) Test is required if the number and cross-sections of spokes give rise to technical concerns

3) Test required if there is doubt regarding corrosion and ageing resistance.

## 4.2 Motorcycles

Restriction	Motorcycles				
	none				
Base material	Aluminium		Magnesium		Rim and wheel hub: aluminium or steel
Type	single-piece	compound construction	single-piece	compound construction	Wire-spoke wheel
4.6.1 Bending-fatigue test	x	x	x	x	x
4.6.2 Rim rolling test	x	x	x	x	x
4.6.3 Energy absorption test	x	x	x	x	--
4.6.4 Impact test	--	--	--	--	--
4.6.5 Alternating torsion test	x	x	x	x	x
4.6.6 Corrosion test	x <sup>1)</sup>	x <sup>1)</sup>	x	x	x <sup>1)</sup>
4.6.7 Materials test	x	x	x	x	x
4.6.8 Mounting test	x	x	x	x	x

x = test required

-- = test not required

<sup>1)</sup> A test is necessary if there is doubt regarding corrosion or ageing resistance

## 4.3 Trailers for passenger cars

Restriction	Passenger-car trailers				
	Rim diameter code 12 - 16				
Base material	Aluminium		Magnesium		Steel
Type	single-piece	compound construction	single-piece	compound construction	disk wheel
4.6.1 Bending-fatigue test	x	x	o	o	x
4.6.2 Rim rolling test	--	x	o	o	x
4.6.3 Energy absorption test	--	--	o	o	--
4.6.4 Impact test	x	x	o	o	--
4.6.5 Alternating torsion test	--	--	o	o	--
4.6.6 Corrosion test	x <sup>1)</sup>	x <sup>1)</sup>	o	o	--
4.6.7 Material test	x	x	o	o	x
4.6.8 Mounting test	x	x	o	o	x

x = test required

-- = test not required

o = test requirements not specified

<sup>1)</sup> A test is necessary if there is doubt regarding corrosion or ageing resistance

**4.4 Lorries and omnibuses**

	Lorries and omnibuses			
Restriction	Taper bead seat rims, rim diameter code 17.5 - 22.5			
Base material	Aluminium		Magnesium	
Type	Single-piece	compound construction	Single-piece	compound construction
4.6.1 Bending-fatigue test	x	o	o	o
4.6.2 Rim rolling test	x	o	o	o
4.6.3 Energy absorption test	x	o	o	o
4.6.4 Impact test	--	o	o	o
4.6.5 Alternating torsion test	--	o	o	o
4.6.6 Corrosion test	x <sup>1)</sup>	o	o	o
4.6.7 Materials test	x	o	o	o
4.6.8 Mounting test	x	o	o	o

x = test required

-- = test not required

o = test requirements not specified

<sup>1)</sup> A test is necessary if there is doubt regarding corrosion or ageing resistance**4.5 Trailers / semi-trailers for lorries and semi-trailer towing vehicles**

	Trailers / semi-trailers for lorries and semi-trailer towing vehicles			
Restriction	Taper bead seat rims, rim diameter code 17.5 - 22.5			
Base material	Aluminium		Magnesium	
Type	single-piece	compound construction	single-piece	compound construction
4.6.1 Bending-fatigue test	x	o	o	o
4.6.2 Rim rolling test	x	o	o	o
4.6.3 Energy absorption test	x	o	o	o
4.6.4 Impact test	--	o	o	o
4.6.5 Alternating torsion test	--	o	o	o
4.6.6 Corrosion test	x <sup>1)</sup>	o	o	o
4.6.7 Materials test	x	o	o	o
4.6.8 Mounting test	x	o	o	o

x = test required

-- = test not required

o = test requirements not specified

<sup>1)</sup> A test is necessary if there is doubt regarding corrosion or ageing resistance

**4.6 Test procedures**

**4.6.1 Bending fatigue test**

4.6.1.1. Test procedure

In the bending fatigue test the side forces acting on the wheel during cornering are simulated. To verify adequate strength, two wheels must be tested for each load level. Each wheel is clamped rigidly to a test rig, and a rotary bending moment  $M_b$  is applied appropriately via the wheel attachment face (e.g. by means of a load arm with flange with the same connecting dimension as the intended vehicle). Light-alloy wheels are clamped by means of a clamping ring on the inner rim flange. Where alternative methods of clamping are used, these must be proved to be equally reliable.

The connecting bolts or nuts are tightened with the tightening torque specified by the vehicle manufacturer, and retightened after approximately 10,000 load cycles.

4.6.1.2 Test formulae:

Passenger car and off-road vehicles	$M_{bmax} = f * F_R(\mu * r_{dyn} + e)$
Lorries and omnibuses	
Trailers/semi-trailers for lorries /semi-trailer towing vehicles	
Trailers for passenger cars	
Motorcycles	$M_{bmax} = f * F_R(r_{dn} + e + l)$

- $M_{bmax}$ : reference moment for load levels [Nm]
- $F_R$ : permissible static wheel load [N]
- $r_{dyn}$ : dynamic tyre radius of the largest intended tyre [m]
- $e$ : offset (as per DIN 70020) [m]
- $l$ : half width of tread [m]
- $f$ : wheel load increase factor [-]
- $\mu$ : coefficient of friction between tyre and road [-]

4.6.1.3 Correction factors

If wheels are connected to unsteered, rigid triple axis units of trailers/semi-trailers for lorries / semi-trailer towing vehicles, the actually permissible wheel load must be reduced to 0.933 times the underlying wheel load ( $F_R$ ) or the test continued until twice the minimum number of load cycles have been exerted. There must be no technical crack.

4.6.1.4 The test is carried out according to the following criteria. A new wheel must be used for each load level ( $x \% * M_{bmax}$ ):

	Passenger car and off-road vehicle	Motorcycles	Passenger-car trailers	Lorries / semi-trailer towing vehicles and omnibuses	Trailers/semi-trailers for lorries
Coefficient of friction $\mu$	0.9	--	0.9	0.7	0.7
Wheel load increase factor $f$	2.0	Front wheel: 0.80 Rear wheel: 0.60	2.0	2.73	2.52

Set number of load cycles per minute	Set number of load cycles per minute as high as possible, but below natural resonance threshold.
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**Aluminium / Magnesium**

	Passenger car and off-road vehicle	Motorcycles	Passenger-car trailers	Lorries / semi-trailer towing vehicles and omnibuses	Trailers/semi-trailers for lorries
Minimum number of load cycles at 75% $M_{bmax}$	$2.0 * 10^5$	$1.0 * 10^6$ (at 100% $M_{bmax}$ )	$0.66 * 10^5$	$1.0 * 10^6$	
Minimum number of load cycles at 50% $M_{bmax}$	$1.8 * 10^6$	--	$0.69 * 10^6$	$5.0 * 10^6$	
Assessment criteria	Free from technical cracks				
Permissible drop in tightening torque	$\leq 30 \%$			$\leq 20\%$	

**Steel**

	Passenger cars and off-road vehicles	Motorcycles	Passenger-car trailers
Minimum number of load cycles at 75% $M_{bmax}$	$6.0 * 10^4$	$3.5 * 10^5$ (at 100% $M_{bmax}$ )	$2.0 * 10^4$
Minimum number of load cycles at 50% $M_{bmax}$	$6.0 * 10^5$	--	$2.3 * 10^5$
Assessment criteria	An excitation-rod deflection which is 10% greater than that determined after approximately 10,000 load cycles		
Permissible drop in tightening torque	$\leq 30 \%$		

-- = test not required

## 4.6.1.5 Test routine for wheel families

Wheels of one wheel family with the same number of bolt holes, identical contours, different pitch-circle diameters and/or different offsets may be combined and subjected to equal or lower test moments if the following test routine is adhered to. Wheel types with the largest central hole must be included in the test. A negative test may be offset against two positive tests. In the case of a second negative test result, modified test samples must be requested.

Required tests:

Wheels to be tested	Bending fatigue test (additional)	
	KZ	LZ
Smallest PCD	1	1
Largest PCD	1	1
Other PCDs		
≤ 6.5 mm	-	-
> 6.5 mm (additional)	1	1
Other offsets		
≤ 2 mm	-	-
> 2 to 5 mm	1	-
> 5 mm	1	1

Tests in the case of a subsequent wheel-load increase

static wheel load up to 6000 N:		
≤ 2 % <sup>1)</sup>	-	-
> 2 to 10 %	1	1
static wheel load higher than 6000 N: (max. 10% increase in test moment)	1	1

KZ = bending fatigue test at 75 %  $M_{bmax}$

LZ = bending fatigue test at 50%  $M_{bmax}$

If the test-moment increase is more than 10% compared to that of the initial assessment, the entire test must be repeated.

<sup>1)</sup> Procedure only permissible if initial assessment was completed without any complaints

#### 4.6.2 Rim rolling test

4.6.2.1 The stress acting on the wheel in straight-ahead driving or during cornering is simulated in rim rolling tests. For this purpose, two wheels are rolled on an external-drum test rig with a minimum diameter of 1.7m. If similar but not identical test rigs are used, the transferability of the results must be verified.

4.6.2.2 Test formula:

All types of vehicles	$F_P = f * F_R$
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$F_P$  = test load [N]

$F_R$  = permissible static wheel load [N]

f = wheel load increase factor [-]

4.6.2.3 The test is carried out according to the following criteria

	Passenger cars and off-road vehicles	Motorcycles	Passenger-car trailers	Lorries/semi-trailer towing vehicles and omnibuses	Trailers/semi-trailers for lorries/semi-trailer towing vehicles
Direction of rolling	straight ahead			straight ahead 17.5° camber	
Wheel-load increase factor f	2.5 2.0 <sup>1)</sup> 2.25 <sup>2)</sup>	2.25	2.0	2.0 (straight ahead) 1.5 (17.5° camber)	
Tyres	Standard; in the case of several options: tyres with the largest nominal width				
Rolling speed [km/h]	60 - 100			25-40	
Rolling distance or number of wheel revolutions	2000 m (see footnotes 1+2)	6000 km	2000 km	4 * 10 <sup>6</sup> wheel revolutions (straight ahead) 3 * 10 <sup>6</sup> wheel revolutions (17.5° camber)	
Tyre inflation pressure at start of test (not regulated)	Road driving: up to 1.6 bar above 1.6 bar		Rim rolling test 2.8 bar 4.5 bar		1.1 times the rated tyre inflation pressure under maximum vehicle wheel load
Assessment criterion	No technical cracks or loosening of spokes			No technical cracks	
Permissible drop in tightening torque <sup>3)</sup>	≤ 30%			≤ 20%	

<sup>1)</sup> Alternative option for off-road vehicles: 5000 km

<sup>2)</sup> For passenger-car steel-disk wheels: 1000km

<sup>3)</sup> The test is carried out by tightening (not by loosening) the wheel bolts or nuts.

### 4.6.3 Energy absorption test

The stress on the wheel when it rolls over an obstacle is checked at the critical points of both the inner and outer rim flange. Critical points of the rim circumference are

- a) the areas of the nave connection (spokes) and
- b) the area between two connections or ventilation openings and the valve hole area.

During this test, the rim flange in question is suitably deformed. A force-distance diagram is plotted whilst pressure is being applied.

#### 4.6.3.1 Test formula

Lorries/semi-trailer towing vehicles and omnibuses: Trailers/semi-trailers for lorries:	$F_P = f * F_R$
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$F_P$  = test load [N]

$f$  = wheel-load increase factor [--]

$F_R$  = permissible static wheel load [N]

#### 4.6.3.2 The test is carried out according to the following criteria:

	Motorcycles	Lorries/semi-trailer towing vehicles and omnibuses	Trailers/semi-trailers for lorries/semi-trailer towing vehicles
Direction of force	radial		
Test plunger	Cylindrical radius 55 <sup>+1</sup> mm	Hemispherical radius 25 <sup>+1</sup> mm	
Factor f	not defined, test is carried out up to a maximum of 20 mm deformation travel	1.5 (inner rim flange) 2.0 (outer rim flange)	1.5
Clamping of wheel	Floating axle	By means of mounting hole and flange	
Rate of deformation	0.2 to 2 mm/s		
Assessment criterion	1.)	2.)	

- 1.) The deformation energy absorbed by the rim flanges is determined from the force-distance diagram. Deformation energy is assessed up to the point at which the compressive force, after reaching its maximum value, has dropped to 60% of this value, but, at the most, up to a deformation travel of 20 mm. The test is considered positive if the following minimum values for the absorbed deformation energy are reached at each point of the rim-flange circumference:

	Front wheels	Rear wheels
Deformation energy [J]	0.1 [m] * $F_R$	0.07 [m] * $F_R$

The permanent deformation between the compressive forces  $2 * F_R$  and  $6 * F_R$  for the front wheel or between  $2 * F_R$  and  $5 * F_R$  for the rear wheel shall not exceed 1 mm.

- 2.) The test is considered positive if at least the above load can be absorbed at each point of the rim circumference without resulting in technical cracks. Plastic deformation is permissible.

**4.6.4 Impact test**

The fracture behaviour of the wheel when running over an obstacle at the outer rim flange is to be checked at the critical positions. To verify satisfactory fracture behaviour, an impact test must be performed according to ISO 7141.

**4.6.4.1 Test formula**

$$D = 0.6 * F_R / g + 180 \text{ kg}$$

D = Drop weight [kg]

$F_R$  = permissible static wheel load [N]

g = acceleration of the fall 9.81 m/s<sup>2</sup>

**4.6.4.2 The test is carried out according to the following criteria:**

	<b>Passenger cars and off-road vehicles</b>
Test set-up	as per the last-amended version of ISO 7141
Tyre-inflation pressure	as stipulated by the tyre manufacturer for the permissible wheel load and maximum vehicle speed, but in any case not less than 2 bar
Tyres	standard tyres; where there is a choice between several tyres, those with the smallest rated width or, in the case of identical rated width, those with the smallest rolling circumference
Assessment criteria	the test is considered positive if no visible cracks appear on the wheel nave, and within one minute no complete pressure loss is detected. Fractures and deformation caused by direct contact with the drop weight are permissible.
Number of test samples	1 per impact position
Impact positions	In the area of the nave connection (spokes) between two connections (ventilation opening), taking into account the position of the valve hole. As far as possible, the impact position should be selected in such a manner that the stress is introduced between two attachment points.

**4.6.4.3 Test program for wheel families**

Tests required:

Wheels to be tested	Impact test
Smallest PCD	1 per impact position
Largest PCD	1 per impact position
Deviating offset ≤ 15 mm	--
> 15 mm	1 per impact position

#### 4.6.5 Alternating torsion test

The tangential forces acting on the wheel during braking and accelerating are simulated in a fatigue test. For each load level, two wheels must be checked. Each wheel is rigidly clamped at a rim flange to the test rig. An alternating torsional moment  $M_T$  is then applied in a suitable manner via the hub mating face, e.g. by means of the intended brake disk or other attached parts.

The mounting bolts or nuts are tightened with the torque specified by the wheel manufacturer.

##### 4.6.5.1 Test formula

$$M_T = f \cdot F_R \cdot r_{dyn}$$

$M_T$  = Alternating torsional moment [Nm]

$f$  = Wheel load increase factor

$F_R$  = Permissible static wheel load [N]

$r_{dyn}$  = Dynamic tyre radius of the largest tyre [m] in the family

The test is carried out according to the following criteria:

	<b>Motorcycles</b>	<b>Passenger cars and off-road vehicles</b>
Wheel load increase factor $f$	1.0 (front wheel) 1.1 (rear wheel)	1.0
Minimum number of load cycles at 100% $M_T$	$1 \cdot 10^6$	--
Minimum number of load cycles at 90% $M_T$	--	$2 \cdot 10^5$
Minimum number of load cycles at 45% $M_T$	--	$2 \cdot 10^6$
Assessment criterion	No technical cracks or loosening of spokes	
Permissible drop in tightening torque <sup>2</sup>	$\leq 30\%$	

-- = test not required

#### 4.6.6. Corrosion test

##### 4.6.6.1 Salt spray test

A salt spray test in accordance with SS DIN 50021 (duration 384 hours) must be performed.

##### 4.6.6.2 Preparing the test specimen

- a) Criss-cross cuts (DIN 53151) and artificial-stone-impact damage (DIN 55995) are applied to a test specimen with a standard paint finish in the areas that are exposed during road driving (rim flange, rim base area of wheel inner side).
- b) Tyre and valve must be fitted and removed ten times in order to simulate the unavoidable stress to the surface finish in practice.

##### 4.6.6.3 Test procedure

The pre-treated and unchanged test specimen, including all parts which could cause galvanic (contact) corrosion is subjected in "upright" position to a salt spray test. Every 48 hours, the wheel is rotated through 90°.

<sup>2</sup>The test is carried out by tightening (not by loosening) the wheel mounting bolts or nuts.

It is important to use the largest vehicle-wheel attachment face of the application range.

Subsequently, the test specimen is subjected to a strength test. The type of strength test will depend on the damage incurred by the wheel which has undergone the corrosion test.

#### 4.6.6.4 Assessment

The individual constructional measures to counter galvanic corrosion (coatings, galvanised and cadmium-plated bushes/bolts, insulating layers, etc.) are assessed. Micrographs of the main corrosion areas are required for documentation.

No significant corrosion should have occurred after a test period of 192 hours.

The wheel must still be serviceable even after 384 hours of salt spray testing, e.g. the wheel mounting and tyre seat must be fully intact.. Depending on where corrosion is detected, serviceability must be verified by a bending fatigue test according to Section 4.6.1.4 or a rim rolling test according to Section 4.6.2.3.

#### 4.6.7 Materials test

The following metallurgical tests must be documented:

	Passenger cars and off-road vehicles	Motorcycles	Trailers for passenger cars	Lorries or omnibuses	Trailers/semi-trailers for lorries
Aluminium alloys	A	A	A	A	A
Magnesium alloys	A, B, C, D	A, B, C, D	--	0	0
Steel	D, E	D, E	D, E	--	--

- A) Documentation of mechanical properties and positions from which the samples were taken by the applicant.
- B) Determination of mechanical properties ( $R_{p0.2}$ ,  $R_m$ , and  $A_{\%}$ ) in accordance with EN 10002 in the wheel mounting, nave/rim transition and rim well areas.
- C) Preparation of micrographs, particularly of the wheel connection/wheel nave transition, assessment of microstructure. Trace elements which are critical for corrosion must be uniformly distributed.
- D) The main alloy components must be determined and compared with the manufacturer documentation.
- E) Documentation of mechanical properties of the initial material, e.g. in the form of an Acceptance Test Certificate B in accordance with ISO 404.
- 0) Test requirements not specified.
- Test not required

#### 4.6.8 Mounting tests

##### 4.6.8.1 Test of unhindered movement of wheel and tyres

Wheels and tyres must move freely under all normal traffic operating conditions, taking into account the tyre tolerances provided for in standards. Should the road test reveal rubbing of the wheel/tyre combination, the modifications necessary to ensure adequate freedom of movement must be documented in the expertise. Adequate operational integrity of the vehicle must be maintained following any modification. The necessity of a subsequent acceptance test as provided for in § 19 (3) of the StVZO must be pointed out.

#### 4.6.8.2 Test of thermal stress acting on brake system

The modified wheel/tyre combination must not reduce the brake system's thermal load-bearing capacity to less than that of the standard (unmodified) condition.

#### 4.6.8.3 Track changes

If there are track changes of more than + 2% compared with the maximum track of the series vehicle, verification of adequate operational strength must be provided by the vehicle manufacturer or by appropriate tests and inspections.

In the case of vehicles with a separate chassis, which are suitable for heavy off-road operation, a track change of +4% can be accepted without special verification of the operational integrity.

Where track modifications have been made, the effects of the change in kingpin offset on the driving and braking behaviour must be assessed by suitable road tests. Changes compared to the standard track must be documented in the expertise.

#### 4.6.8.4 Driving behaviour test

It must be demonstrated that the modified wheel/tyre combination does not result in vehicle driving behaviour which is inferior to that of the standard combination. Driving comfort criteria need not be considered in the assessment. The expertise must include information about any modifications made to the chassis, and must point out the necessity of a subsequent acceptance test as per § 19 (3) StVZO.

#### 4.6.8.5 Wheel covers

It must still be possible to provide the vehicle with the modified wheel/tyre combination with a sufficiently effective wheel cover which satisfies the valid regulations. Any reworking necessary to ensure adequate wheel covering must be described in the expertise. Attention must be drawn to the necessary acceptance test as per § 19 (3) StVZO.

## 5. Documents to be submitted by the applicant

For each type of wheel, the applicant must submit the following documentation

- in triplicate for the application of a general type approval
- one copy for the application of a component expertise.

A technical description including all important details and specifying the manufacturing locations:

- method of manufacturing the wheel blank;
- mechanical working;
- heat treatment;
- material with chemical analysis and strength values;
- corrosion protection;
- tightening torques for threaded assemblies;
- extent of the most important quality controls and their documentation;
- type and fitting of balance weights;
- centring rings;
- any accessories (e.g. valves, wheel mounting parts, hub caps or splash shields in the case of lorry wheels);
- shop drawings of wheel and all accessories.

The applicant must provide the required number of specimens and finished-wheel samples of the relevant types to the testing authority.

## 6. Conformity of production

Every wheel marketed and sold within the scope of these guidelines must be manufactured in such a way that it conforms to the tested type and complies with the regulations outlined in these guidelines.

In order to guarantee observance of regulations, manufacturing must be constantly monitored. Traceability of all parts must be ensured by the manufacturer.

The holder of a general type approval or a component expertise for custom wheels must, in particular

- ensure that procedures for the monitoring of product quality are applied;
- have access to the facilities used to monitor conformity of production with the approved type in question;
- record the test results and archive the accompanying documents;
- analyse the results of each type of test in order to monitor and ensure the constancy of product characteristics, taking into account the permissible deviations in industrial production;
- ascertain that, for each sample or specimen which reveals non-conformance with the test type in question a new sample is taken and tested. All necessary measures must be taken to ensure that production conformance is re-established.

Prior to the award of type approval, the approval authority checks whether the measures and processes have been implemented which are necessary to effectively monitor compliance of the manufactured wheels with the approved type.

The competent authority can take samples at any time and send them for retesting to the test authority which prepared the technical report.

## 7. Technical report

The competent authority issues a code of practice describing a standardised procedure for all questions arising in conjunction with test report preparation pertaining to the award of General Type Approval of custom wheels

This code of practice can be obtained from

**Kraftfahrt Bundesamt  
24932 Flensburg.**

## **Annex 1**

### **Guidelines for the testing and inspection of custom wheels for motor vehicles and their trailers**

#### **Simplified procedure for the testing and inspection of ident wheels and duplicate steel-disk wheels**

##### **Scope and definitions** (Section 1 and 2 of the guidelines)

This Annex describes a simplified testing and inspection procedure for ident and duplicate steel-disk wheels as per the definitions given under paragraphs 2.27.1 and 2.27.2 of the guidelines.

The simplified procedure described hereunder cannot be applied to duplicate wheels which are not made of steel.

##### **Test procedures to be applied** (Section 4 of the guidelines)

###### **General**

The following procedures are defined for the testing, inspection and approval of ident wheels and duplicate steel-disk wheels:

Test results obtained by the wheel manufacturer can be recognised if the manufacturer has appropriate testing, inspection and measuring equipment and if, over an extended period of time, the results included in the test documents submitted have been found to conform to the test results obtained by the Technical Service for the wheels supplied.

###### **Duplicate steel-disk wheels**

As an alternative to the test regulations outlined in these guidelines, the operational strength of duplicate steel-disk wheels can be verified by comparison with the operational strength of the wheels approved in the vehicle type approval. For this purpose, bending fatigue tests as per 4.6.1 and rim rolling tests as per 4.6.2 of these guidelines are carried out at two load levels on both the duplicate steel-disk wheels and the wheels approved in the respective vehicle's type approval. The tests are continued until the stipulated number of load cycles has been reached or the wheel breaks.

In all the tests, the duplicate steel-disk wheels must reach or exceed the number of load cycles of the wheels approved by vehicle type approval.

Instead of the testing and inspection regulations outlined in these guidelines, it is also possible to apply the vehicle manufacturer's test regulations for the wheel approved by vehicle type approval. In this case, such testing and inspection regulations must be disclosed for verification purposes. The different wheel loads approved by the vehicle manufacturer and underlying these regulations must likewise be disclosed.

###### **Ident wheels**

The same test procedure as for duplicate steel-disk wheels must be applied to ident wheels; however, these tests are only carried out in the form of spot checks.

**Mounting test** (paragraph 4.6.8 of the guidelines)

Provided the following requirements are satisfied and are identical to the requirements pertaining to standard wheels, a mounting test can be dispensed with in the case of ident wheels and duplicate steel-disk wheels.

- use of the mounting elements approved for the wheel in question by the vehicle manufacturer;
- use of the tyres approved for the wheel in question in the vehicle type approval
- use of the accessories required for vehicle safety. These must be specified in the expertise.

**Documents to be submitted by the applicant** (Section 5 of the guidelines)**General**

- Declaration of obligation on the part of the wheel manufacturer to the Technical Service and the approval authorities that he/she will notify the latter immediately of any known changes made by the vehicle manufacturer which relate to the approval of the standard wheel.
- Test results provided by the vehicle manufacturer (if available) must be submitted

**Ident wheel**

In addition, the wheel manufacturer must furnish evidence that the manufactured wheel is identical to one of the wheels approved by vehicle type approval, and that it demonstrates identical quality standards.

**Duplicate steel-disk wheel**

In addition, the wheel manufacturer must furnish evidence that the manufactured wheel is a duplicate of a steel-disk wheel approved by vehicle type approval, and that it demonstrates identical quality standards.