

22 March 2007

## **AGREEMENT**

### **CONCERNING THE ADOPTION OF UNIFORM TECHNICAL PRESCRIPTIONS FOR WHEELED VEHICLES, EQUIPMENT AND PARTS WHICH CAN BE FITTED AND/OR BE USED ON WHEELED VEHICLES AND THE CONDITIONS FOR RECIPROCAL RECOGNITION OF APPROVALS GRANTED ON THE BASIS OF THESE PRESCRIPTIONS \*/**

(Revision 2, including the amendments which entered into force on 16 October 1995)

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#### **Addendum 123: Regulation No. 124**

Date of entry into force: 2 February 2007

#### **UNIFORM PROVISIONS CONCERNING THE APPROVAL OF WHEELS FOR PASSENGER CARS AND THEIR TRAILERS**



**UNITED NATIONS**

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\*/ Former title of the Agreement:

Agreement Concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, done at Geneva on 20 March 1958.



Regulation No. 124

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF WHEELS  
FOR PASSENGER CARS AND THEIR TRAILERS

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1. SCOPE

This Regulation covers new replacement wheels designed for vehicles in categories M<sub>1</sub>, M<sub>1</sub>, G, O<sub>1</sub> and O<sub>2</sub> 1/.

It does not apply to original equipment wheels or vehicle manufacturer's replacement wheels as defined in paragraphs 2.3. and 2.4.1. It does not apply to "Special wheels", as defined in paragraph 2.5., which shall remain subjected to national approval.

This Regulation comprises requirements for wheel manufacture and installation.

2. DEFINITIONS

For the purpose of this Regulation:

2.1. "Wheel" means a rotating load-carrying member between the tyre and the axle. It usually consists of two major parts:

- (a) the rim;
- (b) the wheel disc.

The rim and wheel disc may be integral, permanently attached, or detachable.

2.1.1. "Disc wheel" means a permanent combination of a rim and wheel disc.

2.1.2. "Wheel with demountable rim " means a wheel so constructed that the demountable rim is clamped to the wheel disc.

2.1.3. "Rim" means that part of the wheel on which the tyre is mounted and supported.

2.1.4. "Wheel disc" means that part of the wheel which is the supporting member between the axle and the rim.

2.2. "Wheel type" means a wheel which does not differ in the following essential characteristics:

2.2.1. the wheel manufacturer;

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1/ Categories M and O as defined in Annex 7 to the Consolidated Resolution on the Construction of Vehicles (R.E.3) (document TRANS/WP.29/78/Rev.1/Amend.2, as last amended by Amend.4).

- 2.2.2. wheel or rim size designation (according to ISO 3911:1998);
- 2.2.3. construction materials;
- 2.2.4. wheel attachment holes;
- 2.2.5. maximum load capacity;
- 2.2.6. recommended maximum inflation pressure;
- 2.2.7. method of production (welded, forged, cast,...).
- 2.3. "OE-wheels" means wheels which are authorized to be fitted, to the vehicle model, by the vehicle manufacturer during the production of the vehicle.
- 2.4. "Replacement wheels" means wheels which are intended to replace the OE wheels during the service life of the vehicle. Replacement wheels may belong to one of the following category:
  - 2.4.1. "Vehicle manufacturer's replacement wheels" being wheels supplied by the vehicle manufacturer;
  - 2.4.2. "Identical replacement wheels" being wheels which are manufactured using the same manufacturing equipment and material as that used for replacement wheels supplied by the vehicle manufacturer. They differ from vehicle manufacturer's replacement wheels only by the absence of vehicle manufacturer's trademarks and part number;
  - 2.4.3. "Replica replacement wheels" being wheels which are replicas of vehicle manufacturer's replacement wheels but produced by a manufacturer who is not a supplier of the vehicle manufacturer with the specified wheel. With regard to the design (basic contour, dimensions, inset, material type and quality and so on) and service life they fully correspond to vehicle manufacturer's replacement wheels;
  - 2.4.4. "Pattern part replacement wheels" being wheels produced by a manufacturer who is not a supplier of the vehicle manufacturer with the specified wheel. With regard to the design, inset, rim designation wheel fixing PCD and spigot mounting diameter, correspond to that of an OE-wheel, but wheel contour, material and so on, may be different.
- 2.5. "Special wheels" means wheels which are not OE-wheels and which do not fulfil the criteria for wheels described in paragraph 2.4. (for example wheels with different rim width or diameter).
- 2.6. "Inset" means the distance from the attachment face of the disc to the centre line of the rim (that can be positive, as shown in Figure 1 below, zero, or negative).

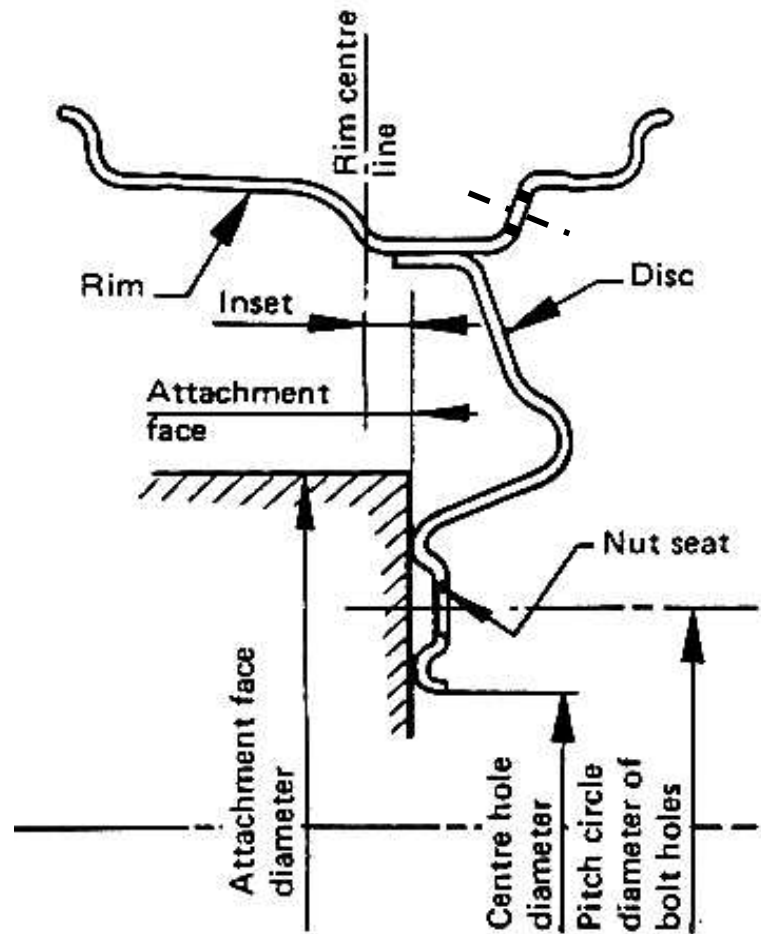


Figure 1

- 2.7. "Dynamic radius" means the dynamic loaded radius defined as the theoretical rolling circumference divided by  $2\pi$  of the largest tyre to be used on the wheel as specified by the wheel manufacturer.

2.8. "International Tyre and Rim Standards" mean documents concerning wheel standardization issued by the following Organizations:

- (a) The International Organization for Standardization (ISO) 2/;
- (b) The European Tyre and Rim Technical Organization (ETRTO) 3/: "Standards Manual";
- (c) The European Tyre and Rim Technical Organization (ETRTO) 3/: "Engineering Design Information - obsolete data";
- (d) The Tyre and Rim Association Inc. (TRA) 4/: "Year Book";
- (e) The Japan Automobile Tyre Manufacturers Association (JATMA) 5/: "Year Book";
- (f) The Tyre and Rim Association of Australia (TRAA) 6/: "Standard Manual";
- (g) The Associação Latino Americana de Pneus e Aros (ALAPA) 7/: "Manual de Normal Technicas";
- (h) The Scandinavian Tyre and Rim Organisation (STRO) 8/: "Data Book".

2.9. "Technical crack" is a material separation with a propagation of more than 1 mm occurring during a dynamic test (defects caused by the production process are not to be taken into account).

2.10. "Wheel calliper" is the rotating profile shape, formed by the internal wheel contour (see Annex 10, figure 1).

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The tyre standards can be obtained from the following addresses:

2/ ISO, 1, rue de Varembe, Case postale 56, CH-1211 Genève 20 – Switzerland.

3/ ETRTO, 32 Av. Brugmann - Bte 2, B-1060 Brussels, Belgium.

4/ TRA, 175 Montrose West Avenue, Suite 150, Copley, Ohio, 44321 USA.

5/ JATMA, NO.33 MORI BLDG. 8th Floor 3-8-21, Toranomom Minato-Ku, Tokio 105-0001, Japan.

6/ TRAA, Suite 1, Hawthorn House, 795 Glenferrie Road, Hawthorn, Victoria, 3122 Australia.

7/ ALAPA, Avenida Paulista 244-12° Andar, CEP, 01310 Sao Paulo, SP Brazil.

8/ STRO, Älggatan 48 A, Nb, S-216 15 Malmö, Sweden.



2.11. "Tyre size designation" means a designation showing the nominal section width, the nominal aspect ratio and the conventional number that denotes the nominal rim diameter (these terms are further defined in Regulation No. 30).

### 3. APPLICATION FOR APPROVAL

3.1. The application for approval of a wheel type shall be submitted by the manufacturer, or by his duly accredited representative, and shall be accompanied by:

3.1.1. Drawings, in triplicate, sufficiently detailed to permit identification of the type. They shall also show the position intended for the approval mark and for the wheel markings;

3.1.2. Technical description including at least the following characteristics:

3.1.2.1. Category of replacement wheels – see paragraphs 2.4.2., 2.4.3. and 2.4.4.;

3.1.2.2. rim contour designation - wheel inset - wheel attachment details;

3.1.2.3. tightening torque for studs and nuts;

3.1.2.4. fixing method of balancing weights;

3.1.2.5. necessary accessories (i.e. additional mounting components);

3.1.2.6. International Standard reference;

3.1.2.7. suitable for tubeless tyre mounting;

3.1.2.8. suitable valves types;

3.1.2.9. maximum load capacity;

3.1.2.10. maximum inflation pressure;

3.1.2.11. detail of material including chemical composition (see Annex 4);

3.1.2.12. tyre size designations specified for original equipment by the vehicle manufacturer.

3.1.3. Documentation in accordance with paragraph 1. of Annex 10 to this Regulation:

- (a) vehicle characteristics (Annex 10, paragraph 1.2.);
- (b) additional characteristics (Annex 10, paragraph 1.3.);
- (c) fitting instructions details (Annex 10, paragraph 1.4.); and
- (d) additional requirements (Annex 10, paragraph 2.).

3.1.4. Sample wheels representative of the wheel type necessary for the execution of laboratory tests or test reports issued by the Type Approval Authority.

- 3.2. In case of application for approval of an identical wheel, the applicant shall satisfy the type approval authority that the wheel is indeed an "identical replacement wheel" as defined in paragraph 2.4.2.
4. APPROVAL
- 4.1. If the wheel submitted for approval in accordance with paragraph 3. above meets the requirements, then approval for this type of wheel shall be granted.
- 4.2. An approval number shall be assigned to each type approved. The first two digits (at present 00 for the Regulation in its original form) shall indicate the series of amendments incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval. The same Contracting Party may not assign the same number to another type of wheel.
- 4.3. Notice of approval or refusal or extension of approval of a type of wheel under this Regulation shall be communicated to the Parties to the 1958 Agreement which apply this Regulation by means of a communication form conforming to the model in Annex 1 to this Regulation.
- 4.4. Every wheel conforming to a type approved under this Regulation shall bear, in addition to the markings prescribed in paragraph 5., a clearly legible and indelible international approval mark consisting of:
- 4.4.1. a circle surrounding the letter "E" followed by the distinguishing number of the country which has granted approval (see Annex 2). 9/

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9/ 1 for Germany, 2 for France, 3 for Italy, 4 for the Netherlands, 5 for Sweden, 6 for Belgium, 7 for Hungary, 8 for the Czech Republic, 9 for Spain, 10 for Serbia, 11 for the United Kingdom, 12 for Austria, 13 for Luxembourg, 14 for Switzerland, 15 (vacant), 16 for Norway, 17 for Finland, 18 for Denmark, 19 for Romania, 20 for Poland, 21 for Portugal, 22 for the Russian Federation, 23 for Greece, 24 for Ireland, 25 for Croatia, 26 for Slovenia, 27 for Slovakia, 28 for Belarus, 29 for Estonia, 30 (vacant), 31 for Bosnia and Herzegovina, 32 for Latvia, 33 (vacant), 34 for Bulgaria, 35 (vacant), 36 for Lithuania, 37 for Turkey, 38 (vacant), 39 for Azerbaijan, 40 for The former Yugoslav Republic of Macedonia, 41 (vacant), 42 for the European Community (Approvals are granted by its Member States using their respective ECE symbol), 43 for Japan, 44 (vacant), 45 for Australia, 46 for Ukraine, 47 for South Africa, 48 for New Zealand, 49 for Cyprus, 50 for Malta, 51 for the Republic of Korea, 52 for Malaysia, 53 for Thailand, 54 and 55 (vacant) and 56 for Montenegro. Subsequent numbers shall be assigned to other countries in the chronological order in which they ratify or accede to the Agreement Concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions, and the numbers thus assigned shall be communicated by the Secretary-General of the United Nations to the Contracting Parties to the Agreement.

- 4.4.2. the number of this Regulation, followed by the letter "R", a dash and the approval number according to paragraph 4.2.
- 4.5. The approval mark shall be permanent, visible and clearly legible, when the tyre is fitted on the wheel.
- 4.6. Annex 2 to this Regulation gives an example of the arrangement of the approval mark.
- 4.7. The wheel manufacturer's facilities may be used for test purposes provided that the Type Approval Authority or a designated representative witnesses the tests.
5. WHEEL MARKINGS
- 5.1. The wheel shall be permanently and legibly marked as follows, in a position chosen by the manufacturer, but visible when the tyre is fitted on the wheel:
- 5.1.1. manufacturer name or trade mark;
- 5.1.2. the wheel or rim contour designation;
- 5.1.2.1. It shall be expressed according to the prescription of one International Tyre and Rim Standards and includes at least:
- rim size designation comprising:
- rim contour designation nominal rim diameter,
- the symbol "x" if one piece rim,
- the symbol "-" if multipiece rim,
- letter "A" if the well is located asymmetrically (optional),
- the letter "S" if the well is located symmetrically (optional).
- 5.1.3. the wheel inset;
- 5.1.4. date of manufacture(at least the month and year);
- 5.1.5. the wheel/rim part number.
- 5.2. Annex 3 to this Regulation gives an example of the arrangement of the wheel markings.

6. GENERAL REQUIREMENTS

- 6.1. Rim contour shall conform to the International Standard specified by the wheel manufacturer.
- 6.2. Rim contour shall ensure the correct fitting of tyres and valves.
  - 6.2.1. Wheels designed for use with tubeless tyres shall ensure air retention.
- 6.3. Materials used for the construction of the wheel shall be analysed according to Annex 4.
- 6.4. In the case of identical replacement wheel as defined in paragraph 2.4.2., there shall not be any requirement for physical testing as given in paragraph 6.5. or vehicle fitment checking as given in paragraph 2. of Annex 10 to this Regulation.
- 6.5. The replica replacement wheels and pattern part replacement wheels shall satisfy the following tests:
  - 6.5.1. Steel wheels
    - 6.5.1.1. Disc wheels
      - (a) rotating bending test as per Annex 6;
      - (b) rolling test as per Annex 7.
    - 6.5.2. Aluminium alloy wheels
      - 6.5.2.1. One piece wheels
        - (a) Corrosion test as per Annex 5. If the process within a production line is always the same, only one representative test is to be carried out;
        - (b) Rotating bending test as per Annex 6;
        - (c) Rolling test as per Annex 7;
        - (d) Impact test as per Annex 8.
      - 6.5.2.2. Demountable rim wheels
        - (a) Corrosion test as per Annex 5;
        - (b) Rotating bending test as per Annex 6;

- (c) Rolling test as per Annex 7;
  - (d) Impact test as per Annex 8;
  - (e) Alternating torque test as per Annex 9.
- 6.5.3. Magnesium alloy wheels
- 6.5.3.1. One piece wheels
- (a) Corrosion test as per Annex 5;
  - (b) Rotating bending test as per Annex 6;
  - (c) Rolling test as per Annex 7;
  - (d) Impact test as per Annex 8.
- 6.5.3.2. Demountable rim wheels
- (a) Corrosion test as per Annex 5;
  - (b) Rotating bending test as per Annex 6;
  - (c) Rolling test as per Annex 7;
  - (d) Impact test as per Annex 8;
  - (e) Alternating torque test as per Annex 9.
- 6.6. Where a wheel manufacturer submits application for type approval for a range of wheels, it is not considered necessary to carry out all tests on every type of wheels in the range. Worst case selection may be made at the discretion of the type approval Authority or the designated Technical Service (see Annex 6 paragraph 4. of this Regulation).
- 6.7. Pattern part replacement wheels shall satisfy the following requirements to guarantee proper fitment on the vehicle:
- 6.7.1. The nominal rim diameter, nominal rim width and nominal inset of ECE-approved wheels shall be the same as the manufacturer's replacement wheel.
- 6.7.2. Wheels shall be suitable for tyres of the tyre size designations specified initially by the vehicle manufacturer for the particular model concerned.

6.7.3. The checks and documentation relevant to the wheel/vehicle fitment are described in Annex 10.

## 7. MODIFICATIONS AND EXTENSION OF APPROVAL FOR WHEEL

7.1. Every modification of the wheel type shall be notified to the Approval Authority which granted the type approval. The Approval Authority may then:

7.1.1. either consider that the modifications made are unlikely to have appreciable adverse effects and that in any case the type of wheel still complies with the requirements;

7.1.2. or require a further test.

7.2. Confirmation or refusal of approval, specifying the alterations, shall be notified by the procedure specified in paragraph 4.3. above to the Parties to the Agreement applying this Regulation.

7.3. The Competent Authority issuing the extension of approval shall assign a series number to each communication form drawn up for such an extension.

## 8. CONFORMITY OF PRODUCTION

8.1. The conformity of production procedures shall comply with those set out in Appendix 2 to the Agreement (E/ECE/324-E/ECE/TRANS/505/Rev.2).

8.2. The authority which has granted type approval may at any time verify the conformity control methods applied in each production facility. The normal frequency of these verifications shall be once every two years.

## 9. PENALTIES FOR NON-CONFORMITY OF PRODUCTION

9.1. The approval granted in respect of a type of wheel pursuant to this Regulation may be withdrawn if the requirements set forth above are not met or if a wheel bearing the approval mark does not conform to the type approved.

9.2. If a Contracting Party to the Agreement applying this Regulation withdraws an approval it has previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation, by means of a communication form conforming to the model in Annex 1 to this Regulation.

## 10. PRODUCTION DEFINITELY DISCONTINUED

If the holder of an approval completely ceases to manufacture a wheel approved in accordance with this Regulation, he shall so inform the authority which granted the approval. Upon receiving the relevant communication, that authority shall inform

the other Parties applying this Regulation by means of a communication form conforming to the model in Annex 1 to this Regulation.

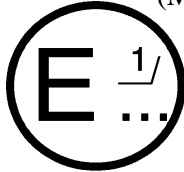
11. NAMES AND ADDRESSES OF TECHNICAL SERVICES RESPONSIBLE FOR CONDUCTING APPROVAL TESTS AND OF ADMINISTRATIVE DEPARTMENTS

The Contracting Parties to the Agreement applying the Regulation shall communicate to the United Nations secretariat the names and addresses of the Technical Services responsible for conducting approval tests and of the Administrative Departments which grant approval and to which forms certifying approval or extension or refusal or withdrawal of approval, or production definitely discontinued issued in other countries, are to be sent.

Annex 1

COMMUNICATION

(Maximum format: A4 (210 x 297 mm))



issued by: Name of administration:  
 .....  
 .....

concerning: 2/

- APPROVAL GRANTED
- APPROVAL EXTENDED
- APPROVAL REFUSED
- APPROVAL WITHDRAWN
- PRODUCTION DEFINITELY DISCONTINUED

of a wheel type, pursuant to Regulation No. 124

Approval No. ....

Extension No. ....

1. Wheel manufacturer: .....
2. Wheel type designation:.....
- 2.1. Category of replacement wheels:.....
- 2.2. Construction material:.....
- 2.3. Method of production: .....
- 2.4. Rim contour designation: .....
- 2.5. Wheel inset: .....
- 2.6. Wheel attachment: .....
- 2.7. Maximum load capacity .....
3. Address of the manufacturer: .....
4. If applicable, name and address of manufacturers' representative: .....
5. Date on which the wheel was submitted for approval tests: .....
6. Technical Service responsible for carrying out the approval test: .....
7. Date of test report issued by the Technical Service: .....
8. Number of test report issued by the Technical Service: .....
9. Remarks: .....
10. Approval granted/refused/extended/withdrawn 2/:.....
11. Reason(s) for the extension (if applicable): .....
12. Place: .....
13. Date: .....
14. Signature/Name: .....
15. Annexed is a list of documents making up the approval file, deposited with the Competent Authority which granted approval, a copy can be obtained on request.

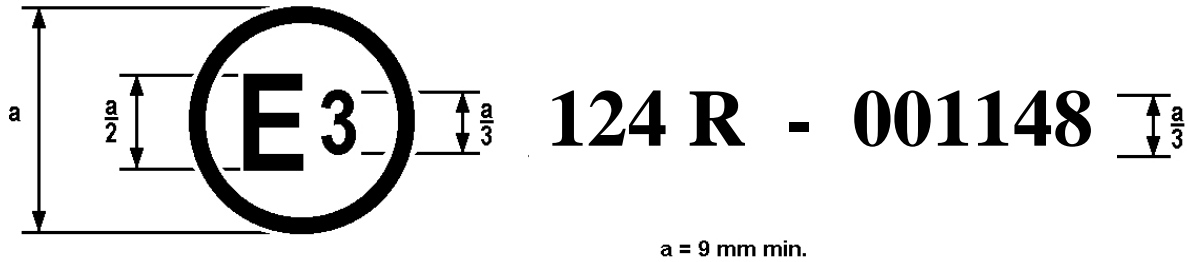
1/ Distinguishing number of the country which has granted/extended/refused/withdrawn approval (see the provisions of the Regulation concerning approval).

2/ Strike out what does not apply.



Annex 2

ARRANGEMENT OF THE APPROVAL MARK



The wheel bearing the above approval mark is a wheel that has been approved in Italy (E3) under approval number 001148.

The first two digits of the approval number indicate that the approval was granted in accordance with the requirements of Regulation No. 124 in its original form.

The marking of approval mark, the Regulation number and approval number may be at a distance from each other respecting the sequence.

Annex 3

ARRANGEMENT OF THE WHEEL MARKINGS

Example of markings which shall be applied to a wheel conforming to this Regulation:

ABCDE 5 ½ J x 14 FH 36 01 99 ab123

This example of marking defines a wheel:

manufactured by ABCDE

having a rim contour designation (5½ J)

having a one piece construction(x)

having a nominal rim diameter code (14)

having a non symmetrical location of the well (no mark)

having a flat hump configuration of the bead-seat area on one side only (FH) – optional marking

having a wheel inset of 36 mm

manufactured in January 1999 (0199)

the manufacturer's part number (ab123).

The rim designation shall include in the following order the rim contour designation, the construction, the nominal rim diameter code, the location of the well and the bead-seat configuration, as in the example 5½ J x 14 FH. It is also permitted to reverse the order for the first three elements as in the example 14 x 5½ J FH.

The marking of the wheel inset, the date of production and manufacturer's name may be at a distance from the rim designation.

Annex 4

MATERIAL TEST

The following metallurgical analysis shall be carried out and reported:

| Material        | Tests   |
|-----------------|---------|
| Aluminium alloy | a, c, e |
| Magnesium alloy | a, c, e |
| Steel           | a, b, d |

- (a) Chemical analysis of the raw-material.
- (b) Check of the following mechanical characteristics ( $R_{p0,2}$ ,  $R_m$ , and  $A$ ) relevant to the materials:
- (i) percentage elongation after fracture ( $A$ ): Permanent elongation of the gauge length after fracture ( $L_u - L_o$ ), expressed as a percentage of the original length ( $L_o$ ).
- Where:
- original gauge length ( $L_o$ ): Gauge length before application of force.
- final gauge length ( $L_u$ ): Gauge length after rupture of the test piece.
- (ii) proof strength, non-proportional extension ( $R_p$ ): Stress at which a non-proportional extension is equal to a specified percentage of the extensometer gauge length ( $L_e$ ). The symbol used is followed by a suffix giving the prescribed percentage of the extensometer gauge length, for example:  $R_{p0,2}$ .
- (iii) tensile strength ( $R_m$ ): Stress corresponding to the maximum force ( $F_m$ ).
- (c) Check of the mechanical characteristics ( $R_{p0,2}$ ,  $R_m$ , and  $A$ ) of test-pieces taken from the hub mounting area and in the disc to rim transition area or in the failure zone if any.
- (d) Analysis of the metallurgic defects and of the raw material structure.
- (e) Analysis of the metallurgic defects and of the test-pieces structure taken from the hub mounting area and in the disc to rim transition area or in the failure zone if any.

Annex 5

CORROSION TEST

1. Carry out a salt-spray test as per ISO 9227 for 384 hours.

1.1. Sample preparation

A surface treated sample, taken from production, shall be damaged by cross engraving and stone impact (ISO 565) to represent damaging situations during the normal usage of vehicle (damage shall be in the area of the rim flange and inside the wheel).

1.2. Test development

The surface treated sample shall pass a salt-spray test, in which the sample and any components with which is normally in contact are put in upright position into the salt-spray test equipment. The wheel is turned through 90° every 48 hours.

1.3. Evaluation

Individual measures which may affect the corrosion are to be evaluated (covers, crews, zinc or cadmium buses, alloy insulating covers, etc.)

The test documentation shall include photos showing the main corrosion points which have been mechanically washed in order to show the material defects.

There shall not be any significant corrosion after a test duration of 192 hours. After 384 hours the wheel functionality, the mounting components and the tyre bead seat shall not be adversely affected by corrosion. This shall be confirmed by a rotating bending test as per Annex 6 or by a rolling test as per Annex 7, depending on the location of the corrosion.

Annex 6

ROTATING BENDING TEST

1. Test Description

During the rotating bending test, the lateral forces acting on wheel in driving around a curve are simulated. Four wheel samples shall be tested, two at 50 per cent and two at 75 per cent of the maximum side force. The wheel rim is fixed rigidly to the test bench, and a bending moment  $M_b$  is applied to the hub mounting area (i.e. through a loading arm with a flange having the same pitch circle diameter as the vehicle for which the wheel is intended). Light alloy wheels are fixed using the internal rim flange by two semicircular flanges.

Should other fixing devices be used, it is necessary prove their equivalence.

Screws or fixing nuts are tightened to the torque stated by the vehicle manufacturer and retightened after 10,000 cycles approximately.

2. Formula for the bending moment calculation

Cars and off-road vehicles:  $M_{bmaX} = S * F_v ( \mu * r_{dyn} + d )$

$M_{bmaX}$  = maximum reference bending moment [Nm]

$F_v$  = maximum load capacity of wheel [N]

$r_{dyn}$  = dynamic radius of largest tyre recommended for wheel [m]

$d$  = inset [m]

$\mu$  = coefficient of friction

$S$  = factor of safety

3. The test is carried out with two percentage values (50 per cent and 75 per cent) of the max moment and on the basis of the following standards

|                           |  |
|---------------------------|--|
| Coefficient of friction   | 0.9  |
| Factor of safety          | 2.0  |
| Nominal cycles per minute | The number of cycles per minute can be the maximum possible but outside the testing rig resonance frequency. |

| Vehicle category   | Aluminium / Magnesium  |                                   | Steel                               |                                   |
|--|--|-----------------------------------|-------------------------------------|-----------------------------------|
|  | M <sub>1</sub> and M <sub>1</sub> G  | O <sub>1</sub> and O <sub>2</sub> | M <sub>1</sub> and M <sub>1</sub> G | O <sub>1</sub> and O <sub>2</sub> |
| Min cycles with 75 per cent M <sub>bmaX</sub>  | 2.0*10 <sup>5</sup>  | 0.66*10 <sup>5</sup>              | 6.0 * 10 <sup>4</sup>               | 2.0*10 <sup>4</sup>               |
| Min cycles with 50 per cent M <sub>bmaX</sub>  | 1.8*10 <sup>6</sup>  | 0.69*10 <sup>6</sup>              | 6.0*10 <sup>5</sup>                 | 2.3*10 <sup>5</sup>               |
| Acceptance limits  | Shaft displacement less than 10 per cent greater than the displacement measured after approximately 10,000 cycles. |                                   |                                     |                                   |
|  | Technical cracks are not accepted.   |                                   | -                                   |                                   |
| Allowable loss of tightening torque initially applied to the wheel fixing studs and nuts <u>1/</u> | Maximum 30 per cent  |                                   |                                     |                                   |

4. Test schedule for range of wheel types

Wheels of the same type (paragraph 2.2.) but with different inset values can be grouped using the highest value of test bending moment according to the following test schedule. Wheel versions having a larger centre hole shall be included in the test. In the case of a failure further samples shall be tested.

Necessary tests:

| Number of wheels to be tested | Rotating bending test |           |
|-------------------------------|-----------------------|-----------|
|                               | Short test            | Long test |
| Minimum PCD                   | 1                     | 1         |
| Maximum PCD                   | 1                     | 1         |
| if only one PCD               | 2                     | 2         |
| Inset variations up to 2 mm   | --                    | --        |
| From 2 mm to 5 mm             | 1                     | --        |
| > 5 mm                        | 1                     | 1         |

Tests to be carried out should the maximum permitted wheel load subsequently increase:

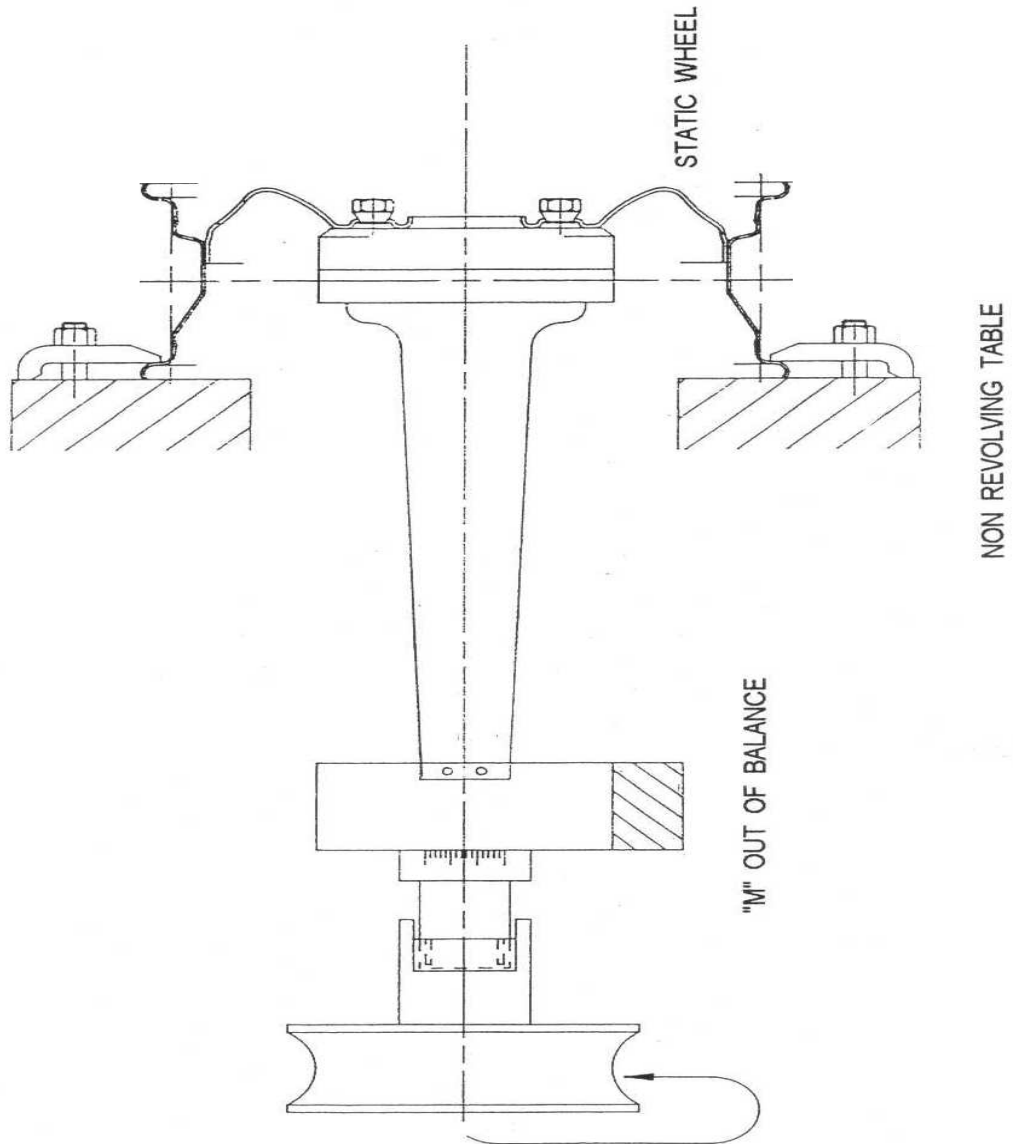
1/ Check loss of tightening torque of wheel fixings by retightening, not by measuring torque to loosen fixings.

|   |   |   |
|---|---|---|
| If the resulting test bending moment increases up to 10 per cent max. | 1 | 1 |
|---|---|---|

Short test = rotating bending test with 75 per cent of  $1 M_{bmax}$   
 (calculated for the max wheel load)

Long test = rotating bending test with 50 per cent of  $M_{bmax}$

Should the testing moment be increased of more of 10 per cent, when compared to the first approval, the whole programme shall be repeated.



Example of a rotating bending test rig.

Annex 7

ROLLING TEST

1. Test Description

In the rolling test the stress on the wheel when driving straight ahead is simulated by testing a wheel rolling against a drum which has a minimum outside diameter of 1.7 m, in the case of an external rolling test, or a minimum internal diameter equal to the dynamic radius of the tyre divided by 0.4 in the case of an internal rolling test. Two wheels shall be tested.

2. Formula for calculation of the test load

|                       |                 |
|-----------------------|-----------------|
| All types of vehicles | $F_p = S * F_v$ |
|-----------------------|-----------------|

$F_p$  = testing load [N]

$F_v$  = wheel maximum load capacity of the wheel [N]

S = factor of safety

3. Tests Procedure and Requirements

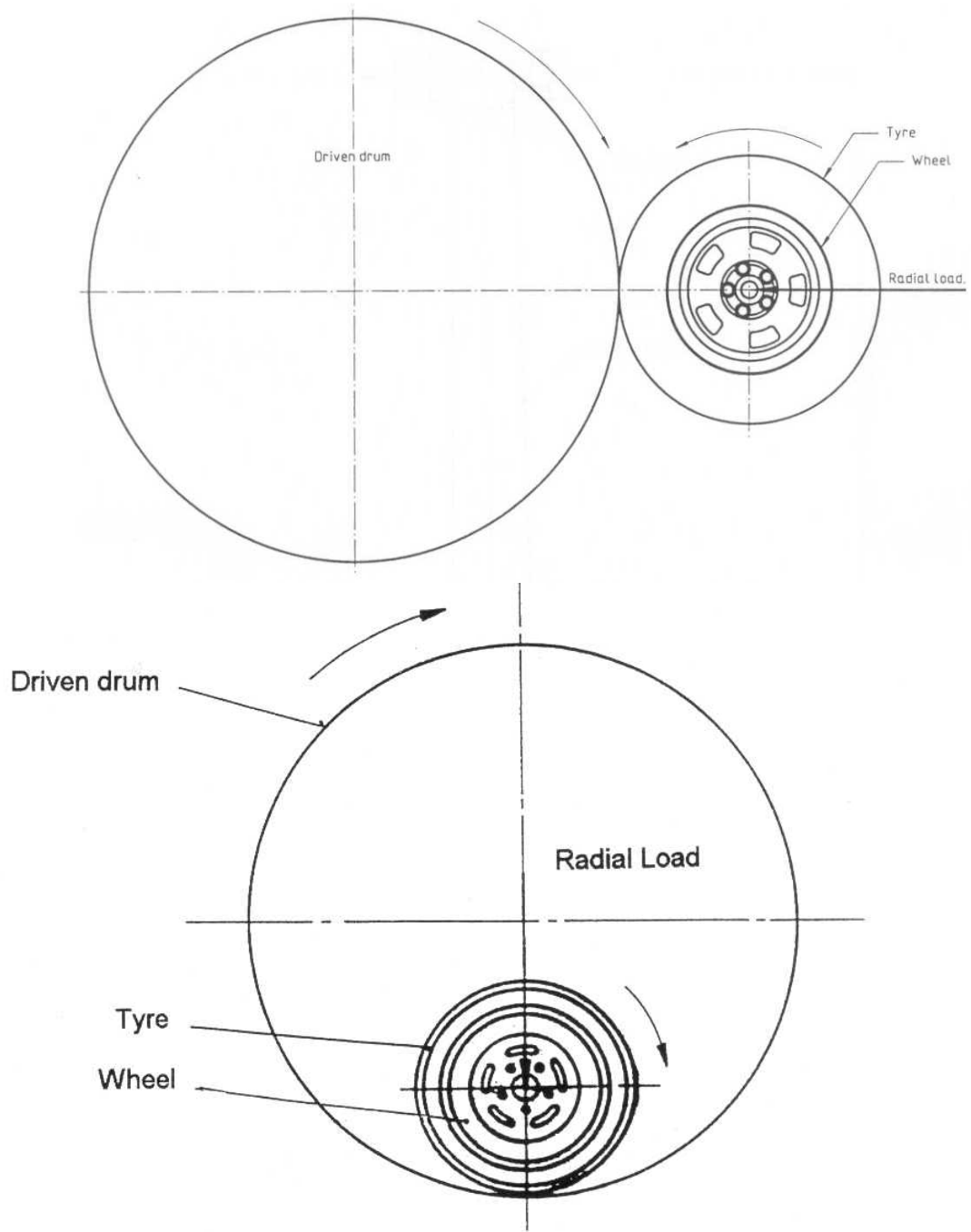
Tests are carried out on the basis of the following specifications:

|  | M <sub>1</sub> and M <sub>1</sub> G  | O <sub>1</sub> and O <sub>2</sub>                |
|--|--|--|
| Rolling direction  | Straight   |  |
| Factor of safety - S   | 2.5<br>2.25 <u>1/</u>  | 2.0  |
| Tyres  | Taken from normal (series) production and, if possible, of the maximum nominal section width recommended for the wheel |  |
| Testing speed in km/h  | The max. allowed by the tyre given by the speed index, usually 60-100 km/hour  |  |
| Equivalent rolling distance  | 2,000 km<br>1,000 km <u>1/</u>   | 2,000 km<br>1,000 km <u>1/</u>                   |
| Tyre pressure at start of test (nor checked or controlled during the test)                         | Normal usage:<br>Up to 160 kPa<br>More than 160 kPa  | rolling test pressure<br>280 kPa<br>min. 400 kPa |
| Limits of acceptance   | Technical cracks and/or air leakage are not accepted.  |  |
| Allowable loss of tightening torque initially applied to the wheel fixing studs and nuts <u>2/</u> | ≤ 30 per cent  |  |

1/ For passenger cars steel disc wheels.

2/ Check loss of tightening torque of wheel fixings by retightening - not by measuring torque to loosen fixing.





Examples of rolling test rigs.

Annex 8

IMPACT TEST

1. Test Description

Wheel strength with regard to the fractures on edges and other critical points when the wheel strikes an obstacle shall be checked. In order to show the sufficient resistance to fractures it is necessary carry out an impact test as per Annex 8 - Appendix 1.

2. Formula for the calculation of test load

$$D = 0.6 * F_v / g + 180 \text{ [kg]}$$

D = value of falling mass [kg]  
 $F_v$  = maximum wheel load capacity [N]  
g = acceleration due to gravity 9.81 m/s<sup>2</sup>

3. Test Procedure and Requirements

|                                | $M_1$ and $M_1G$   |
|--------------------------------|--|
| Procedure and requirements     | As per Annex 8 – Appendix 1  |
| Tyre pressure                  | The tyre pressure recommended by the tyre manufacturer based on the load index and the max. vehicle speed, but at least 200 kPa.   |
| Tyres                          | Tyres taken from normal (series) production with the minimum nominal section width and minimum rolling circumference on the range of tyres recommended for the particular wheel.   |
| Acceptance criteria            | The test shall be considered satisfactory if there is not any visible fracture penetrating through the wheel surface and if there is not any loss of inflation pressure within one minute of completing the test. Fractures and indentations caused by the direct contact with the falling weight are acceptable.<br>In the case of wheels with demountable rims or other components that can be dismantled, if threaded fastenings that are close to the spoke or ventilation holes fail the wheel is to be considered as having failed the test. |
| Number of samples to be tested | One for each impact position.  |
| Impact positions               | One in the area connecting spokes to rim and further one in the area between two spokes, very close to the valve hole.<br>If possible, the impact direction shall not coincide with the radial line between a fixing hole and the wheel centre.  |

4. Tests schedule for range of wheel types

Tests necessary:

| Wheels to be tested            | Impact test                  |
|--------------------------------|------------------------------|
| Minimum PCD of fixing holes    | One for each impact position |
| Maximum PCD of fixing holes    | One for each impact position |
| Insert differences up to 15 mm | --                           |
| > 15 mm                        | One for each impact position |

Annex 8 - Appendix

PASSENGER CARS - LIGHT ALLOY WHEELS - IMPACT TEST

1. SCOPE

This annex specifies a laboratory test procedure to evaluate the axial (lateral) kerb impact collision properties of a wheel manufactured either wholly or partly of light alloys. It is intended for passenger car applications, with the purpose of screening and/or quality control of the wheel.

2. TEST EQUIPMENT

2.1. New wheels, fully processed, representative of wheels intended for passenger car application, fitted with a tyre.

2.2. Impact loading test machine with a vertically acting striker having an impacting face at least 125 mm wide and at least 375 mm long and sharp edges broken by radius or chamfer, in accordance with figure 1. The falling mass,  $D$ , within a tolerance of  $\pm 2$  per cent, expressed in kilograms, shall be as follows:

$$D = 0.6 * F_v / g + 180 \text{ [kg]}$$

where  $F_v / g$  is the maximum static wheel loading, as specified by the wheel and/or vehicle manufacturer, expressed in kilograms.

2.3. Mass of 1,000 kg.

3. CALIBRATION

Ensure, by means of a test calibration adapter, that the 1,000 kg mass (paragraph 2.3.) applied vertically to the centre of the wheel fixing as shown in figure 2 causes a deflection of  $7.5 \text{ mm} \pm 0.75 \text{ mm}$  when measured at the centre of the beam.

4. TEST PROCEDURE

4.1. Mount the test wheel (paragraph 2.1.) and tyre in the test machine (paragraph 2.2.) such that the impact loading is applied to the rim flange of the wheel. The wheel shall be mounted with its axis at an angle of  $13^\circ \pm 1^\circ$  to the vertical with its highest point presented to the striker.

The tyre mounted on the test wheel shall be the smallest nominal section width tubeless radial-ply tyre intended for use on that wheel. The inflation pressure shall

be that specified by the vehicle manufacturer or, in the absence of such specification, it shall be 200 kPa.

The temperature of the test environment shall remain within a range of 10 °C to 30 °C throughout the test period.

- 4.2. Ensure that the wheel is mounted on the hub fixture with dimensionally representative fixings such as would be used on a vehicle. Manually tighten the fixings to a value or by a method as recommended by the vehicle or wheel manufacturer.

Because the design of wheel centre members may vary, test a sufficient number of locations on the wheel rim circumference to ensure that the integrity of the centre members is assessed. Use new wheels each time.

In case of test on the spoke, that spoke is to be chosen where the bolt hole is closest.

- 4.3. Ensure that the striker is over the tyre, and overlaps the rim flange by 25 mm ± 1 mm. Raise the striker to a height of 230 mm ± 2 mm above the highest part of the rim flange and allow it to fall.

## 5. FAILURE CRITERIA

The wheel is considered to have failed the test if any of the following apply:

- (a) visible fracture(s) penetrate through a section of the centre member of the wheel assembly;
- (b) the centre member separates from the rim;
- (c) the tyre loses all air pressure within 1 min.

The wheel is not considered to have failed the test by deformation of the wheel assembly or by fractures in the area of the rim section struck by the face plate of the striker.

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Note: Tyres and wheels used in the tests should not be used subsequently on a vehicle.

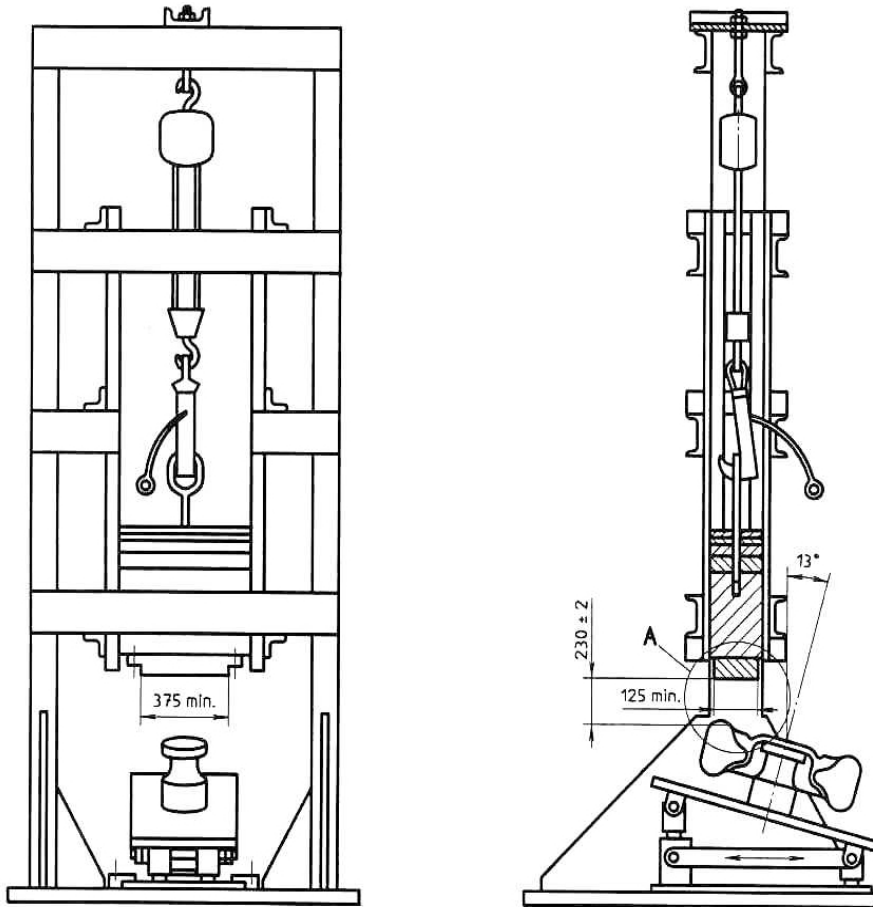


Figure 1 – Impact loading test machine

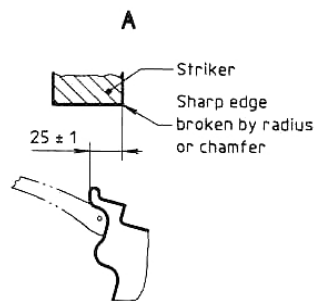


Figure 1 - Detail A

Dimensions in millimetres

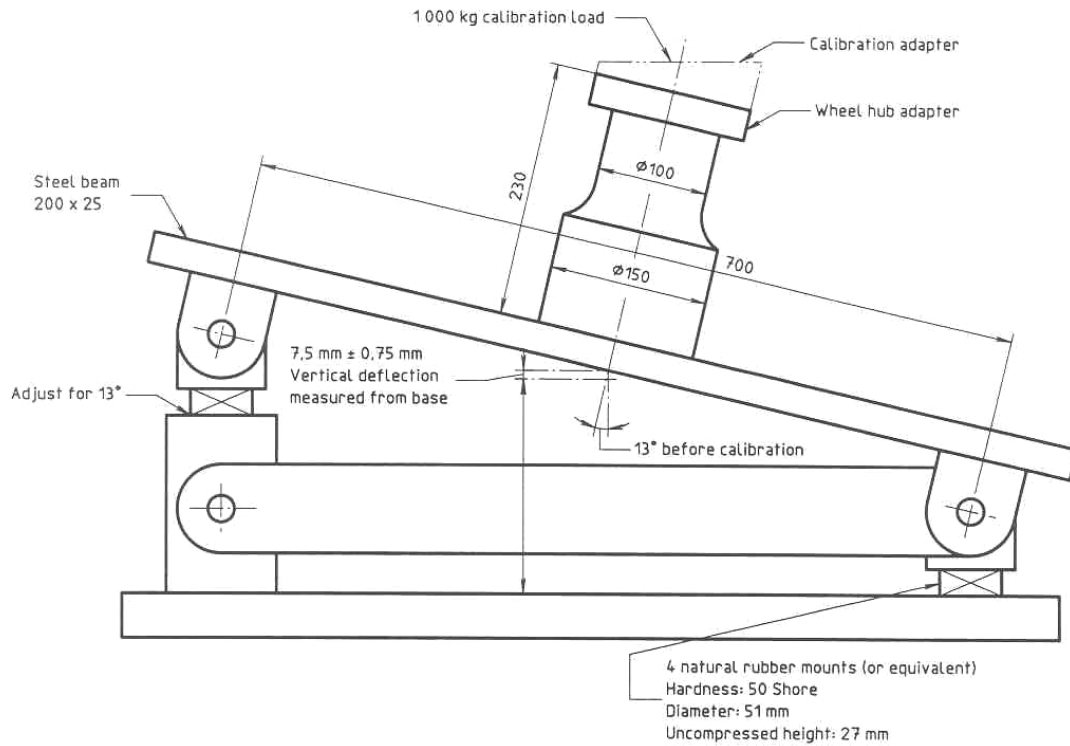


Figure 2 – Application of loading to centre of wheel mount

Dimensions in millimetres

Annex 9

ALTERNATING TORQUE TEST

1. Test Description

In an alternating torque test the torque acting on wheel during braking and acceleration is simulated. The sample wheels shall be tested at each percentage value (50 per cent and 75 per cent ) of the maximum calculated torque. Each wheel flange is rigidly fixed on the test table and stressed by an alternating torque of  $\pm M_T$ , introduced through the attachment face i.e. through a brake disc or through other components.

2. Formula for the calculation of the test torque

$$M_T = S * F_V * r_{dyn}$$

Where:

- $M_T$  = test torque [Nm]  
S = factor of safety  
 $F_V$  = maximum wheel load capacity [N]  
 $r_{dyn}$  = dynamic radius [m]

Tests are carried out on the basis of the following parameters:

|   |                                 |
|---|---------------------------------|
| Factor of safety S  | 1,0                             |
| Min number of cycles with $\pm 90$ per cent $M_T$                                     | $2 * 10^5$                      |
| Min number of cycles with $\pm 45$ per cent $M_T$                                     | $2 * 10^6$                      |
| Acceptance criteria   | Technical cracks not acceptable |
| Allowable loss of the initial torque applied to wheel fixing studs and nuts <u>1/</u> | 30 per cent                     |

1/ Check loss of tightening torque of wheel fixings by retightening, not by measuring torque to loosen fixing.



Annex 10

VEHICLE FITMENT CHECKS AND DOCUMENTATION

1. Application and fitting information

The type approval authority shall be supplied with a copy of following information which shall also be supplied to the consumer with the wheel.

1.1. Wheel characteristics

ECE approval number, wheel type and variant, international rim designation (for example, 15 H2 x 5 ½ J) and inset.

1.2. Vehicle characteristics

Vehicle manufacturer, vehicle model name and description, vehicle power and VIN range including at least WMI, VDS and first digit of VIS describing the model year (see ISO 3779-1983).

1.3. Additional characteristics

Any particular requirements, special fittings and so on that are specified when using the manufacturer's replacement wheels or specific requirements for the ECE approved wheel.

1.4. Fitting instruction detail

Recommendations and safety precautions when fitting the wheel;

Use of any additional or substitute wheel fixing components, for example, longer wheel bolts or studs with alloy wheels;

Wheel fixing tightening torque; drawing attention to the importance of this aspect and the need to preferably use a calibrated torque wrench;

Instruction regarding the necessity to re-tighten the wheel fixing after 50 km of driving;

References to the use and mounting of hubcaps, if applicable.

1.5. Example of a possible structure of the application and fitting information table.

Wheel characteristics (mandatory fields in bold characters)

|                     |                         |               |                     |                  |                        |
|---------------------|-------------------------|---------------|---------------------|------------------|------------------------|
| ECE approval number | Wheel type              | Size          | Inset               | Pcd              | Fixing holes <u>1/</u> |
| XY R-I 0001148      | 6014                    | 6Jx14H2       | 38 mm               | 98 mm            | 4                      |
| Wheel variant       | Control spigot location | Wheel marking | centre ring marking | Centre hole Dia. | max. wheel load in N   |
| A                   | Yes                     | 98-38         | 120-98              | 58.1 mm          | 5500                   |

Vehicles' characteristics

| Vehicle manufacturer | Vehicle model name | Vehicle type   | Power in kW | Identification (VIN) |        |         |
|----------------------|--------------------|----------------|-------------|----------------------|--------|---------|
|                      |                    |                |             | WMI                  | VDS    | Year(s) |
| FIAT                 | ALFA ROMEO 145/146 | ALFA ROMEO 930 | 66-95       | 1C9                  | Y817H3 | 4       |

Additional characteristics

| Ref. | Characteristic             |
|------|----------------------------|
| 1/   | Spherical fastening screws |

2. Additional requirements

2.1. Wheel calliper check

The design of the inner contour of the wheel (wheel calliper see Figure 1) must provide sufficient space for the brake, suspension and steering components.

In the case where the wheel calliper is outside of the vehicle manufacturer's replacement wheel calliper, no verification is necessary.

In the case where the calliper is inside the vehicle manufacturer's replacement wheel calliper, a check shall be carried out of wheel operating clearance with respect to brake, suspension and steering components and general under body components, taking into account the effect of wheel balance weights.

As a rule, the following criteria have to be fulfilled:

- (a) minimum clearance for brake components (worst case, for example with new brake linings): 3 mm 1/),

1/ Use of vehicle manufacturer brake component profiles and wheel caliper is recommended. However in-service monitoring is necessary because of possible change of brake parts and/or OE-wheel calliper during the vehicle production run.

- (b) minimum clearance for suspension components (e. g. upper and lower suspension arms): 4 mm,
- (c) minimum clearance for steering components (e.g. track rod and steering joints): 4 mm, and
- (d) minimum clearance between balance weights and vehicle components: 2 mm.

The check may be carried out statically or dynamically. If the various clearances on the vehicle manufacturer's replacement wheel are less than those given above, then these can be accepted.

## 2.2. Ventilation holes check

An approved wheel shall not reduce the brake efficiency in comparison with a manufacturer's replacement wheel.

The heat transfer from the brakes into steel wheels is regarded as being more severe than that with of light alloy wheels. In the case where the vehicle manufacturer's replacement wheel is designed for a defined air circulation from the brake through the wheel ventilation holes (for example by "windmilling" effect) and where the area of the ventilation holes, in a pattern part replacement wheel, is smaller than the corresponding vehicle manufacturer's replacement wheel, a comparison test shall be carried out to evaluate the brake efficiency.

The test shall follow the requirements of Regulation No. 13, Appendix 4, paragraph 1.5. Type I - Fade test procedure. The criterion is the brake temperature. The maximum temperature measured (discs, drum) using the vehicle manufacturer's replacement wheel must not be exceeded with the wheel to be approved.

Any hubcaps normally fitted are to be taken into account.

## 2.3. Wheel fixing

The use of vehicle manufacturer's replacement wheel fixing components is recommended. Any special wheel fixing components shall allow fitting of the pattern part replacement wheel without requiring any additional change. The basic number of wheel fixings, for example 4 holes, 5 holes and so on, shall not be changed. Wheel fixings shall not foul other components, for example, brake components. Regarding wheel bolts, nuts and studs, the length of thread engagement shall be the same as achieved by the vehicle manufacturer's replacement wheel and wheel fixings. The profile of the bolts / nuts shall be compatible with the profile of the location hole in the approved wheel. The material used for the wheel fixing components shall be at least equivalent to the vehicle manufacturer's replacement wheel fixing components.

In the case where wheel accessories are provided, any necessary special tools for mounting and demounting shall also be provided.

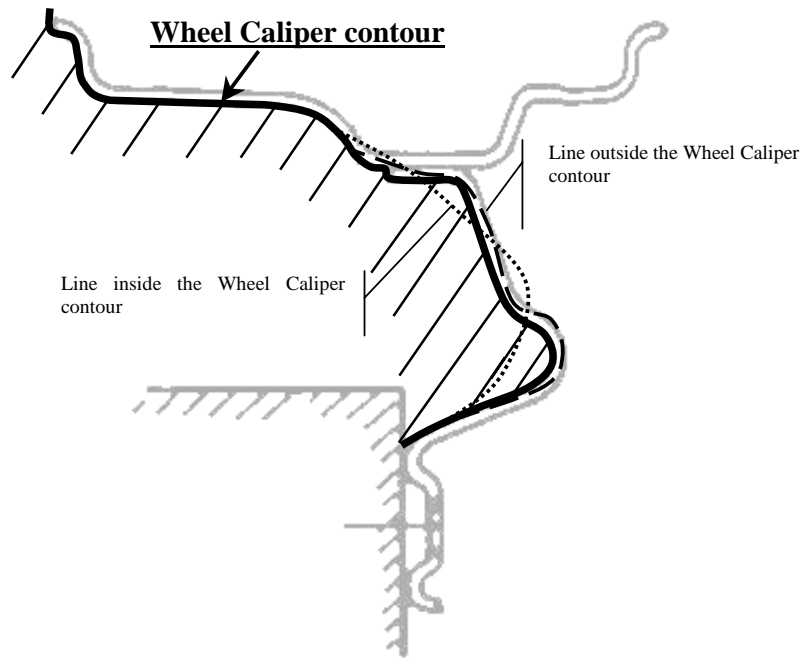
Where different wheel fixing components are supplied, they shall be detailed in the information required by paragraph 1.2., and any necessary special fitting tools shall be provided.

2.4. External projections

The approved wheel when fitted to the vehicle, together with any necessary wheel accessories, shall not create any danger. The requirements of Regulation No. 26 shall be respected.

2.5. Miscellaneous

The test report shall contain the details and results of the tests carried out. It shall confirm that the tested wheel meets the requirements.



**Figure 1:** Wheel inner contour including examples of inside and outside situations.

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