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Translation

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Technical approval of monobloc wheels

Application document for standard EN 13979-1

Homologation technique des roues monobloc - Document d'application de la norme EN 13979-1
Technische Zulassung von Vollrädern - Anwendungsdokument für die EN 13979-1

UNION INTERNATIONALE DES CHEMINS DE FER
INTERNATIONALER EISENBAHNVERBAND
INTERNATIONAL UNION OF RAILWAYS

Leaflet to be classified in Volume:

V - Transport stock

Application:

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All members of the International Union of Railways

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1st edition, February 2003	First issue
2nd edition, May 2007	Overhaul of the leaflet to explain or complement the regulations set out in EN 13979-1

The person responsible for this leaflet is named in the UIC Code

Contents

Summary

The purpose of this leaflet is to explain or complement the regulations set out in *EN 13979-1* for obtaining UIC technical approval for a wheel. For each chapter of the EN, the leaflet therefore gives explanations or additional material as necessary.

In relation to the EN, this leaflet defines the inspection procedure applied at UIC level to arrive at the decision to grant UIC technical approval.

UIC technical approval is granted to the wheel design. The approval can then be used by any manufacturer once all issues relating to ownership of the design have been dealt with.

1 - Scope

This leaflet also applies to the wheels of powered axles.

When making applications for the UIC technical approval of wheels made from grades ER8 and ER9 steel, regulations on the initiation and propagation of wheel tread defects shall be added to those contained in this document in order to obtain approval.

2 - Reference documents

(see Bibliography - page 66)

EN 13103, Railway applications - Wheelsets and bogies - Non-powered axles - Design method.

EN 13104, Railway applications - Wheelsets and bogies - Powered axles - Design method.

EN 13262, Railway applications - Wheelsets and bogies - Wheels - Product requirements.

EN 13979-1 Railway applications - Wheelsets and bogies - Monobloc wheels - Technical approval procedure - Part 1: Forged and rolled wheels

UIC Leaflet 510-2: Trailing stock - Wheels and wheelsets - Conditions concerning the use of wheels of various diameters.

ERRI B 126/DT 366: Braking problems - Brake control for freight trains on long gradients.

ERRI B 169/RP6: Standardization of wheelsets - Monitoring of solid wheels in service Non-destructive ultrasonic determination of the residual stresses in the rims of solid wheels.

ERRI B 169/RP 9: Standardization of wheelsets - Specification for wheels. Mechanical dimensions. Fatigue strength.

ERRI B 169/RP 10: Standardization of wheelsets - Definition of a specification for solid axisymmetrical wheels Verification of mechanical design: fatigue strength Towards a better shape for the wheel centre.

ERRI B 169/RP 12: Standardization of wheelsets - Production of a universal matrix representative of damage to a railway component with a view to performing fatigue tests.

UIC Leaflet 518: Testing and approval of railway vehicles from the point of view of their dynamic behaviour - Safety - Track fatigue - Ride qualit.

3 - Parameters for the definition

3.1 - Parameters for geometrical interchangeability

No further information. See prescriptions on *EN 13979-1, chapter 3.1* (see Bibliography - page 66).

3.2 - Parameters for thermomechanical assessment

NB : This chapter only looks at the thermomechanical design criteria for tread-braked wheels.
For the thermomechanical tests, a worn rim is defined as a rim with a minimum thickness of 25 +0/ +3 mm between the lathe jaw clamping diameter and the diameter of the wheel tread.

3.2.1 - Drag braking

Thermomechanical behaviour is defined by the maximum energy generated by friction between the brake blocks and the wheel tread that the wheel submitted for approval will be required to dissipate during drag braking.

3.2.1.1 - General

This energy is defined as:

- a power P_a[1] that is a function of time, where $P_a = m.g.v_a$ gradient
  where:
  - m: mass of the vehicle on rail per wheel [in kg];
  - g: acceleration exerted by gravity [in m.s^{-2}];
    gradient: average gradient of the line (gradient expressed in ‰) (see *ERRI B 126/DT 366* - see Bibliography - page 66).

It depends on:

- an application time t_a (in s) as defined in *ERRI B 126/DT 366*.

- the average running speed v_a [in m.s^{-1}], as defined *ERRI B126/DT 366*.

NB : When one of the application parameters of an already-approved wheel changes, tests should be carried out to check that the thermomechanical behaviour has not deteriorated.

1. In case of mixed braking, only that part of the braking power P_a, that is exerted on the wheels is considered.

3.2.1.2 - Special case of freight rolling stock braked with cast-iron blocks only[1]

When monobloc wheels are fitted to wagons that are 100% tread-braked, the following parameters shall be taken into account:

Wheel diameter range in [mm] [a]	1 000 to 920 and 920 to 840	840 to 760	760 to 680
Standard power value	50 kW	42,5 kW	38 kW
Application time	45 min	45 min	45 min
Running speed	60 km/h	60 km/hj	60 km/h
N.B: The standard power values applied correspond to the maximum values resulting from a braking incident with cast-iron brake blocks			

a. These axle-load limit values are taken from UIC Leaflet 510-2 and are valid only for the thermomechanical assessment

NB : For specific types of freight traffic, the values for power and/or application time and/or running speed can be modified to check on the thermomechanical behaviour of these wheels in the context of a limited utilisation.

3.2.1.3 - Special case of freight rolling stock with composite/sintered brake blocks only

Thermomechanical behaviour shall be verified during drag braking, in accordance with point 3.2.1.2 with UIC-approved brake blocks.

3.2.1.4 - Other types of rolling stock (powered and passenger)

Pending the work currently in progress in Working Group B169.10, (see Bibliography - page 66) thermomechanical behaviour shall be verified during drag braking in accordance with point 3.2.1.1 - page 4.

1. P10 grey cast-iron brake block with two 320 mm blocks (1 block on each side of the wheel).

3.2.2 - Braking to a stop

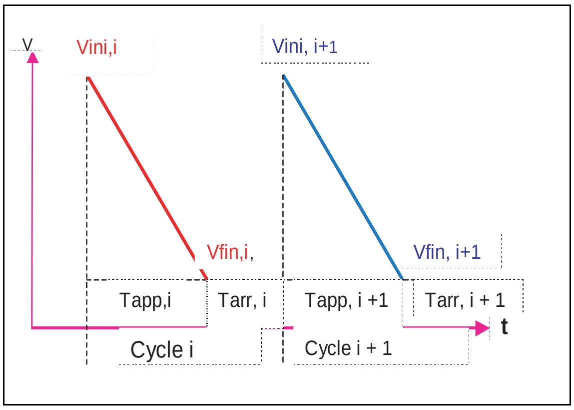
Thermomechanical behaviour is defined by the maximum energy generated by friction between the brake blocks and the wheel tread that the wheel submitted for approval will be required to dissipate when braking to a stop.

3.2.2.1 - General

The energy to be dissipated is defined by the cumulative effect of a succession of braking cycles (index i) with total power P_a[1]$= \Sigma Pi$. The power Pi is defined as follows:

$Pi = m\Upsilon i\ (Vini,i-Vfin,i)$ where:

- speed at start of braking: Vini,i $[m.s^{-1}]$
- speed at end of braking: Vfin,i $[m.s^{-1}]$
- train deceleration $\Upsilon i\ [m.s^{-2}]$
- mass of the vehicle on rail per wheel [in kg]



It depends on:

- an application time Tapp,i
- the interval between two cycles Tarr,i

3.2.2.2 - Case of freight rolling stock with cast-iron brake blocks

The thermomechanical behaviour does not need to be verified when braking to a stop but only during drag braking (see point 3.2.1.2 - page 5).

3.2.2.3 - Case of freight rolling stock with composite/sintered brake blocks

The thermomechanical behaviour does not need to be verified when braking to a stop but only during drag braking (see point 3.2.1.2).

3.2.2.4 - Other rolling stock types (powered and passenger)

Pending the work currently in progress in Working Group B169.10, thermomechanical behaviour shall be verified during drag braking in accordance with point 3.2.2.1.

1. In case of mixed braking, only that part of the braking power P_a that is exerted on the wheels is considered

3.2.3 - Braking under exceptional load

Thermomechanical behaviour is defined by the maximum braking energy generated by friction between the brake blocks and the wheel tread that the wheel to be approved is required to dissipate under exceptional load.

3.2.3.1 - General

In order to ensure operating safety the wheels must, wherever possible, be able to withstand braking under exceptional load (braking incidents, etc.).

3.2.3.2 - Case of freight rolling stock with cast-iron brake blocks

Verification of thermomechanical behaviour under exceptional load - which corresponds to a braking incident, in order words the fusion of the cast-iron brake block - shall be carried out in accordance with point 3.2.1.2 - page 5.

NB : for specific types of traffic the exceptional load must be defined.

3.2.3.3 - Case of freight rolling stock with composite/sintered brake blocks

In abeyance.

3.2.3.4 - Case of suburban type passenger rolling stock

For braking with cast-iron brake blocks, verification of thermomechanical behaviour under exceptional load - which corresponds to a braking incident, in other words the fusion of the cast-iron block - shall be carried out in accordance with point 3.2.3.2.

NB : for specific types of traffic, the exceptional load must be defined.

3.2.3.5 - Case of powered axles

When specific measures are not taken (diagnostics, operating rules) a distinction should be made between the following cases:

1. Failure of the dynamic brake or trailing vehicle (without dynamic brake activated):

   For drag braking:

   - with cast-iron brake blocks, apply point 3.2.1.2 - page 5
   - with composite/sintered brake blocks, apply point 3.2.1.3 - page 5

   For braking to a stop:

   - with cast-iron brake blocks, apply point 3.2.2.2 - page 6
   - with composite/sintered brake blocks, apply point 3.2.2.3 - page 6

2. Braking incident:

   - with cast-iron brake blocks, apply point 3.2.3.2 - page 7
   - with composite/sintered brake blocks, apply point 3.2.3.3 - page 7

3. Wheel slip:

A check shall be carried out to ensure that the thermomechanical loading is not higher than that recorded in the other cases above.
If it is not, no particular action is necessary, otherwise, the design must take account of the loadings recorded.

3.2.3.6 - Case of passenger coaches

For braking with cast-iron brake blocks, verification of thermomechanical behaviour under exceptional load - which corresponds to a braking incident, in other words the fusion of the cast-iron block - shall be carried out in accordance with point 3.2.3.2 - page 7.

NB : for specific types of traffic, the exceptional load must be defined.

4 - Description of the wheel to be approved

The designer of the wheel submitted for approval must provide full documentation as defined in Appendix H - page 41.

5 - Assessment of geometric interchangeability

Appendix F - page 37 to this leaflet gives a basic diagram for verifying interchangeability using the example of a standard ERRI wheel (axle-load of 22,5 tonnes).

6 - Assessment of thermomechanical behaviour

No further information. See prescriptions on *Norm EN 13979-1, chapter 6*.

7 - Assessment of mechanical behaviour

7.1 - General procedure

The assessment procedure to be followed is illustrated in point B.1 - page 22 . This leaflet requires a mechanical assessment procedure under exceptional load in addition to the provisions of *Norm EN 13979-1*.

7.2 - First stage - Calculation

For the mechanical design of wheels in accordance with this leaflet, no limit is set for the ratio between maximum axle-load and running tread diameter.

Unlike the thermomechanical assessment, mechanical behaviour can be assessed exclusively by calculation. It is for this reason that the designer of the wheel is asked to demonstrate that the calculation model being used will provide reliable results. The procedure to be followed for this demonstration is set out in Appendix C - page 26 to this leaflet.

Appendix C to EN 13979-1 is considered as **normative**.

7.2.1 - Applied forces

7.2.1.1 - Exceptional loading

Exceptional loading of wheels for all types of rolling stock is defined in *UIC Leaflet 518, point 3.4* (see Bibliography - page 66) as follows:

- Vertical force $Fz_{lim} = 90 + Q$ where Q = load per wheel in kN, but also with a limitation linked to speed as indicated in the table below:

Speed in km/h	Fz_{lim} in kN
v < 160	200
160 ≤ v < 200	190
200 ≤ v < 250	180
250 ≤ v < 300	170
300 < v	160

- Lateral force $Fy_{lim} = \alpha\,(10 + P_0/3)$ where P_0 = axle-load in kN and $\alpha = 1$ for all rolling stock types.

7.2.1.2 - Service loadings for non-tilting rolling stock

1. **Conventional forces**

   The assessment is carried out in accordance with *EN 13979-1, point 7.2.1*.
   The forces to use are the conventional forces defined for axles in standards *EN 13103 and EN 13104* (see Bibliography - page 66).
   These forces shall apply when the proportion of line section comprising curves with a radius of ≤ 800 m is less than 24% of the total distance covered in one life cycle.

2. **Non-conventional forces**

   If the proportion of sections consisting of curves with a radius ≤ 800 m is greater than 24% of the total distance covered in one life cycle, then the load spectrum shall be defined in accordance with *ERRI B 169/RP 12* (see Bibliography - page 66) or the simplified method in Appendix G - page 38.

7.2.1.3 - Service loading for tilting rolling stock: acceleration (a_q) > 1 ms $^{-2}$

1. **Conventional forces to be used for calculations**

   The following load cases shall be considered in cases where they are applicable:

Case 1: **Straight track**

Fz_1 = -1,25 Q.g

Fy_1 = 0

Case 2: **Curved track**

Fz_2 = -1,25 Q.g

Fy_2 = 0,8 [a] Q.g for non-guiding axles

Fy_2 = 0,9 [a] Q.g for powered and guiding axles

Case 3: **Switches and crossings**

Fz_3 = -1,25 Q.g

Fy_3 = -0,6 . Fy_1 = -0,6 . 0,6 Q.g

= -0,36 Q.g for non-guiding axles

Fy_3 = -0,6 . Fy_2 = -0,6 . 0,7 Q.g

= -0,42 Q.g for powered and guiding axles

a. These values are consistent with standards EN 13103 and 13104 for the design of axles for tilt-body rolling stock.

2. **Non-conventional forces**

   If the proportion of line sections with curves of radius ≤ 800 m is greater than 24% of the total distance covered in one life cycle, the load spectrum shall be defined in accordance with *ERRI B169/RP12*.

7.2.2 - Calculation procedure

7.2.2.1 - Under exceptional loading

The assessment shall be carried out by calculating the principal stresses at all points of the mesh for the three load cases.

7.2.2.2 - Under service loading for non-tilting rolling stock

The assessment shall be carried out in accordance with *EN 13979-1, Point 7.2.2* .

7.2.2.3 - Under service loading for tilting rolling stock

The assessment shall be carried out in accordance with *EN 13979-1, Point 7.2.2*.

7.2.3 - Decision criteria

7.2.3.1 - Under exceptional loading

For each node, the VON MISES equivalent stress must remain less than or equal to the elasticity limit of the material.

7.2.3.2 - Under service loading for non-tilting rolling stock

1. **Uniaxial fatigue criteria to be used for axisymmetrical wheels**

   The fatigue criteria to be used and the method and assumptions for determining these stresses are described in Appendix B - page 22.

2. **Multiaxial fatigue criteria to be used for non-axisymmetrical wheels (with holes in the web for example)**

   If there exists a multiaxial stress during one wheel revolution, then a multiaxial fatigue criterion shall be used (currently under development in Committee B169).

7.2.3.3 - Under service loading for tilting rolling stock

1. **Uniaxial fatigue criteria to be used for axisymmetrical wheels**

   The fatigue criteria to be used and the method and assumptions for determining these stresses are described in Appendix B.

2. **Multiaxial fatigue criteria to be used for non-axisymmetrical wheels (with holes in the web for example)**

   If there exists a multiaxial stress during one wheel revolution, then a multiaxial fatigue criterion shall be used (currently under development in Committee B169).

7.2.4 - Assessment of uniawial mechanical design for special cases

Such cases can include for example wagons with a large overhang when propelled. Checks should be carried out to ensure that the conventional forces are applicable. If this is not the case, the assessment shall be carried out in accordance with *EN 13979-1* but with loadings determined using *ERRI B169/RP12* or the simplified method described in Appendix G - page 38.

7.3 - Second stage - Bench test

This assessment is carried out in accordance with *EN 13979-1, Appendix D*. This Appendix D is considered to be **normative** for this UIC leaflet.

The forces to be applied are obtained using a global matrix from which the test stresses should be defined.

Three cases are considered:

- The global matrix of stresses is known, since already determined for the same application in accordance with *ERRI B 169/ RP 12*. Where this is the case, there is no need to carry out new field tests.

- The global matrix of stresses is not known. Where this is the case, field tests must be carried out in accordance with *ERRI B 169/ RP 12* in order to determine the local stress matrix to be reproduced on the test bench.

- The global matrix of loading is unknown for the entire application. The global matrix is made up in this case of the superimposition of known elementary matrices and matrices determined additionally through field testing (*ERRI B 169/ RP 12*) taking account of weighting factors.

8 - Assessment of accoustical behaviour

No further information. See prescriptions on *EN 13979-1, Point 8*.

9 - Technical approval documents

The designer of the wheel to be approved must provide all the documents stipulated in Appendix H - page 41 (Procedure for the technical approval of wheels).

At the end of the conformity assessment procedure, if it is successful, UIC shall issue its approval and send to the supplier a conformity assessment certificate in accordance with Appendix I - page 64.

Appendix A - Assessment of thermomechanical behaviour

A.1 - Assessment flow chart

See *Norm EN 13979-1, Appendix A1*.

A.2 - Brake rig test procedure

A.2.1 - Definition of brake applications

The parameters for the brake applications are based on the stipulations of point 3.2 - page 4. When braking to a stop, the brake applications should generate if possible a crack depth of 9 ± 1 mm. However, if this depth is not obtained after a maximum of 270 applications, the test shall be halted.

In the case of tread-braked monobloc wheels with wheel tread diameters of 1 000 mm to 840 mm this gives:

- Type of brake blocks for drag braking:
  - block made from P10 grey cast-iron or composite material, depending on the intended use of the wheel,
  - brake configuration Bg 2 x 320
- Type of brake blocks for braking to a stop:
  - generally blocks made from composite materials, fitted so as to protrude by 5 mm

Table 1 : Wheel with new rim, ∅ 1 000 to 840 mm

<table>
<tr><th>Wheel</th><th>Type of brake application</th><th>Number of brake applications</th><th>Nominal brake power</th><th>Duration of braking</th><th>Speed</th></tr>
<tr><td rowspan="4">New wheel rim</td><td>Drag braking</td><td>3</td><td>30 kW</td><td>45 ± 1 min.</td><td>60 ± 1 km/h</td></tr>
<tr><td>Braking to a stop</td><td>270 [a]</td><td colspan="3">Initial braking speed: 150 ± 2 km/h
Axle-load: 22,5 t
Duration of braking: 55 ± 5 s
Initial braking temperature: ≤ 50°C</td></tr>
<tr><td>Drag braking</td><td>1</td><td>40 kW</td><td>45 ± 1 min.</td><td>60 ± 1 km/h</td></tr>
<tr><td>Drag braking</td><td>1 + n [b]</td><td>50 kW</td><td>45 ± 1 min.</td><td>60 ± 1 km/h</td></tr>
</table>

a. or until one of the cracks is 9 + 1 mm deep, starting from the notch.
b. number of drag braking applications at 45 + 5 kW until fracture, or until a state close to fracture, or interrupt test if the residual stresses stabilise, but a maximum of 10.

Table 2 : Wheel with worn rim, ∅ 1 000 to 840 mm

Wheel	Type of brake application	Number of brake applications	Nominal brake power	Duration of braking	Speed
Worn wheel rim	Drag braking	2	30 kW	45 ± 1 min.	60 ± 1 km/h
	Braking to a stop	270 [a]	Initial braking speed: 120 ± 2 km/h Axle-load: 22,5 t Duration of braking: 45 ± 5 s Initial braking temperature: ≤ 50°C		
	Drag braking	1	40 kW	45 ± 1 min.	60 ± 1 km/h
	Drag braking	1 + n [b]	50 kW	45 ± 1 min.	60 ± 1 km/h

a. or until one of the cracks is 9 + 1 mm deep, starting from the notch.
b. number of drag braking applications at 45+5 kW until fracture, or until a state close to fracture, or interrupt test if the residual stresses stabilise, but a maximum of 10.

The following brake applications are used for wheels with a tread diameter of 840 mm to 680 mm:

Table 3 : Wheels with new and worn rims, ∅ 840 to 680 mm

Wheel	Type of brake application	Number of brake applications	Nominal brake power	Duration of braking	Speed
New and worn wheel rims	Drag braking	3	30 kW	45 ± 1 min.	60 ± 1 km/h
	Braking to a stop	270 [a]	Initial braking speed: 120 ± 2 km/h Axle-load: 20 t Duration of braking: 45 ± 5 s Initial braking temperature: ≤ 50°C		
	Drag braking	1	35 kW [b] 30 kW [c]	45 ± 1 min.	60 ± 1 km/h
	Drag braking	1 + n [d]	42,5 kW [b] 38 kW [c]	45 ± 1 min.	60 ± 1 km/h

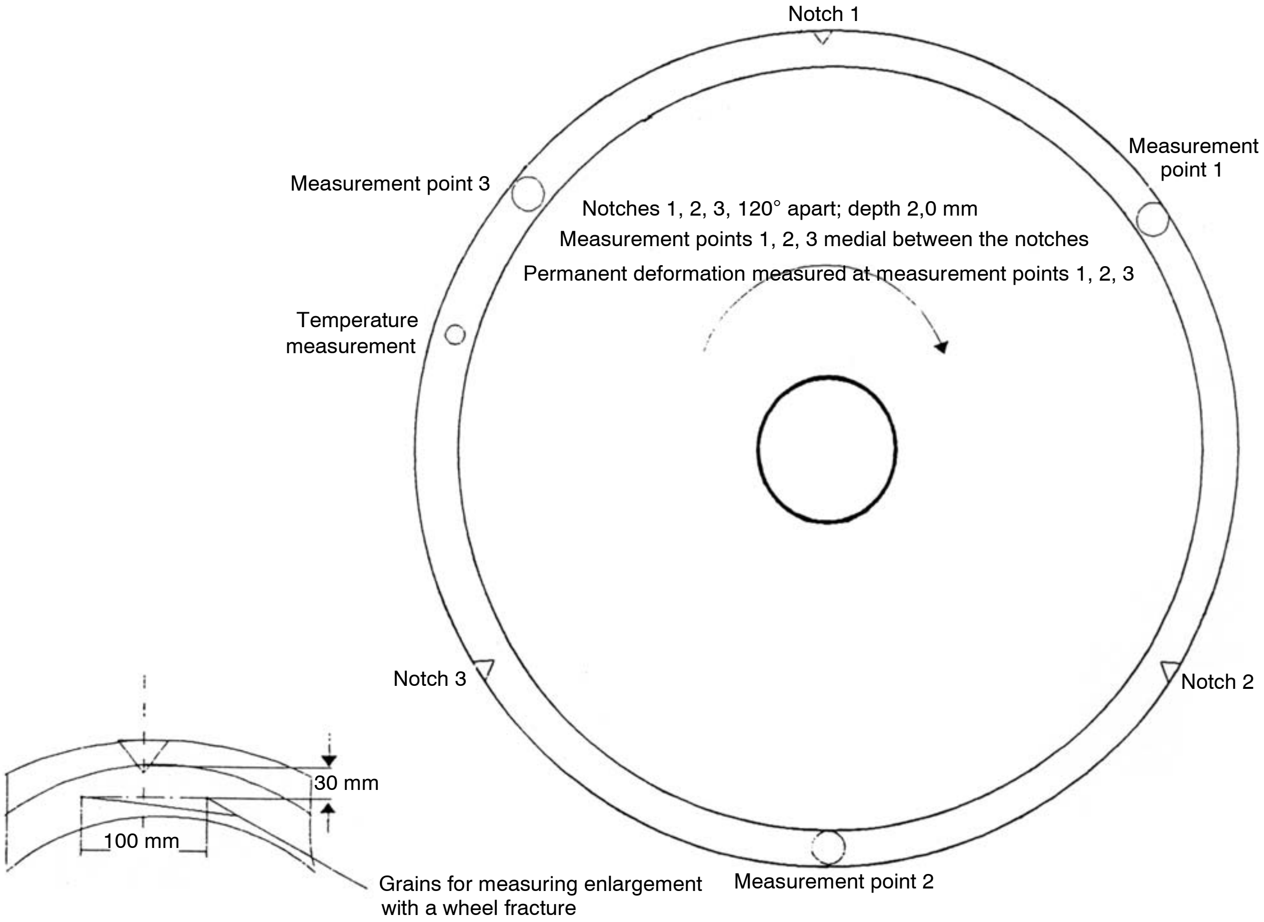
a. or until one of the cracks is 9 + 1 mm deep, starting from the notch.
b. wheel tread diameter from 840 mm to 760 mm.
c. wheel tread diameter from 760 mm to 680 mm.
d. number of drag braking applications at 42,5 kW (b.) or 38 kW (c.) until fracture, or until a state close to fracture, or interrupt test if the residual stresses stabilise, but a maximum of 10.

A.2.2 - Pre-cracking of the wheel rim

The wheel that is to undergo the fracture test must have a crack in the outer edge of the tread.

This crack can be produced using the method outlined below:

- making three mechanical notches in the outer edge of the wheel tread, at 120° intervals as shown in the diagram below:



- Drag braking applications followed by braking to a stop shall be carried out to produce a clearly-defined initiation crack. The provisions that apply for drag braking are equivalent to those in point A.2.1 - page 18. For brake applications to a stop, the brake block shall be fitted so as to project by 5 mm in relation to the front outer face of the wheel rim. When the initiation crack has reached the necessary depth, the residual stresses are measured in the wheel rim and the tests continued with drag braking applications.

A.2.3 - Measuring methods specific to the test

While the test is proceeding, it is important to monitor the development of circumferential residual stresses in the wheel rim. This is done by ultrasound. *ERRI report B169/RP6* (see Bibliography - page 66) explains how to conduct these inspections.

A.2.4 - Fracture of the wheel

After the fracture test (whether or not fracture has occurred), one of the cracks shall be opened to document the size and propagation of the crack. The fracture toughness shall also be determined.

Appendix B - Assessment of mechanical behaviour

B.1 - Assessment flow chart

$\Delta\sigma_c$:	Range of the calculated stress [MPa]
$\Delta\sigma A_u$:	range of the permissible stress for wheels with machined webs = 360 MPa
$\Delta\sigma A_b$:	range of the permissible stress for wheels with unmachined webs = 290 MPa
σ VON MISES :	VON MISES stress
Re :	conventional elasticity limit

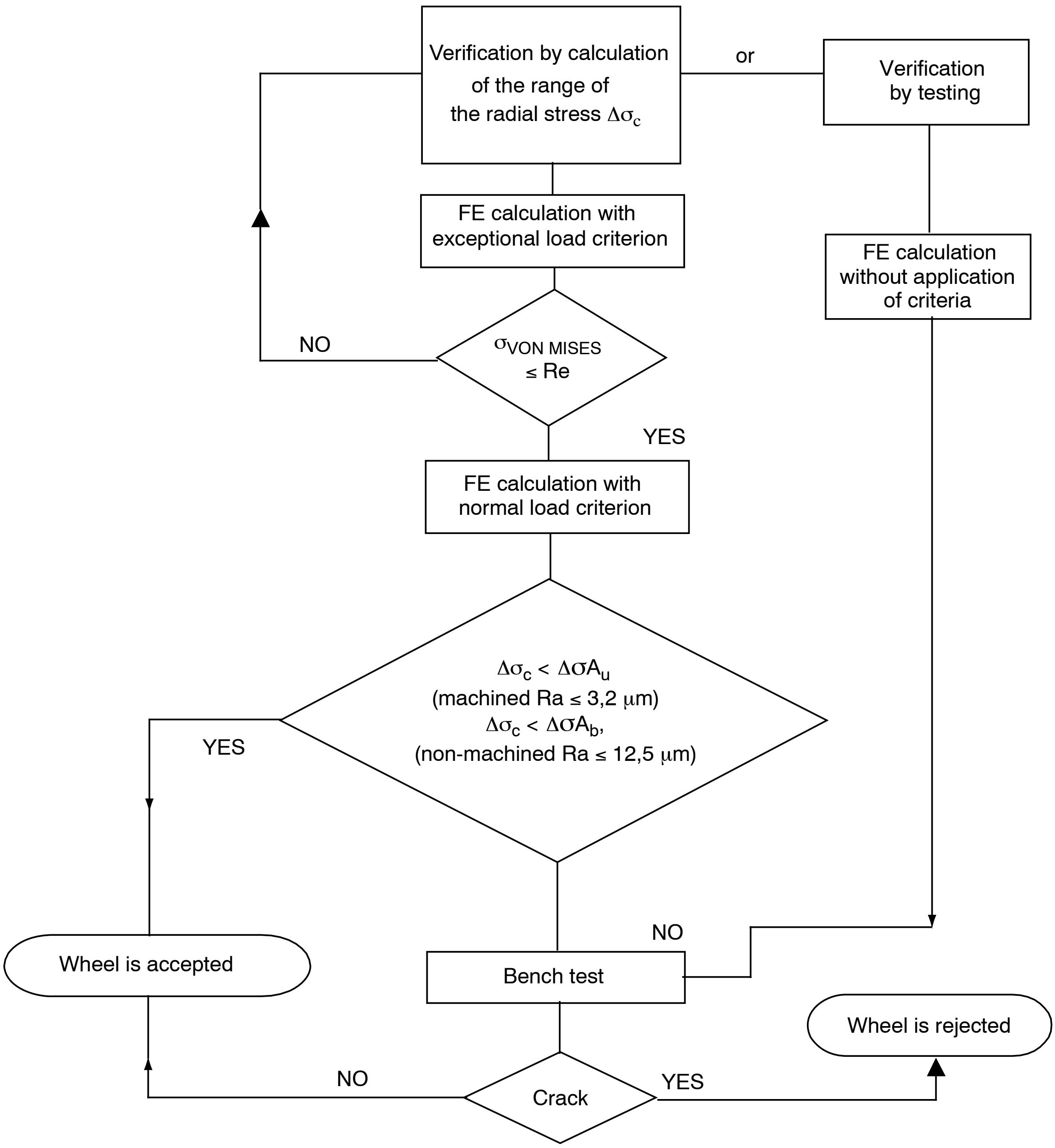


Fig. 1 - Verification flow chart

NB : the stress range is double the stress amplitude.

B.2 - Calculation method

B.2.1 - Principle

The calculation under conventional load will give stresses for all points on the wheel web that can then be compared with the permissible stress levels.

If the calculated stresses are less than the permissible stresses, in other words situated within the fatigue zone, then the design is correct and the wheel web should not crack in service.

If the calculated stresses lie outside this zone, the web design must be reviewed and the calculation repeated until the condition is satisfied; otherwise mechanical design verification tests must be carried out (see point B.1 - page 22).

B.2.2 - Loading

Normal operating conditions

The load to be used is determined from:

- the static load of the vehicle on rail, for the vertical and lateral forces,
- the speed, for the centrifugal force.

Account is also taken of stresses produced when the wheel is shrink-fitted to the axle. The mean compression value shall be used.

Exceptional operating conditions

For operating conditions other than those referred to as normal, the load spectrum for the application in question must be determined as described in *ERRI B 169/RP 12*.

B.2.3 - Calculation method

B.2.3.1 - Scope of application

The finite element calculation shall be applied to all axisymmetrical wheels. This limitation is made necessary by the choice of the monoaxial fatigue criterion.

For wheels that are not axisymmetrical, a new fatigue criterion must be chosen - for example a Crossland or Dang Van fatigue criterion - with the associated permissible stresses.

B.2.3.2 - Meshing

During the first stage, the mesh for the wheel must ensure a good correlation between the calculated nominal permissible stresses and their measured equivalents.

Since the wheel geometry is axisymmetrical, the mesh is generally produced from a meridian half-section with plane axisymmetrical elements able to accommodate a non-axisymmetrical load.

The dimensions considered shall be the minimum dimensions for the wheel web, with the rim at wear limit.

Volumic (3D) meshing may be necessary.

B.2.3.3 - Method for analysing the stresses

The method involves establishing a mean stress and a dynamic stress for each node of the structure. This is calculated as follows:

$$\sigma_{middle} = \frac{\sigma_{max} + \sigma_{min}}{2}$$

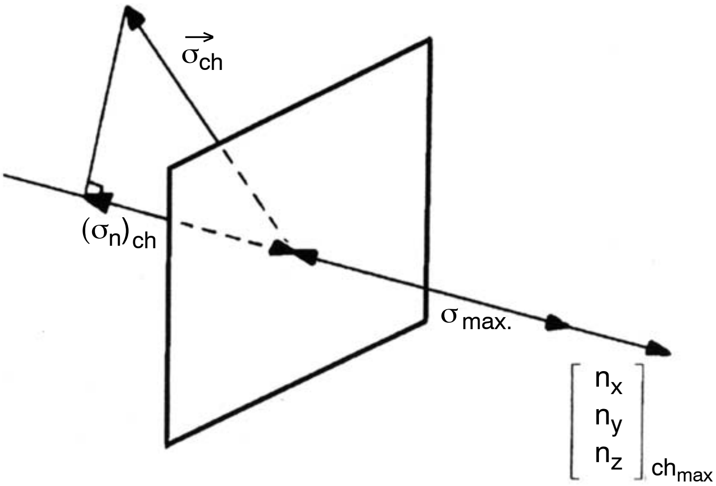
$$\sigma_{dynamic} = \frac{\sigma_{max} - \sigma_{min}}{2}$$

σ_{max} and σ_{min} are established as follows:

- Let $\begin{bmatrix} \sigma_1 & 0 & 0 \\ 0 & \sigma_2 & 0 \\ 0 & 0 & \sigma_3 \end{bmatrix}_{ch}$, be the matrix of principal stresses in a node and for the load case "ch" where $(\sigma_1 \geq \sigma_2 \geq \sigma_3)$.
- Let ch_{max} be the load case corresponding to $\sigma_{i\ max.}$ from among "N" load cases
- Let $\begin{bmatrix} n_x \\ n_y \\ n_z \end{bmatrix}_{ch_{max}}$ be the unit vector for the direction of $(\sigma_j)_{ch_{max}}$
- We take: $\sigma_{max} = (\sigma_j)_{ch_{max}}$
- $(\sigma_N)_{ch}$ is the normal component of the stress vector on the normal plane $\begin{bmatrix} n_x \\ n_y \\ n_z \end{bmatrix}_{ch_{max}}$ expressed as $\overrightarrow{\sigma_{ch}}$ for load case "ch"

$$(\sigma_N)_{ch} = \underbrace{\begin{bmatrix} \sigma_{xx} & \sigma_{xy} & \sigma_{xz} \\ \sigma_{xy} & \sigma_{yy} & \sigma_{yz} \\ \sigma_{xz} & \sigma_{yz} & \sigma_{zz} \end{bmatrix}_{ch} \begin{bmatrix} n_x \\ n_y \\ n_z \end{bmatrix}_{ch_{max}}}_{\overrightarrow{\sigma_{ch}}} \bullet \begin{bmatrix} n_x \\ n_y \\ n_z \end{bmatrix}_{ch_{max}}$$

- We take σ_{min} equal to the smallest value of $(\sigma_N)_{ch}$ from among all the load cases.



In reduced notation, we wish to determine σ_{ij}.

In a standard case, σ_{11} will be sufficient to gauge the fatigue state.

For wheels, σ_2 may be very close to σ_1, and it is therefore necessary to analyse σ_{11}, σ_{12}, σ_{21} and σ_{22} to be sure of obtaining the least favourable case (σ_1 is often in a radial section and σ_2 in a circumferential section).

B.3 - Test method used to determine permissible stresses

This method is set out in *ERRI-Committee B 169/RP 9* (see Bibliography - page 66).

B.4 - Assessment of mechanical design by testing

This assessment is set out in *Standard EN 13979-1, Appendix D*.

Appendix C - Assessment method for a finite element calculation model

C.1 - Principle

Unlike the thermomechanical assessment, mechanical behaviour can be evaluated exclusively by calculation. It is for this reason that the wheel designer is asked to demonstrate that his calculation model delivers reliable results.

To this end, this appendix gives an example of the application of this leaflet to a wagon wheel (ERRI) suitable for 22,5 t/axle running at a maximum speed of 120 km/h, for a monoaxial mechanical fatigue design. This application must be used to demonstrate the validity of the finite element calculation model.

A static test with strain gauge measurements applying load cases 2 and 3 from *EN 13979-1* must also be carried out in order to validate this calculation code. A drawing of the wheel (with dimensions) that underwent this static test must be enclosed as part of the approval submission.

The principle behind this evaluation of the calculation model is illustrated in the diagram below.

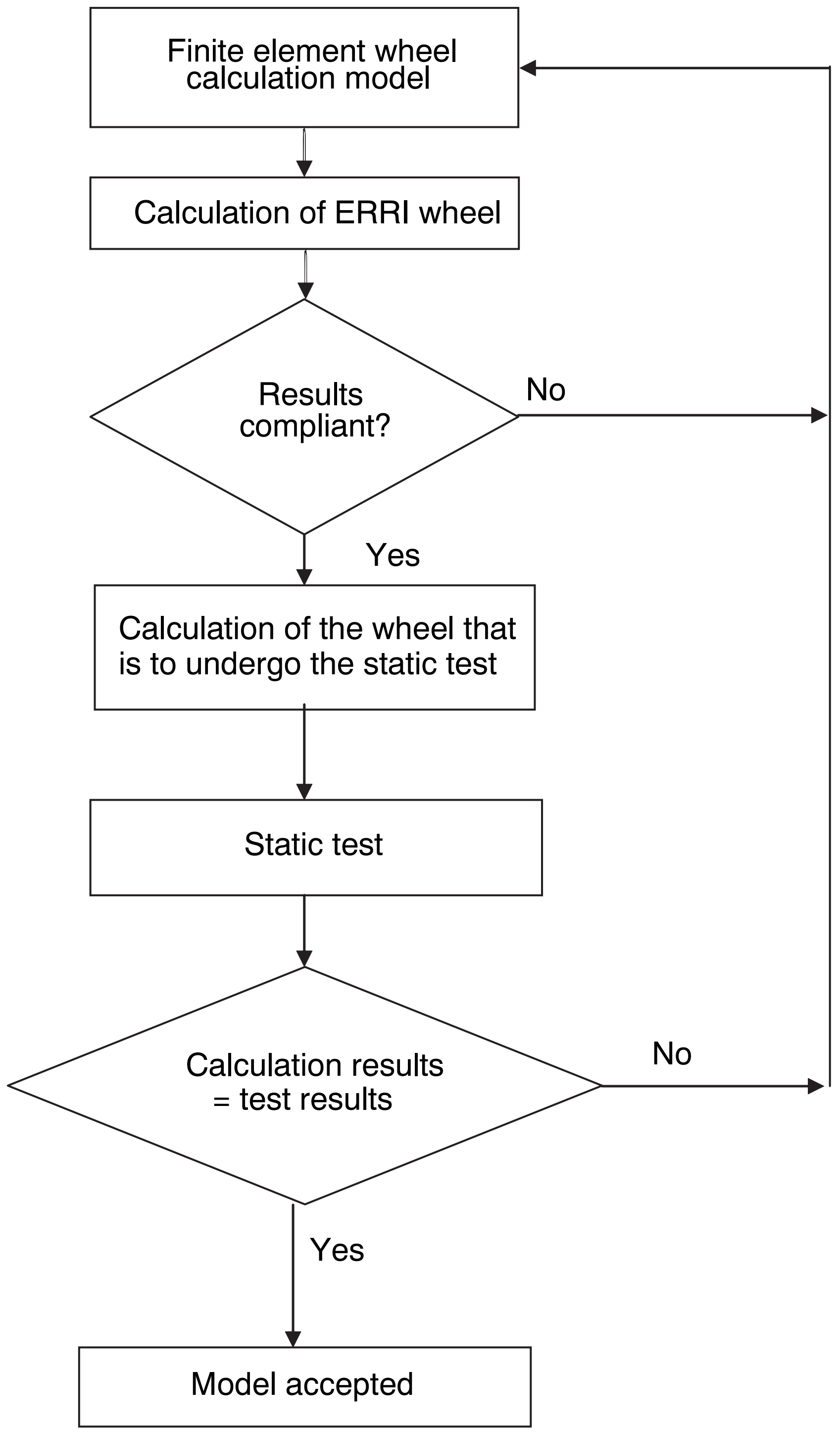


Fig. 2 - Assessment method for a finite element calculation model

C.2 - Application example: wagon wheel suitable for 22,5 t/axle

C.2.1 - The wheel

The wheel in question is the ERRI standard ∅ 920 mm wheel with maximum radial wear of 25 mm (Reference: UIC/ORE-200-M-1111-0001).

C.2.2 - The mathematical model

C.2.2.1 - The mesh

Experience shows that stresses in the wheel web under the effect of the loads defined in this leaflet are greatest for wheels at the wear limit. The wheel was therefore modelled with a radial wear of 25 mm at the rim.

The mesh of the wheel was defined so as to be sure to identify the maximum stresses at all points of the wheel web. In other words, the precision of the mesh takes account of the type of element selected and the convergence of the results as a function of the mesh density in the wheel web.

The axle was modelled to take account of stresses resulting from the wheel being shrink-fitted onto the axle.

The model is axisymmetrical.

C.2.2.2 - Loads and limit conditions

Only two nodes of the axle are locked in the radial direction, leaving it free to bend.

Only one of these two points is locked in the axial direction, to make the model static.

The load is non-axisymmetrical (broken down into Fourier series) and complies with the provisions of standard *EN 13979-1, Point 7.2*, in other words for an axle-load of 22,5 t:

- $Fz_1 = Fz_2 = Fz_3$ = 137 953 N

- Fy_2 = 66 217 N

- Fy_3 = 39 730 N

A mean compression of 0,325 mm at the diameter was assumed for each load case.

C.2.3 - Results

C.2.3.1 - Static stresses

For each load case, the different types of stresses (radial, axial, circumferential, VON MISES, principal maximum, principal average and principal minimum) can be analysed at any point on the wheel web.

The tables that follow give the values obtained for 14 points situated at different diameters on the outer and inner faces of the wheel web as shown in Fig. 3 - page 34.

The values of these calculated stresses were then validated by tests on the bench.

Table 4 : Results for load case 1 (maximum values in the measuring zone)

Measuring points		Radial-stresses σ_x (MPa)	Axial-stresses σ_y (MPa)	Circumferential stresses σ_z (MPa)	Von-Mises-Stresses σ_{VM} (MPa)	Principal stresses σ_I (MPa)	Principal stresses σ_{II} (MPa)	Principal stresses σ_{III} (MPa)
Ø310	Inner face	-77	-53	103	183	103	-10	-127
	Outer face	-16	-17	127	147	127	2	-34
Ø328	Inner face	-102	-49	67	187	67	-5	-146
	Outer face	7	-6	120	120	120	8	-8
Ø370	Inner face	-187	-26	41	205	41	-7	-196
	Outer face	51	-1	121	106	121	51	-1
Ø400	Inner face	-186	-6	17	194	17	-4	-188
	Outer face	62	-4	119	103	119	62	1
Ø557	Inner face	-251	-8	-25	240	-5	-25	-254
	Outer face	136	-4	151	148	151	136	-4
Ø690	Inner face	-36	-1	6	39	6	0	-36
	Outer face	-37	1	49	64	49	1	-38
Ø710	Inner face	-32	-1	9	36	9	-1	-32
	Outer face	-41	-1	36	64	36	0	-42

Table 5 : Results for load case 2 (maximum values in the measuring zone)

Measuring points		Radial-stresses σ_x (MPa)	Axial-stresses σ_y (MPa)	Circumferential stresses σ_z (MPa)	Von-Mises-Stresses σ_{VM} (MPa)	Principal stresses σ_I (MPa)	Principal stresses σ_{II} (MPa)	Principal stresses σ_{III} (MPa)
Ø310	Inner face	-6	-13	133	144	133	6	-18
	Outer face	-112	-53	90	198	90	-5	-152
Ø328	Inner face	16	-5	129	125	129	16	-5
	Outer face	-140	-37	56	206	56	-4	-173
Ø370	Inner face	99	3	142	126	142	102	0
	Outer face	-214	-12	18	229	18	-5	-221
Ø400	Inner face	112	2	142	129	142	113	-1
	Outer face	-228	-5	4	229	4	-3	-229
Ø557	Inner face	-92	-1	26	101	26	-1	92
	Outer face	-7	-1	11	15	11	-1	-8
Ø690	Inner face	31	-1	54	48	54	31	-1
	Outer face	-131	-5	-18	123	-2	-18	-132
Ø710	Inner face	31	-1	53	47	53	31	-1
	Outer face	-131	-2	-17	123	-2	-17	-131

Table 6 : Results for load case 3 (maximum values in the measuring zone)

Measuring points		Radial-stresses σ_x (MPa)	Axial-stresses σ_y (MPa)	Circumferential stresses σ_z (MPa)	Von-Mises-Stresses σ_{VM} (MPa)	Principal stresses σ_I (MPa)	Principal stresses σ_{II} (MPa)	Principal stresses σ_{III} (MPa)
Ø310	Inner face	-28	-27	122	150	122	-6	-56
	Outer face	-71	-39	105	173	105	-3	-100
Ø328	Inner face	-30	-22	104	138	104	-1	-51
	Outer face	-82	-25	81	161	81	-2	-105
Ø370	Inner face	-24	-9	96	116	96	-2	-31
	Outer face	-110	-8	59	151	59	-3	-114
Ø400	Inner face	-6	-2	92	95	92	-1	-7
	Outer face	-113	-3	50	145	50	-2	-114
Ø557	Inner face	-153	-4	5	152	5	-3	-153
	Outer face	52	-2	68	63	68	52	-2
Ø690	Inner face	-5	-1	30	32	30	-1	-5
	Outer face	-83	-2	12	87	12	-1	-83
Ø710	Inner face	-11	-1	29	34	29	-1	-12
	Outer face	-83	-2	8	87	8	-1	-83

This shows that, whatever the load case, the VON MISES stresses (directly comparable to the elasticity limit of material Re = 355 MPa) remain below 355 MPa at all points of the wheel web:

- load case 1: 240 MPa max
- load case 2: 229 MPa max
- load case 3: 173 MPa max

C.2.3.2 - Fatigue analysis

At all points of the wheel web, values can be obtained for the mean and dynamic stresses for each type of analysis σ_{ij}.

Example of an analysis for a node

The node chosen is the one where the dynamic stress is highest.

Table 7 : Table of stresses for each load case

Load case	Matrix of stresses									Principal stresses								
	radial Sx (MPa)			axial Sy (MPa)			Circum-ferential Sz (MPa)			maximum S1 (MPa)			Average S2 (MPa)			minimum S3 (MPa)		
1	-186			-6			14			14			-4			-188		
Orientation	1	0	0	0	1	0	0	0	1	0	0	1	0,11	0,99	0	0,99	-0,11	0
2	112			2			142			142			113			1		
Orientation	1	0	0	0	1	0	0	0	1	0	0	1	1	- 0,09	0	0,09	1	0
3	-6			-2			92			92			-1			-7		
Orientation	1	0	0	0	1	0	0	0	1	0	0	1	0,453	0,9	0	0,9	- 0,45	0

Table 8 : Table of fatigue analyses

σ_{ij} : Analysis according to the direction of σ_j corresponding to the load case selected for σ_i max.	Analysis						Fatigue	
	Maximum stress (MPa)		Projection of the matrix of stresses on the direction selected $(\sigma_N)_{ch}$ (MPa)			Minimum stress (MPa)	Average stress (MPa)	Dynamic stress (MPa)
		Load case	Load case 1	Load case 2	Load case 3			
σ11	142	2	14	142	92	14	78	64
σ12	113	2	-188	113	-6	-188	-38	150
σ21	142	2	14	142	92	14	78	64
σ22	113	2	-188	113	-6	-188	-38	150

Table 9 : Fatigue analysis in accordance with direction 11

Measuring points		Criterion	Dynamic ratio	Average stresses σ_{moy} (MPa)	Dynamic stresses σ_{dyn} (MPa)
∅310	Inner face	0	0,38	118	23
	Outer face	0	0,36	109	24
∅328	Inner face	0	0,36	98	31
	Outer face	0	0,34	88	32
∅370	Inner face	0	0,41	87	60
	Outer face	0	0,35	69	51
∅400	Inner face	0	0,44	78	64
	Outer face	0	0,40	61	59
∅557	Inner face	0	0,18	-3	20
	Outer face	0	0,49	80	71
∅690	Inner face	0	0,17	30	25
	Outer face	0	0,23	15	34
∅710	Inner face	0	0,13	28	20
	Outer face	0	0,18	10	27

Table 10 : Fatigue analysis in accordance with direction 12

Measuring points		Criterion	Dynamic ratio	Average stresses σ_{moy} (MPa)	Dynamic stresses σ_{dyn} (MPa)
∅310	Inner face	0	0,12	-12	17
	Outer face	0	0,06	-7	9
∅328	Inner face	0	0,43	-47	63
	Outer face	0	0,36	-43	52
∅370	Inner face	**1**	**1,02**	**-52**	**148**
	Outer face	0	0,94	-84	136
∅400	Inner face	**1**	**1,04**	**-38**	**150**
	Outer face	**1**	**1**	**-83**	**145**
∅557	Inner face	0	0,02	-3	2
	Outer face	0	0,5	65	72
∅690	Inner face	0	0,23	-3	33
	Outer face	0	0,03	-3	5
∅710	Inner face	0	0,2	-6	29
	Outer face	0	0,01	-1	1

C.2.4 - Conclusion

In this example, the fatigue analysis shows at least one node in the mesh of the wheel web which does not meet the imposed criteria. The wheel therefore does not conform to this leaflet.

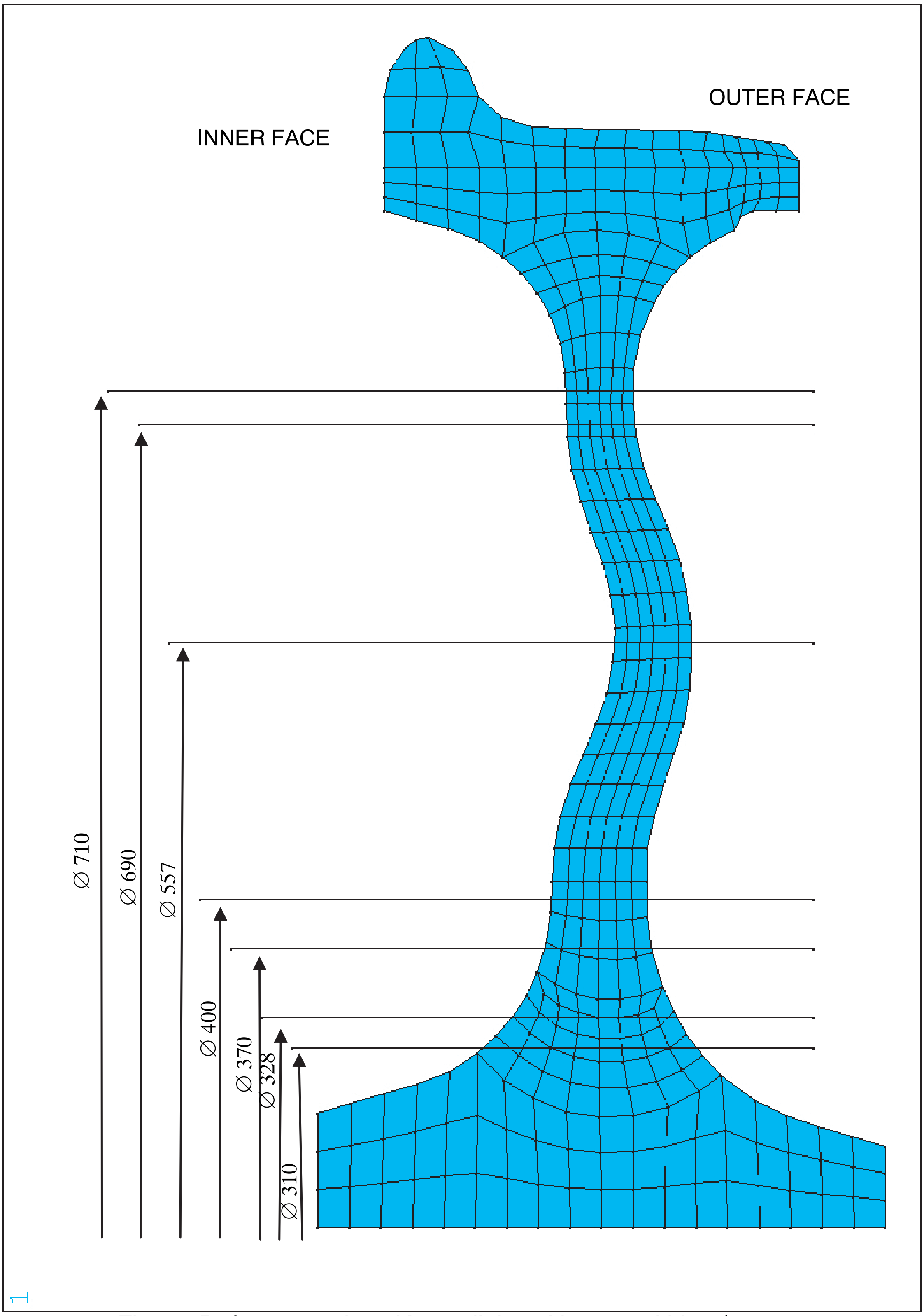


Fig. 3 - Reference points: Key radial positions to within +/- 10 mm

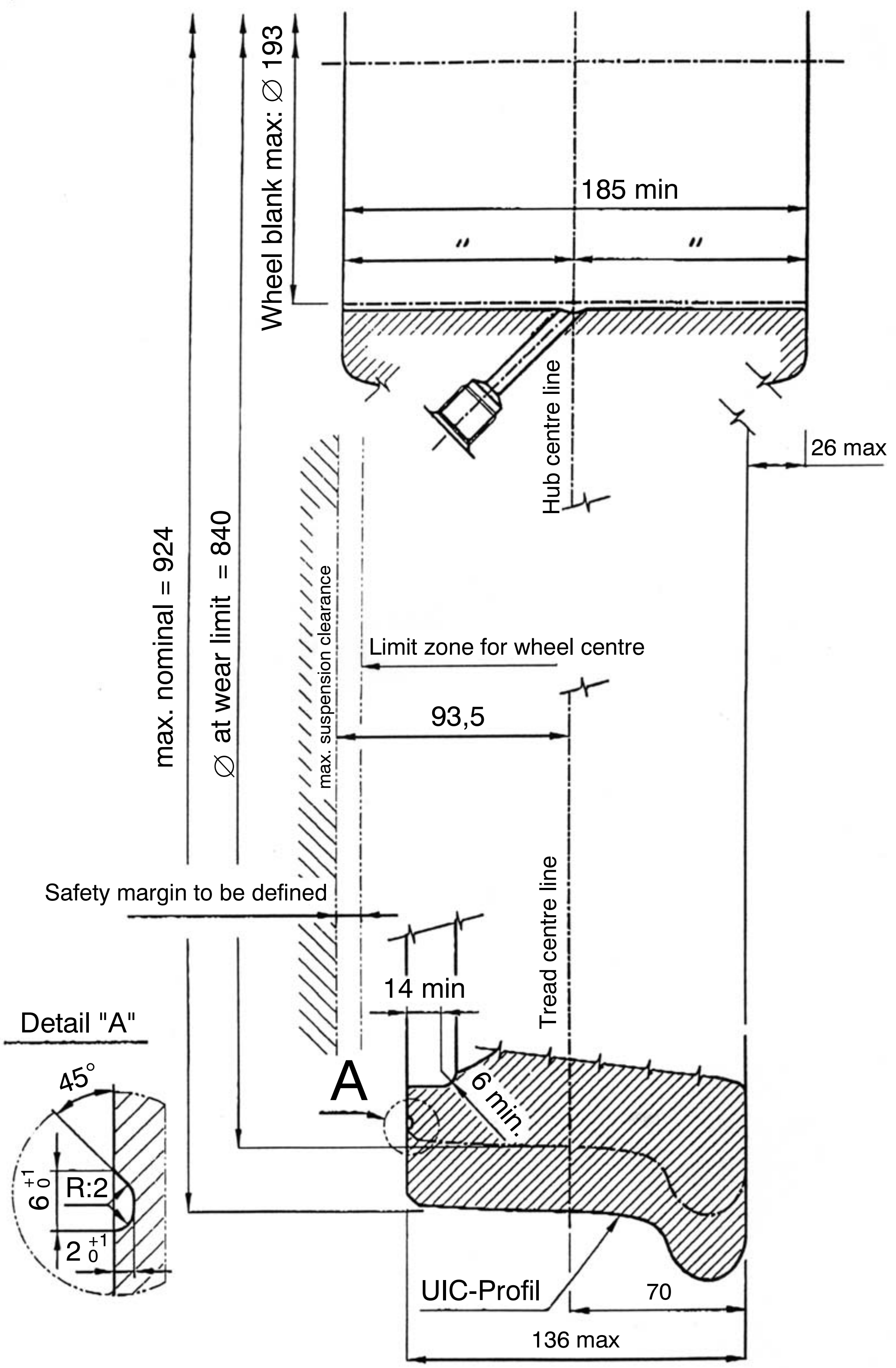
Appendix D - Mechanical behaviour

No addition. See *Norm EN 13979-1*.

Appendix E - Assessment of acoustics behaviour

No addition. See *Norm EN 13979-1*.

Appendix F - Basic diagram for geometrical interchangeability



Appendix G - Simplified procedure for verification of mechanical design

The specification shall be drawn up as follows:

- Test conditions:

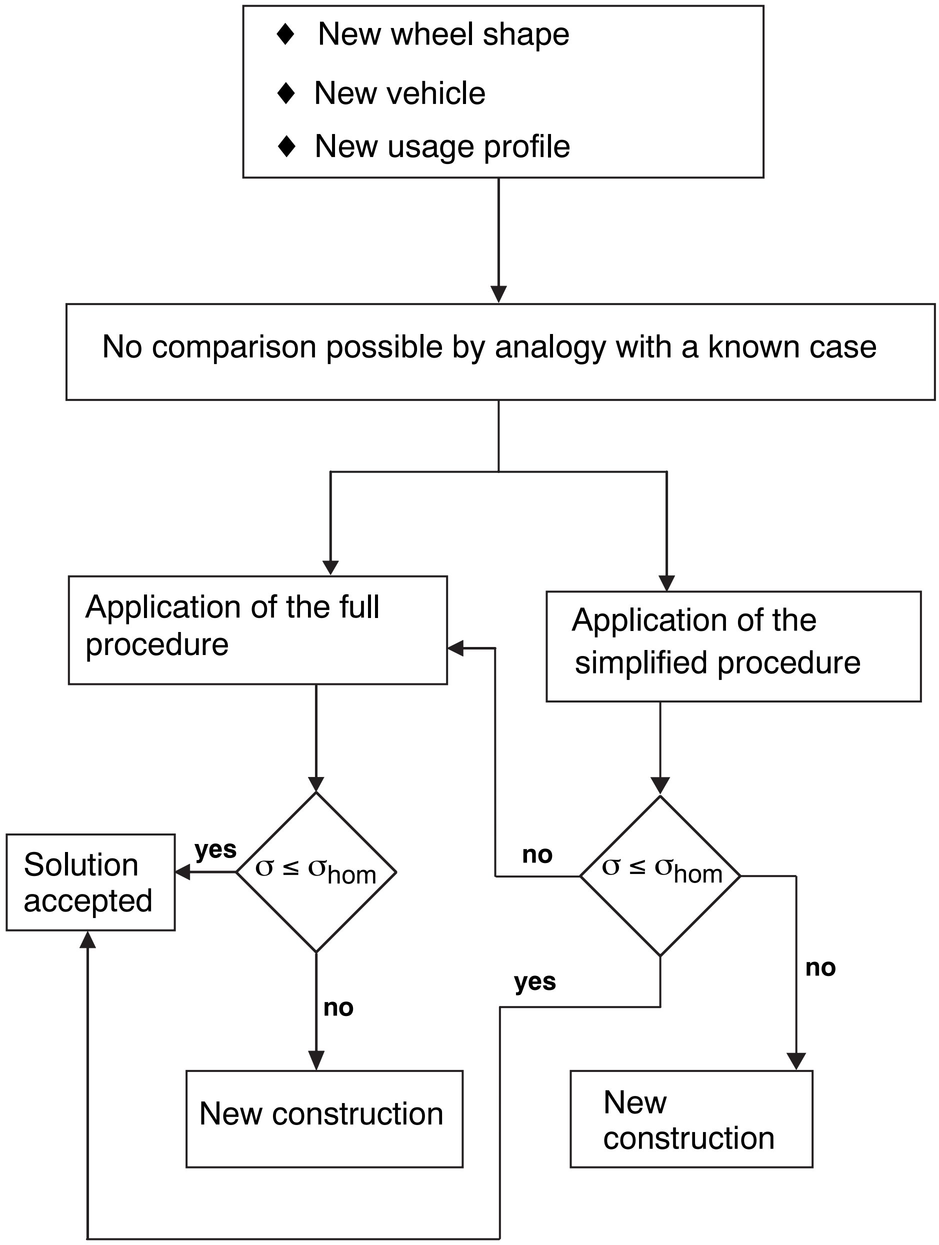
  Front axle, flat profile, dry, cant deficiency greater than 10%, running over at least 10 km over unobstructed open line and over the four smallest switch radii in the planned usage profile, taking account of the least favourable conditions for the maintenance installations.

- Assessment:

  The measuring equipment must be fitted to the wheel at the points where the highest stresses are expected. The highest and the lowest values shall be recorded over the whole of the line, whilst checking that these are not extreme values resulting from the measuring technique used. Finally, the amplitude of the stress shall be determined in order to obtain the load spectrum with a fullness factor of 1.

- Comparison with the Goodman diagram:

  The complete procedure for verifying the design of monobloc wheels is set out in point 7 - page 12. Whilst it fully reflects the state of the art, it is not easy to manage and is costly. Its application is not always justifiable, especially for small series of vehicles or for limited usage profiles or extensions to vehicle usage profiles. In these cases, a simplified procedure can be applied. On the basis of the results obtained through the simplified verifications, a more in-depth study can then be considered. The simplified procedure fits into the overall scheme as shown here.



In the simplified procedure, stresses in the wheel web are determined on a test line featuring the highest possible stresses encountered in the range of use. These stresses, which are due to vehicle-track interaction, are recorded in the following line layouts:

- minimum curve radius in open line, with the maximum permissible cant deficiency,
- switches with minimum radii on the turnout track and very short intermediate straight section,
- minimum curve radius in maintenance zones.

To obtain the least favourable conditions (in terms of wheel/rail contact geometry), which have a major influence on the lateral forces exerted on wheels, particularly for small curve radii, the tests must be carried out with a flat wheel profile on dry rails.

If the permissible stress levels are never exceeded, the design is accepted. If the permissible levels are exceeded one or more times, the full procedure must be applied or the wheel re-designed.

Since this is a step-by-step procedure, it can be applied initially to all cases, with the exception of tilting trains. It should however be noted that it will not necessarily guarantee an optimum wheel development.

Appendix H - Procedure for the technical approval of wheels

H.1 - Part A

H.1.1 - Purpose

The aim of this appendix is to define the arrangements for the technical approval procedure for monobloc wheels in accordance with this leaflet, in order to obtain a technical approval certificate and to feature on the list of approved wheels in application of this UIC Leaflet which describes the UIC conformity assessment procedure.

H.1.2 - Reference documents

EN 13262 (see Bibliography - page 66).

EN 13979-1.

H.1.3 - Parties to the procedure

- The applicant:
  The party applying for the technical approval certificate. In the case of wheels, this is generally the industrial firm which designs and manufactures the wheels.

- The UIC body:
  This is the Study Group for Braking and Running Gear (SG 5), acting in accordance with the new conformity assessment procedure.

  In organising the procedure, it appoints from among its members a running gear expert whose role is to coordinate the work necessary for the assessment.

- Inspection bodies and test centres:
  During the assessment procedure, the expert responsible for coordination makes use of inspection certificates or test reports. These must have been issued by bodies complying with the quality assurance rules set out in standard *EN ISO/IEC 17025* (see Bibliographie - page 66).

H.1.4 - The technical approval procedure

H.1.4.1 - General principles

- The technical approval assessment for a wheel in accordance with *UIC Leaflet 510-5* is given substance by the awarding of a technical approval certificate as defined below:
  The technical approval certificate attests that a new wheel has successfully completed the programme of validations and tests specified in *UIC Leaflet 510-5*. These tests are designed to verify conformity with the product characteristics and specified performances, including fitness for use. It also extends to the scope of utilisation.

- All information obtained during the course of the procedure is treated confidentially and is accessible only to the applicant and the UIC body concerned by the procedure. The applicant may use the certificate and associated report for its own publicity. No other information, whether it concern the design or the results of the certification process, may be published, transferred or used by UIC without the prior authorisation of the applicant. Unless otherwise indicated in the contract between UIC and the applicant, industrial property rights remain with the applicant.

H.1.4.2 - Detailed procedure

The procedure is described in the flow chart in point H.2 - page 43.

H.1.4.2.1 - Application for a technical approval certificate

When an application is made to UIC, the technical approval procedure is launched. Applicants must indicate in the technical documentation the scope of application of the wheel in question, in accordance with the provisions of *UIC Leaflet 510-5*, and the specific conditions of use.

The procedure can only begin once the applicant has made a technical submission to UIC and concluded a contract with UIC.

H.1.4.2.2 - Launch of work

UIC (Study Group 5) shall designate a running gear expert from among its members to be responsible for coordinating the work involved in the assessment.

The expert shall propose an assessment programme based on point H.3 - page 44 and in accordance with the stipulations of *UIC Leaflet 510-5* and the needs of the parties concerned (inspection bodies, test bodies). UIC shall draw up a contract with the applicant setting out the technical aspects (assessment programme) and the financial aspects and submit it to the applicant for agreement.

H.1.4.2.3 - Execution of the work

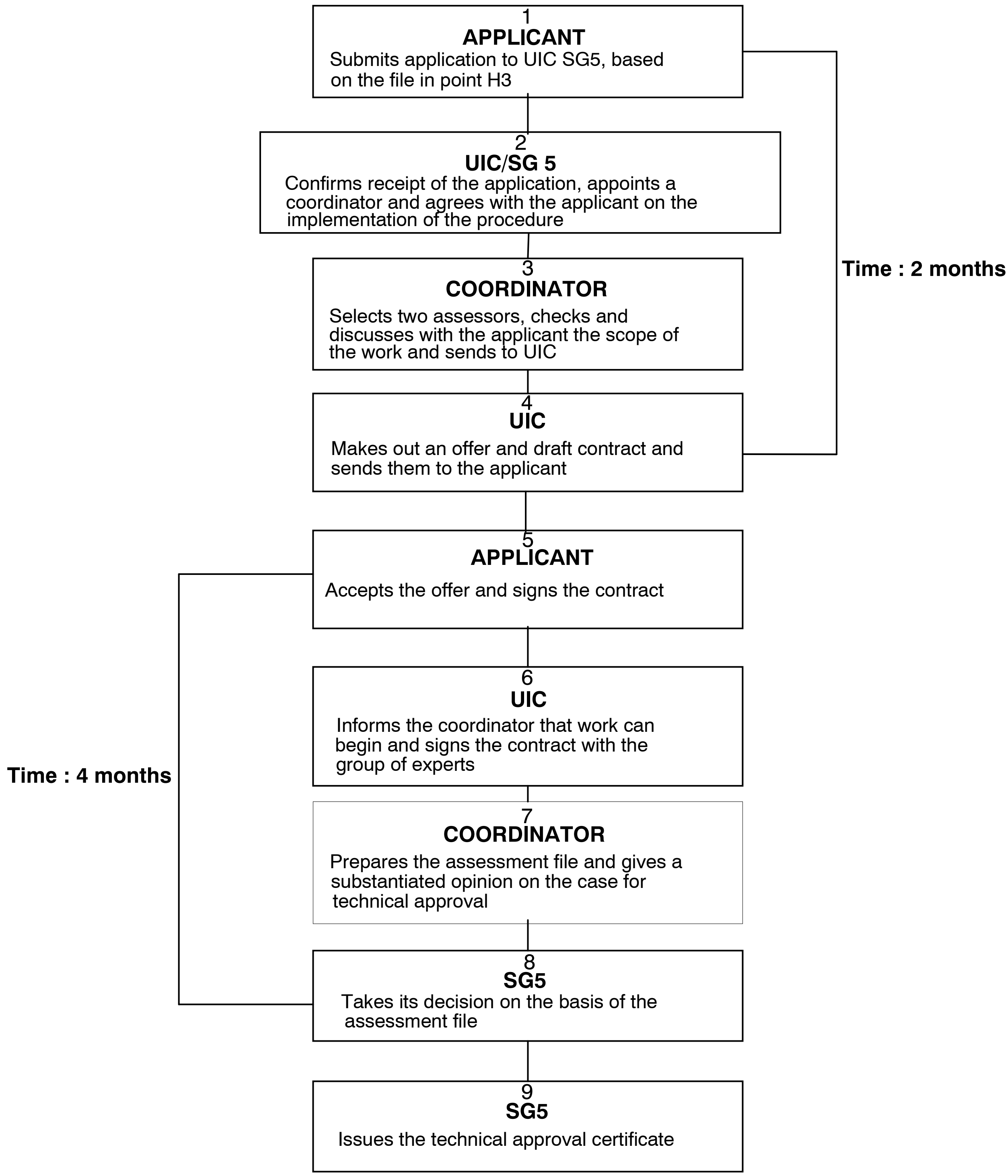
The coordinator shall coordinate the work, provide UIC with an assessment file in accordance with point H.3 and give his technical opinion on the approval application.

H.1.4.2.4 - Sanctioning of the procedure

SG 5 shall take its decision on the technical approval at a plenary session, on the basis of the assessment file and the proposed decision from the group of experts. It shall then, where appropriate, draw up the technical approval certificate using the template shown in Appendix I - page 64 and send it to the applicant, or indicate the reasons why the application was not successful.

H.2 - Part B

Flow chart



H.3 - Part C

Assessment file for monobloc wheels for acceptance

for use in railway traffic as part of their technical approval

- Notice of compliance -

(……wheel type……)

Assessment body: UIC Study Group 5
(address of the current Chairman of
UIC SG 5)

Applicant: ……(Name and address)……………….
………………………………………
………………………………………
………………………………………

List of documents enclosed with the assessment file

Details of the assessment body and the applicant

Assessment body	Applicant
Tel.: .... Fax.: .... E-mail: .... http://	Applicant's name (RU, manufacturer): .... Person responsible: .... Position: .... No. and street:... Postcode and town/city: .... Country: .... Tel.: .... Fax.: .... E-mail: .... http:// ....
Assessment Coordinator: .... Assessor no. 1: .... Assessor no. 2: .... Assessor no. 3:	
Project Manager: .... Tel.: .... Fax.: .... E-mail:	Project Partner: .... Tel.: .... Fax.: .... E-mail: ....
Request from UIC (SG 5) to carry out the assessment Date: .... Request no.:..	Approval application sent to UIC (SG 5) Date: ....
Submission of the assessment report to UIC Date: .... Reference of the report:	Acceptance of the UIC offer Date: .... Contract no.:..
Description of the wheel to be assessed (name, special features)	
Summary of the assessment findings	
Comments from the assessment body:	Comments from the applicant: ....

Notice of compliance with requirements for general characteristics

Requirement specified	Criteria to be met	Conformity yes / no
Identification of the wheel to be assessed: - type of wheel - reference, drawing, etc.		
Qualification: - steel grades ER 6 and ER 7 and other grades	EN 13 262	
Material: - name - composition - manufacturer - supplier - identification of test wheels		
Wheel profile: - wheel tread profile - range of radial wear	 UIC Leaflet 510-2 EN 13715	
Dimensions: - nominal wheel tread diameter - maximum width of rim - diameter at wear limit - bore diameter - position of the rim in relation to the wheelseat - length of hub - shape of wear groove - geometry of wheel clamping zone - shape of rim (for ultrasound measurement of residual stresses)	UIC Leaflet 510-2 EN 13715	
N.B.: Check any interference with parts adjacent to the wheel (e.g.: suspension - bogie frame)		
Comments:		

Position Assessor Coordinator	Name	Date	Initials

Notice of compliance with requirements for geometric interchangeability

Requirement specified	Criteria to be met	Conformity yes / no
Point 1- Functional requirements: - Nominal wheel tread diameter - Rim width - Wheel tread profile - Position of the rim in relation to the wheelseat **Point 2 - Assembly requirements:** - Bore diameter - Hub length - Geometry of the bore entry **Point 3 - Maintenance requirements:** - Diameter at wear limit - Shape of the wear groove - Geometry of the wheel clamping zone - Position and geometry of the oil pressure release orifice (where present) **N.B.:** Check on any possible interference with parts adjacent to the wheel (e.g. suspension - bogie frame)	Refer to plan of the wheel to be replaced	
Comments:		

Position Assessor Coordinator	Name	Date	Initials

Notice of compliance with requirements for thermomechanical aspects

Requirement specified	Criteria to be met	Conformity yes / no
Point 1 - General: - Designer of the monobloc wheel - Manufacturer of the test wheels - Product reference - Reference of drawing - Axle-load - Range for measuring tangential residual stresses by ultrasound • Maximum diameter, wheel tread side, without bevel, Φ_1 • Maximum diameter, web side, without groove, Φ_2 - Geometry of wheel web • Diagram of the wheel web profile • Webs machined or not • Proof that the test wheels represent the least favourable case (by calculation) • Where necessary, correction of results	*UIC Leaflet 510-5*	
Comments:		

Position Assessor Coordinator	Name	Date	Initials

Notice of compliance with requirements for thermomechanical aspects

Requirement specified	Criteria to be met	Conformity yes / no
Point 2 - Thermomechanical calculation (for information only): - Stresses resulting from drag braking (braking energy) - Brake blocks used - Brake block material - Brake block configuration - Results of calculations - Residual stresses - Deformation - Company carrying out the calculations - Certification of that company - Correlation between calculation and measurements, overall correlation with the ERRI wheel	*UIC Leaflet 510-5, Point 3.2*	
Comments:		

Position Assessor Coordinator	Name	Date	Initials

Notice of compliance with requirements for thermomechanical aspects

Requirement specified	Criteria to be met	Conformity yes / no
Point 3.1 - Braking tests on the test bench: - Certification of the test centre • Stresses during drag braking (braking energy) • Data on brake blocks - Brake blocks used - Material - Brake block configuration • Bedding-in of brake blocks (verification of residual stresses) - Measurement of residual stresses • Measuring method • Results: - New wheel: residual stresses - Worn wheel: residual stresses - Measurement of deformation • Method • Results: - New wheel: Hot deformation, Cold deformation - Worn wheel: Hot deformation, Cold deformation - Replacement of brake blocks during braking cycle - Number of drag brake applications before saturation - Anomalies	*UIC Leaflet 510-5, Point 3.2 and Appendix A.2*	
Comments:		

Position Assessor Coordinator	Name	Date	Initials

Notice of compliance with requirements for thermomechanical aspects

Requirement specified	Criteria to be met	Conformity yes / no
Point 3.2 - Fracture tests on the test bench: - Certification of the test centre - Stressing during drag braking followed by braking to a stop - Stressing during braking to a stop - Number of brake applications to a stop, depth of cracks - Stressing of the cracked wheel during drag braking - Type of brake blocks for • drag braking • braking to a stop Number of drag brake applications • before fracture or • before a state close to fracture or • before interruption in case of non-fracture and stabilisation of the residual stress state - Measurement of residual stresses • method • results: - New wheel - Worn wheel - Anomalies	*UIC Leaflet 510-5, Appendix A.2*	
Comments:		

Position Assessor Coordinator	Name	Date	Initials

Notice of compliance with requirements for thermomechanical aspects

Requirement specified	Criteria to be met	Conformity yes / no
Point 3.3 - Braking tests on the line: - Certification of test centre - Execution of brake applications • Monitoring of braking performance: - Braking moment and speed of rotation - Tangential forces and speed • Stresses during drag braking - Type of test vehicle: • Tare • Axle-load of test axles • Brake blocks and their suspension • position of the brake blocks in relation to the outer face of the rim • number of brake block replacements - Compliance with meteorological conditions - Bedding-in state of brake blocks - Test line, line profile - Execution of test cycles - Number of drag braking cycles - Result after ten braking cycles - Measurement of residual stresses • Measuring method • Results: - New wheel: residual stresses - Worn wheel: residual stresses - Measurement of deformation • Measuring method • Results: - New wheel: Hot deformation Cold deformation - Worn wheel: Hot deformation Cold deformation	*UIC Leaflet 510-5, Appendix A.2*	
Comments:		

Position Assessor Coordinator	Name	Date	Initials

Notice of compliance with requirements for mechanical aspects

Requirement specified	Criteria to be met	Conformity yes / no
Point 1 - General: - Supplier reference - Product reference, plan number - Reference material used - Axle-load - Wheel web surface condition (machined, not machined) - Nominal wheel diameter - Wheel diameter at wear limit - Trailing, non-guiding axle or - Guiding axle	*UIC Leaflet 510-5*	
Comments:		

Position Assessor Coordinator	Name	Date	Initials

Notice of compliance with requirements for mechanical aspects

Requirement specified	Criteria to be met	Conformity yes / no
Point 2 - Load: a) Conventional load: Usage profile with less than 24% of curves with a radius of less than 800 m **N.B.:** If the axle is powered or tilting ⇒ Check the validity of the conventional load scenario - Load calculation 1 $F_z = 1{,}25\ Q.g$ $F_y = 0$ - Load calculation 2 $F_z = 1{,}25\ Q.g$ $F_{y1} = 0{,}6\ Q.g$ or $0{,}7\ Q.g$ - Load calculation 3 $F_z = 1{,}25\ Q.g$ $F_{y1} = 0{,}36\ Q.g$ or $0{,}42\ Q.g$	*UIC Leaflet 510-5, Point 7.2.1.2*	
b) Tilting trains Case 1: Running on straight track $F_{z1} = -1{,}25\ Q.g$ $F_{y1} = 0$ Case 2: Running through curves $F_{z2} = -1{,}25\ Q.g$ $F_{y2} = 0{,}8\ Q.g$ for trailing axles $F_{y2} = 0{,}9\ Q.g$ for powered and guiding axles Case 3: Running through switches and crossings $F_{z3} = -1{,}25\ Q.g$ $F_{y3} = -0{,}6\ .\ F_{y1} = 0{,}6\ .\ 0{,}6\ Q.g$ $= -0{,}36\ Q.g$ for trailing axles $F_{y3} = -0{,}6\ .\ F_{y2} = 0{,}6\ .\ 0{,}7\ Q.g$ $= -0{,}42\ Q.g$ for powered and guiding axles	*UIC Leaflet 510-5, Point 7.2.1.3*	

c) <u>Other loads</u> if conventional load scenarios are not applicable ⇒ Verification	*ERRI B169/RP 12*		

Comments:

Position Assessor Coordinator	Name	Date	Initials

Notice of compliance with requirements for mechanical aspects

Requirement specified	Criteria to be met	Conformity yes / no
Point 3 - Calculation: Firm that did the calculations		
a) Certification of the firm doing the calculations: the correlation between calculations and measurements of the stresses must be demonstrated by a calculation on the ERRI reference wheel	*UIC Leaflet 510-5, point 7.2.2 and Appendix C*	
b) If the axle is powered, verification of the validity of the mono-axial criterion: check that the radial stress is equivalent to the principal stress		
c) Verification of the stress analysis	*UIC Leaflet 510-5, Appendix B.2.3*	
d) Verification of the range of the maximum calculated stress and comparison with the range of the maximum permissible stress * machined web $\Delta\sigma$ = 360 MPa * unmachined web $\Delta\sigma$ = 290 MPa VON MISES: σ < Re		
Comments:		

Position Assessor Coordinator	Name	Date	Initials

Notice of compliance with requirements for mechanical aspects

Requirement specified	Criteria to be met	Conformity yes / no
Point 4 - Verification of the design: **a)** Line test (based on results of calculations) * characterisation of the wheels * determination of stresses to be measured * wheel measuring equipment * determination of test sections * execution of line test * Analysis * global matrix, make-up **b)** Random fatigue test * definition of the damage matrix * preparation of the matrix * correlation to take account of web thicknesses * execution of fatigue test * result	*EN 13979-1, Appendix D, Chap. D3*	
Comments:		

Position Assessor Coordinator	Name	Date	Initials

Notice of compliance with requirements for mechanical aspects

Requirement specified	Criteria to be met	Conformity yes / no
Point 4 - Verification of the design (continued):		
a) Monotonic fatigue test		
* Test stresses	*UIC Leaflet 510-5, Appendix B.4*	
* characteristics of the wheels undergoing testing		
* equipping of wheels, execution		
* preparation of wheels and static simulation		
* Correlation		
* Execution of fatigue tests		
* Results		
Comments:		

Position Assessor Coordinator	Name	Date	Initials

Notice of compliance with requirements for acoustic aspects

Requirement specified	Criteria to be met	Conformity yes / no
Optional		

Comments:

Position Assessor Coordinator	Name	Date	Initials

Notice of compliance with the scope of application

Requirement specified	Criteria to be met	Conformity yes / no
Point 1 - General: - The wheel must only be used in a usage profile that conforms to the technical approval - The operator is responsible for ensuring that use is compliant with the technical approval **Point 2 - Use of the wheel**: - Freight traffic: • Combined transport • Rolling road • High speed freight > 120 km/h • maximum gradient / maximum energy / maximum braking power - Passenger traffic: • Regional services • Mainline traffic • High speed rail • Use of tilting trains • maximum energy / maximum stopping braking power - Powered wheels of locomotives • Range of speeds • Range of axle-loads • Type of braking		
Comments:		

Position Assessor Coordinator	Name	Date	Initials

Notice of compliance of the product sample taken and/or tested (characteristics of the test wheels)

Requirement specified	Criteria to be met	Conformity yes / no
Point 1 - General:		
- Reference of the wheel manufacturer	*UIC Leaflet EN 13262*	
- Product reference, reference of the drawing	*UIC Leaflet 510-5* or *EN 13262*	
- Certification of the firm that defined the characteristics of the material		
- Description of the surface condition of the web (machined or not machined)		
- Grade of steel used	*EN 13262*	
- Forge, heat treatment and final treatment	*EN 13262*	
Point 2 - Product definition:		
Chemical composition	*EN 13262*	
Technical characteristics of the material	*EN 13262*	
- Metallographical		
- Metallurgical		
- Residual stresses	*UIC Leaflet 510-5* or *EN 13262*	
- Marking of the wheel	*EN 13262*	
Point 3 - Taking a product sample:		
- Control by sampling of a production batch that is representative of the series		
- Certification of the body that took the sample		
- Size of the batch submitted		
Comments:		

Position Assessor Coordinator	Name	Date	Initials

Notice of compliance of the product: protection of the product by patent

Requirement specified	Criteria to be met	Conformity yes / no
The applicant must provide a signed declaration that the wheel submitted: **a)** is not covered by a patent belonging to another manufacturer. Where this is not the case, the applicant must provide proof that he holds a user licence authorising him to manufacture the product. **b)** is not covered by a patent that he has himself applied for. Where this is the case, the applicant must state: 1. the patent number 2. the date on which it was registered 3. the office with which it was registered 4. a description of the patent and the countries covered under patent law 5. the validity period Any anticipated disputes and/or claims concerning the validity of the patent. The applicant must register a copy of the patent. **N.B.:** In all cases, the certification body shall remain outside the relationship between the applicant and the patent holder(s) and any disputes between them regarding claims. The applicant must register a copy of the patent.		
Comments:		

Position Assessor Coordinator	Name	Date	Initials

Appendix I - Conformity evaluation certificate

Certificate of technical approval

UNION INTERNATIONALE DES CHEMINS DE FER
INTERNATIONALER EISENBAHNVERBAND
INTERNATIONAL UNION OF RAILWAYS

UIC - CERTIFICATE

Number / Nummer / numéro: ....

In accordance with UIC-conformity-assessment from November 2005 it is confirmed that the vehicle component:
Gemäß UIC-Konformitätsbewertung vom November 2005 wird bestätigt, dass Fahrzeugkomponente
Selon la procédure UIC d'évaluation de la conformité de novembre 2005, il est confirmé que le composant de véhicule :

Wheels / Räder / Roues:
Type / Typ / Type

Application field / Anwendungsbereich / Domaine d'application

of the company /der Firma / de la société

…………………………………………..

corresponds to the requests of the adjustable-speed works named in Appendix 1, point 1.
entspricht den Anforderungen des in der Anlage 1, Punkt 1, genannten Regelwerkes.
satisfait aux exigences définies dans l'Annexe 1, point 1.

The technical documents current for this Certification are stated in Appendix 1, point 2
Die für diese Zertifizierung geltenden technischen Dokumente sind in der Anlage 1, Punkt 2 angegeben.
Les documents techniques applicables à cette certification sont repris à l'Annexe1, point 2.

This UIC- Certificate is valid only for the specified wheels / Dieses UIC - Zertifikat ist nur für die bezeichneten Räder gültig/
Ce certificat UIC est valable seulement pour les roues spécifiées.

UIC
Head Quarters / Generaldirektion / Direction Générale
Department Research & Technology
Abteilung Technik & Forschung
Département Technique & Recherche
Study Group / Studiengruppe / Groupe d'Etudes: **5**
16 rue Jean Rey
75015 Paris

Paris, __ _____ 200x

Chairman Study Group 5 Director Research& Technology

UIC-Certificate Nr: ………………

1.) UIC confirms that the above mentioned wheels correspond to the requests of the following regulation: /
Die UIC bestätigt, dass die umseitig zitierten Räder den Anforderungen des unten genannten Regelwerkes entspricht: /
L'UIC confirme que les roues définies ci-dessus sont conformes aux exigences définies dans la réglementation

- **UIC Leaflet 510-5, 2nd edition May 2007**
  UIC-Merkblatt Nr. 510-5, 2. Ausgabe, Mai 2007
- **Fiche UIC n°510-5, 2ème edition, mai 2007**

2.) The technical documents applicable to this Certification are: /Die für diese Zertifizierung geltenden technischen Dokumente sind: / Les documents techniques applicables à cette certification sont les suivants :

- Request of ……….. from : / Antrag der Firma …….. vom : / Demande de la societé ……. du :
- Design No …………….. / Zeichnung-Nr.: ……………. / Dessin N°: …………………… :
- Reports / Berichte / Rapports
- EC Safety data sheet according to / EG-Sicherheitsdatenblatt gemäß / CE Feuille de securité selon:
- Service test report: / Betriebserprobungsbericht: / Rapport d'essais en service:
- Assessment of: / Gutachten von: / Expertise de:

  Name, Adresse, Document / Name, Anschrift, Dokument / Nom, Adresse, Document

- Conclusions of Study Group 5 "Braking and Running Gear": / Schlußfolgerungen der Studiengruppe 5 „Bremswesen und Laufwerke": / Conclusions du Groupe d'Etude 5 "Freinage et Organes de roulement":

  SG5 – Meeting / SG5 - Tagung / Réunion – GE 5
  Paris, xx.xx.200x, Item xx / TOP xx / Point xx

See UIC-Website: http://www.uic.asso.fr/ Activities/Technology and Research/Products/UIC Leaflets/Appendice for the list of products technically approved by UIC.

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Warning

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