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Translation

R

Wagons

Variable-gauge running gear for 1435 mm/1520 mm and 1668 mm

Recommendations for bilateral agreements

Wagons

Organes de roulement à écartement variable 1435 mm/1520 mm et 1668 mm

Recommandations pour les accords bilatéraux

Güterwagen

Fahrwerke mit Spurwechsel 1435 mm/1520 mm und 1668 mm

Empfehlungen für bilaterale Abkommen



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Summary

This leaflet applies to freight wagons with automatic variable-gauge wheelsets, which are able to run on railways with different track gauges. It is intended to allow the railways concerned to conclude the necessary bi- or multilateral agreements, and may be revised in the light of experience. Because of their special equipment, these wagons shall not carry the RIV symbol.

Note:

Points 1.2, 1.5, 2.1.1.6, 2.1.2, 2.1.3.4, 2.1.4.1 to 2.1.4.4, 2.1.5, 2.2.1, 2.2.2, 2.3.2, 2.3.3, 2.4.1, 2.4.2, 2.4.4, 2.5.1, 2.5.2, 2.5.6, 4.1.1, 4.1.4, 4.2.1, 4.2.2 **must be complied with** to facilitate the conclusion of bi- or multilateral agreements.

Points 2.1.1.4, 2.1.1.5, 2.1.3.2, 2.2.4 and 2.4.3 correspond to provisions that **are already obligatory** in another existing UIC leaflet.

1 - General conditions applicable to running gear

1.1 - The running gear should be so designed that wagons equipped with it can run at a speed of ≤ 120 km/h with an axle-load of $\leq 22,5$ t, and at a speed of $120 \text{ km/h} < v \leq 160 \text{ km/h}$ with an axle-load of $\leq 18,0$ t.

1.2 - Running gear, including the mechanisms required for gauge adjustment, shall not exceed the kinematic gauge reference profile specified in *UIC Leaflet 505-1* (see Bibliography - page 17).

1.3 - It is recommended that the wheelbase of the running gear be $\leq 2,0$ m.

1.4 - Wagons equipped with the running gear must be able to:

- negotiate curves with a radius of 150 m when coupled to form a train;
- negotiate curves with a radius of 75 m as individual vehicles;
- pass over hump and flat shunting installations in the operating position in accordance with *UIC Leaflet 505-1*.

Vehicles used in train-ferry traffic should be able to negotiate curves of 120 m radius and a ferry ramp angle of $2,5^\circ$.

1.5 - Running gear intended for use on European rail networks of 1520 mm gauge shall be able to withstand an operating temperature range of -40°C to $+40^\circ\text{C}$. For Asian 1520 mm gauge networks, running gear should be suitable for a temperature range of -60°C to $+45^\circ\text{C}$ and a relative humidity of 0 - 100%.

1.6 - The overall space occupied by the running gear should be such that it may be used on existing vehicles.

1.7 - The noise emissions should not exceed those of existing vehicles.

1.8 - The weight of the running gear should be as low as possible.

1.9 - To identify running gear with automatic variable-gauge wheelsets, the symbol shown in Appendix A - page 14 shall be applied to the running gear frame.

2 - Conditions and characteristics for running gear components from the design and maintenance standpoints

2.1 - Variable-gauge wheelsets

2.1.1 - General characteristics

2.1.1.1 - The weight of the wheelset including locking mechanisms should be as low as possible.

2.1.1.2 - The wheels should be able to move axially to a position allowing them to run on track of 1435 mm and 1520 mm or of 1435 mm and 1668 mm gauge.

It is recommended that the axial movement of the wheels permit running on track of all three gauges.

2.1.1.3 - When adjusted for the gauge concerned, the wheels may either be coupled to the axle body so as not to rotate, and locked, or else mounted and locked on a fixed axle with freedom to rotate.

2.1.1.4 - The wheelset shall be suitable for an axle-load of 20 t and a speed of 120 km/h.

The maximum dimensions for manufacture, reprofiling and operation shall be those set out in *UIC Leaflet 510-2, points 1.3 and 1.4*.

For 1435 mm gauge, the maximum and minimum dimensions for the distance between the inner faces of the wheel flanges of a wheelset and for the distance between the outside surfaces of the wheel flanges are set out in *UIC Leaflet 510-2, points 1.5 and 1.6*. For 1520 mm and 1668 mm gauges, the following dimensions are to be observed:

- Distance between the inner faces of the wheel flanges:

min.	: 1590 mm	}	1668 mm gauge
max.	: 1596 mm		

min.	: 1437 mm	}	1520 mm gauge
max.	: 1443 mm		

- Distance between the outside surfaces of the wheel flanges:

min.	: 1643 mm	}	1668 mm gauge
max.	: 1659 mm		

min. : 1489 mm
max. : 1506 mm } 1520 mm gauge

2.1.1.5 - The electrical resistance of the wheelset shall conform to the provisions of *UIC Leaflet 512, point 1.4*.

2.1.1.6 - The permissible residual unbalance shall conform to the provisions of *UIC Leaflet 510-2* (see [Bibliography - page 17](#)).

2.1.1.7 - Suitable pairs of materials shall be chosen so as to avoid frictional corrosion at the sliding surfaces between axle body and wheel hub.

2.1.1.8 - The locking system and bearing surfaces for the axial movement of the wheels should be protected against corrosion and dirt.

2.1.1.9 - It should be possible to fit variable-gauge wheelsets for 1435 mm/1520 mm gauges without major modifications to the existing bogie designs of 1435 mm gauge railways, similarly for 1668 mm/1435 mm wheelsets and existing bogie designs of 1668 mm gauge railways.

2.1.1.10 - The marking of components and protection against corrosion shall conform to the provisions of *UIC Leaflet 812-3 and 813* (see [Bibliography - page 17](#)).

2.1.2 - Axle shafts

2.1.2.1 - The dimensions of the axle shaft shall satisfy the following conditions:

- adequate strength as specified in *UIC Leaflet 515-3* (see [Bibliography - page 17](#)),
- perfect functioning of the axial movement of the wheels,
- perfect functioning of the roller bearings as specified in *UIC Leaflet 515-5 and 510-1* (see [Bibliography - page 17](#)).

Fixed axles with freely-rotating wheels must also satisfy the conditions of *UIC Leaflet 510-3* (see [Bibliography - page 17](#)).

2.1.2.2 - Chemical composition and mechanical characteristics shall conform to the provisions of *UIC Leaflet 811-1* (see [Bibliography - page 17](#)).

2.1.3 - Wheels

2.1.3.1 - Wheel diameter in new condition should lie between 840 and 1000 mm. The recommended range for wheel diameter is 920 - 840 mm.

2.1.3.2 - The tread profile shall conform to the conditions of *UIC Leaflet 510-2*.

2.1.3.3 - Depending on the braking system, the wheels may be:

- monobloc wheels when tread-braked;

- monobloc wheels or, if approved by the UIC, tyred wheels when disc- or drum-braked.

2.1.3.4 - The grade of steel used for monobloc wheels shall conform to the provisions of *UIC Leaflet 812-3* (see Bibliography - page 17). R7 grade steel is recommended. For wheel tyres, the provisions of *UIC Leaflet 810-1* (see Bibliography - page 17) are obligatory.

2.1.4 - Axle-boxes

2.1.4.1 - Axle-boxes shall be equipped with roller bearings and shall satisfy the conditions of *UIC Leaflet 510-1 and 515-1* (see Bibliography - page 17).

2.1.4.2 - When wheels are connected to the axle body and unable to rotate, then outside-journal types of bearing are to be used. Lineside hot-box detectors must be able to read the temperature of the axle-box.

2.1.4.3 - Axle-boxes used for freely-rotating wheels shall conform to the provisions of *UIC Leaflet 515-5 and 510-1*. Hot-running roller bearings must be detectable by lineside hot-box detectors or by internal systems.

In the bi- or multilateral agreements, a railway may refuse traffic with a variable-gauge wheelset type which is incompatible with its hot-box detection equipment and its operating conditions.

2.1.4.4 - The grease used for lubrication of roller bearings shall conform to the conditions of *UIC Leaflet 814* (see Bibliography - page 17). For running on 1520 mm gauge systems, proof shall also be provided that the grease is suitable for minimum temperatures of -40°C for the European part and -60°C for the Asian part of these systems.

2.1.5 - Locking mechanisms

2.1.5.1 - The locking mechanism which is an integral part of the variable-gauge wheelset shall reliably perform the following functions, allowing for static and dynamic forces, the effects of weather, wear, and possible heating due to braking:

- locking of the wheels of a wheelset in the respective gauge position irrespective of the operating conditions outside the gauge changeover installation;
- release and locking of the wheels while passing through the gauge changeover installation.

2.1.5.2 - It must be possible to see from the outside whether or not the wheels are locked, from the relative position of the components or by an indicator.

2.2 - Running gear frames

2.2.1 - The strength of the running gear frames shall conform to the provisions of *UIC Leaflet 510-3* (see Bibliography - page 17).

2.2.2 - The running gear frame may be welded or cast. The steel used shall be weldable without pre-heating and shall have a minimum tensile strength of 370 N/mm². The minimum values to be observed

for notched bar impact strength (V notch as specified for ISO test) are summarised in the following table:

Notched bar impact strength [J]		
- 20 °C	- 40 °C	- 60 °C ^a
27	27	21

a. Proof required for running on 1520 mm gauge system only.

2.2.3 - A standardised ball pivot bearing as specified in *UIC Leaflet 510-1* (see Bibliography - page 17) should be used for the link between running gear and wagon underframe.

2.2.4 - An electrically-conductive connection as specified in *UIC Leaflet 533* (see Bibliography - page 17) should be provided between running gear and wagon underframe.

2.3 - Suspension

2.3.1 - It is recommended that standardised springs as per *UIC Leaflet 517* (see Bibliography - page 17) be used.

2.3.2 - If coil springs are used, additional components are required for vibration damping (mechanical, hydraulic or other dampers).

2.3.3 - If non-standard springs are used, approval tests in accordance with *UIC Leaflet 517* are to be conducted.

2.4 - Braking equipment

2.4.1 - The braking equipment of the running gear shall be suitable for the maximum speed and maximum axle load, and shall conform to the provisions of *UIC Leaflet 543* (see Bibliography - page 17).

2.4.2 - If block brakes acting on the wheel tread are used, then a brake block changeover facility is required. This will automatically shift the brake blocks to the new position during the gauge changeover operation, and will lock them safely in this new position.

This facility shall not interfere with the effectiveness of brake operation.

If necessary a similar facility should be provided for disc brakes.

2.4.3 - If the friction-based components of the brakes are not visible from the outside, an indicator is to be provided to show the operative position.

2.4.4 - Brake components shall have adequate clearance from all fixed and moving parts in all states of wear.

2.5 - Gauge changeover equipment

2.5.1 - The gauge changeover equipment including the installed checking devices shall be approved.

2.5.2 - For a vehicle passing through the gauge changeover installation at a minimum running speed of 5 km/h and with an axle load of $\leq 22,5$ t, the following conditions shall be met:

- release of axial locking of the wheels in the entry section;
- axial movement of the wheels in the gauge changeover section;
- secure locking of the wheels in the new gauge position in the exit section.

2.5.3 - It is recommended that the following checks be made at the gauge changeover installation, if possible automatically:

- verification that the wheels are locked;
- measurement of the axial force required for gauge changeover, which indicates the condition of the system;
- the electrical resistance of the wheelsets;
- the distance between inside wheel faces.

2.5.4 - The length of the changeover section from one gauge to another should be set so that the axial forces on the wheels during the changeover are as low as possible.

2.5.5 - The gauge changeover installation should if possible be capable of working with several systems.

2.5.6 - If for technical reasons lubricant is used during the changeover, it must not contaminate the wheel treads or brake components.

2.6 - Maintenance

2.6.1 - General conditions

2.6.1.1 - The design should allow the wagons, complete with running gear, to be lifted.

2.6.1.2 - All wearing parts affecting safe operation should be easily checked and replaced.

2.6.1.3 - All parts of the mechanism, in particular wearing parts, should be designed to achieve the same periodicity of maintenance as wagons under the RIV regime.

Scheduled inspections and maintenance work should not be required during transit movements.

Any maintenance work specific to the system should be carried out at the gauge changeover installation.

2.6.1.4 - An effective anti-corrosion agent should be applied to running gear components.

2.6.2 - Variable-gauge wheelsets

2.6.2.1 - It should be possible to fit and remove wheelsets with the lifting or wheelset changeover equipment used for standard wheelsets.

2.6.2.2 - It is recommended that reprofiling be possible with existing wheel lathes.

2.6.2.3 - It is recommended that wheelsets and their individual components run a minimum of 100 000 km before maintenance or for 2 years if the annual distance run is between 50 000 and 100 000 km.

Checks on wheelset geometry and integrity should be possible using existing measuring and testing equipment.

2.6.2.4 - Measures should be taken to prevent the ingress of rain, snow and dust, which can impair reliable operation and increase wear.

2.6.2.5 - It should be easy to test the proper functioning of the locking mechanism.

2.6.3 - Mechanical brake components

2.6.3.1 - It is recommended that brake rigging should incorporate hardened bushes or wear-resistant steels with surface-hardened holes and hardened bolts.

2.6.3.2 - Bolt dimensions should conform to *UIC Leaflet 542* (see Bibliography - page 17).

2.6.3.3 - Replacement of brake blocks or pads should be as simple as possible. It should be possible to replace brake blocks without using an inspection pit.

2.6.3.4 - The mechanism for adjusting piston travel and play in brake blocks or brake pads should be easily accessible.

2.6.4 - Gauge changeover equipment

It is recommended that the guides required to actuate the locking mechanism be made of wear-resistant materials.

The devices for checking the locking must be monitored and maintained so as to ensure their reliability.

3 - Technical operating conditions

3.1 - General conditions

3.1.1 - Vehicles equipped with running gear incorporating variable-gauge wheelsets should be capable of running in trains with no restrictions due to the special nature of their wheelsets.

3.1.2 - Vehicles equipped with running gear incorporating automatic variable-gauge wheelsets shall be marked with the symbols shown in Appendices **B - page 15** or **C - page 16**.

3.1.3 - The gauge adjustment of the running gear shall be possible under the relevant climatic conditions, both for empty wagons and under the maximum permitted axle load and shall take place automatically without manual intervention.

3.1.4 - A visual check of the state of locking of the wheels must be possible.

3.2 - Gauge changeover equipment

3.2.1 - The gauge changeover should be continuous and should be possible without manual intervention.

3.2.2 - It should be possible for unlocked wheels to be detected automatically.

3.2.3 - It is recommended that a visual check of wheel locking be made after the wagon has passed through the installation.

4 - Approval procedure

4.1 - General conditions

4.1.1 - Before vehicle running gear can be used in international traffic on the basis of bi- or multilateral agreements, the signatory railways or accredited bodies shall be given proof of compliance with the conditions set in respect of:

- design,
- maintenance,
- operating safety,
- the approval procedure.

It shall also be demonstrated that the new running gear with variable-gauge wheelsets is at least equal to conventional running gear in terms of safety (i.e. in all areas such as functional reliability of the locking, strength, routine, maintenance, etc.).

4.1.2 - The approval procedure shall extend from the design stage to final approval for commercial operation.

4.1.3 - The conditions to be met by the running gear are set out in the following documents:

- specification containing parameters set by the operator, e.g. area of use, minimum availability, maximum axle load, etc.,
- national and international standards (ISO, CEN, CENELEC),
- international regulations (UIC, RIV).

4.1.4 - Before construction of the running gear, the manufacturer shall demonstrate to the operator, by means of the following calculations and studies, that the running gear meets the set requirements:

- calculation of strength of the axle or axle-shaft,
- calculation of strength of the wheel,
- calculation of strength of the running gear frame,
- calculation of strength of the locking mechanism components,
- calculation of roller bearing life,
- calculation of the wheel stresses resulting from thermal loading from the block brake,
- calculation of max. permissible component wear from the standpoint of functional and operational safety,
- brake calculation,

- study of functional reliability (RAMS - Reliability, Availability, Maintainability, Safety) of the wheel locking and release mechanism in accordance with *EN 50126-0, 1, 2* (see Bibliography - page 17).

These studies must show whether or not the following are necessary:

- additional calculations on the strength of locking mechanism components,
- further tests required,
- different limit values for maximum component wear,
- the application of a special maintenance cycle.

All calculations should allow for any special climatic conditions.

Where components based on known and tested systems are used, these calculations are only required if there is a significant variation in the climatic conditions in operational use.

4.2 - Tests to obtain provisional clearance to run

Before running gear with variable-gauge wheelsets is used in operation, it must be demonstrated through testing that all safety-relevant conditions are satisfied.

4.2.1 - Rig tests

4.2.1.1 - Determination of the fatigue strength of the variable-gauge wheelset by means of a rotational bending test at ≥ 50 km/h. The test shall be in three stages, in the 1435 mm gauge setting, using the following programme:

Stage	No. of cycles	Vertical force [kN]		Transverse force [kN]	
		static	dynamic	static	dynamic
I	$6 \cdot 10^6$	P	$\pm 0,5 P$ at 4 Hz	O	$\pm 0,3 P$ at 2 Hz
II	$2 \cdot 10^6$	P	$\pm 0,6 P$ at 4 Hz	O	$\pm 0,36 P$ at 2 Hz
III	$2 \cdot 10^6$	P	$\pm 0,7 P$ at 4 Hz	O	$\pm 0,42 P$ at 2 Hz

The value P corresponds to the static axle load.

The test is concluded when the wheelset has withstood 10^7 load cycles without damage (positive test), or when a crack or fracture has occurred.

Other equivalent rig tests approved by ERRI SC B 169 may be used.

The fixed axle shaft of a wheelset with freely-rotating wheels is to be considered as a part of the bogie frame and to be tested as such.

4.2.1.2 - Rig tests with new bearing systems as specified in *UIC Leaflet 515-5* (see Bibliography - page 17).

4.2.1.3 - Rig tests with the running gear frame as specified in *UIC Leaflet 510-3* (see Bibliography - page 17).

4.2.1.4 - Determination of the electrical resistance of the wheelset as specified in *UIC Leaflet 512* (see Bibliography - page 17) (new wheelset and after running 100 000 km without gauge changeover).

4.2.1.5 - Sustained braking tests on block-braked variable-gauge wheelsets to a programme still to be finalised (e.g. Gotthard incline). A check is to be made immediately after the braking, to establish if heating has caused any impairment of the locking mechanism or axial movement capability of the wheels. After the wheels have cooled down, the residual tensile stress in the wheel rim may not exceed the limit value specified by ERRI SC B 169.

4.2.1.6 - To demonstrate the operational reliability of the locking mechanism, a minimum of 500 gauge changeovers shall be made without servicing or inspection, at the maximum changeover speed laid down for the system and under the operating conditions prevailing at the gauge changeover installation.

4.2.1.7 - Further tests which may result from the study of operational reliability.

4.2.2 - Running trials

If necessary, the tests listed below shall be carried out for the various gauges.

4.2.2.1 - Proof of safe running as specified in *UIC Leaflet 518* (see Bibliography - page 17).

4.2.2.2 - Proof that the freely-rotating wheels (free wheels), or wheels connected to the axle shaft and unable to rotate, with a diameter of < 840 mm, can negotiate switches and crossings with a tangent of 0,11 without difficulty both in new condition and after running 100 000 km.

4.2.2.3 - Proof that track distortions as defined in ORE SC B 55/RP 8 may be negotiated without derailment and without release of wheel locking.

4.2.2.4 - Proof that the wheels do not release automatically:

- during buffing tests in accordance with ORE SC B12/RP 17,
- under high longitudinal compression forces as defined in *UIC Leaflet 530-2, Appendix 7.1*,
- when passing over rail brakes.

4.2.2.5 - Braking tests to determine braked weight.

4.2.2.6 - Further tests considered necessary following the studies into operational reliability (RAMS).

4.2.2.7 - Provisional approval for operational running will be contingent on the results of testing.

4.2.3 - Testing in service

4.2.3.1 - It is recommended that 8 - 10 wagons with running gear equipped with variable-gauge wheelsets should run in trains operating over routes with different gauges at the permitted maximum speed and maximum axle load. This set of wagons should run a minimum of 100 000 km with at least 100 gauge changeover operations.

The following measurements and checks should be made on the running gear of these wagons during the trial period:

- A visual inspection of the wheelsets after each 10 000 - 15 000 km, with measurement of wheel flange thickness, flange height, q_R and the distance between inside faces of the wheels, together with the electrical resistance between the wheel-rail contact points.
- Recording of all unscheduled servicing and maintenance work.

4.2.3.2 - Any damage to these wagons which has occurred during the trial period is to be recorded and evaluated.

On conclusion of testing in accordance with point **4.2.3.1 - page 13** above, the variable-gauge wheelsets shall be completely disassembled, in order to determine wear of all components.

These results shall serve as the basis for setting the provisional limit dimensions for wear and for drawing up the provisional inspection and maintenance schedules, taking into account the recommendations of the studies on operational reliability.

4.2.3.3 - Reports shall be made of all tests conducted, for submission to the railways wishing to conclude the bi- and multilateral agreements.

4.3 - Approval to run

Approval to run may be given by the signatory railways when operational safety has been demonstrated by the tests, and when the provisional maintenance instructions ensuring that the running gear will behave as required are available.

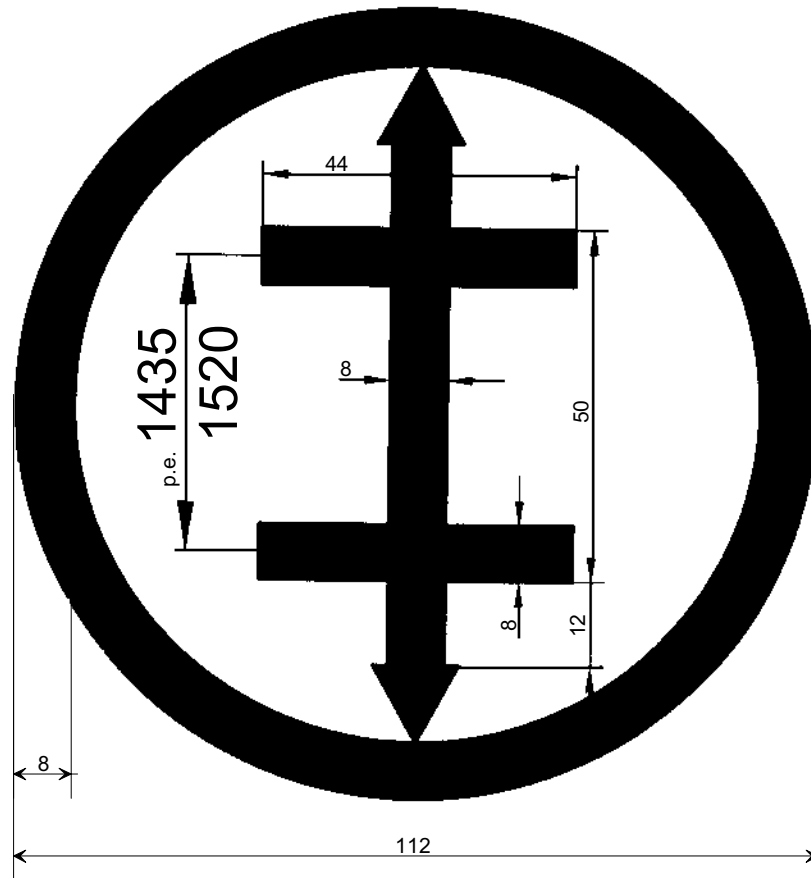
This approval to run should contain further provisions on the nature, periodicity and scope of examinations to be made during the next four years or over 400 000 km.

Any incident affecting operational safety which occurs during this period shall be notified to the railways concerned.

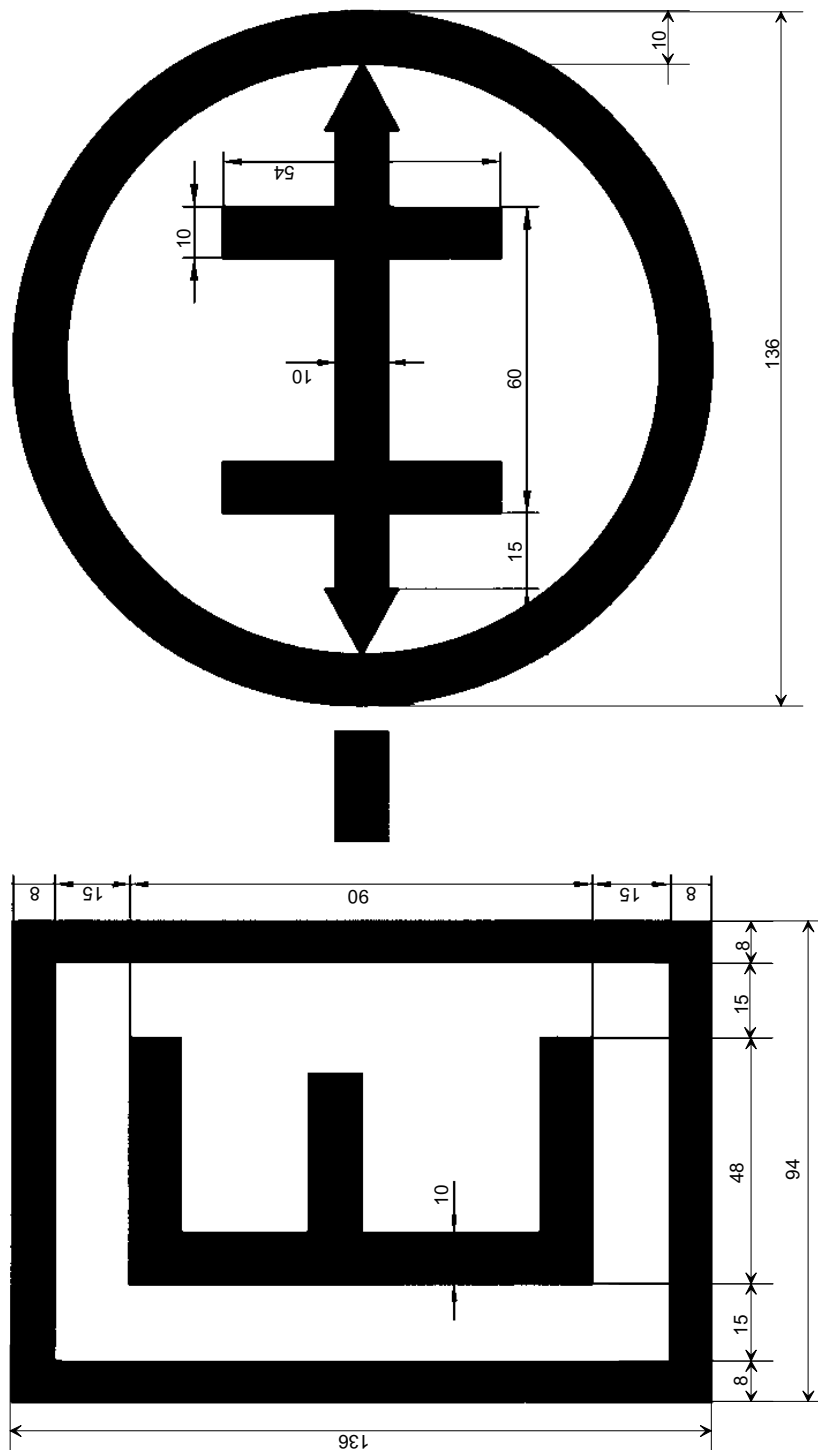
In the event of an incident affecting operational safety, the railway on which the incident has occurred may demand the withdrawal from traffic of the wagons equipped with variable-gauge wheelsets, if the jointly-agreed remedial measures are unsatisfactory.

Tests and examinations in service should be continued if system failures occur.

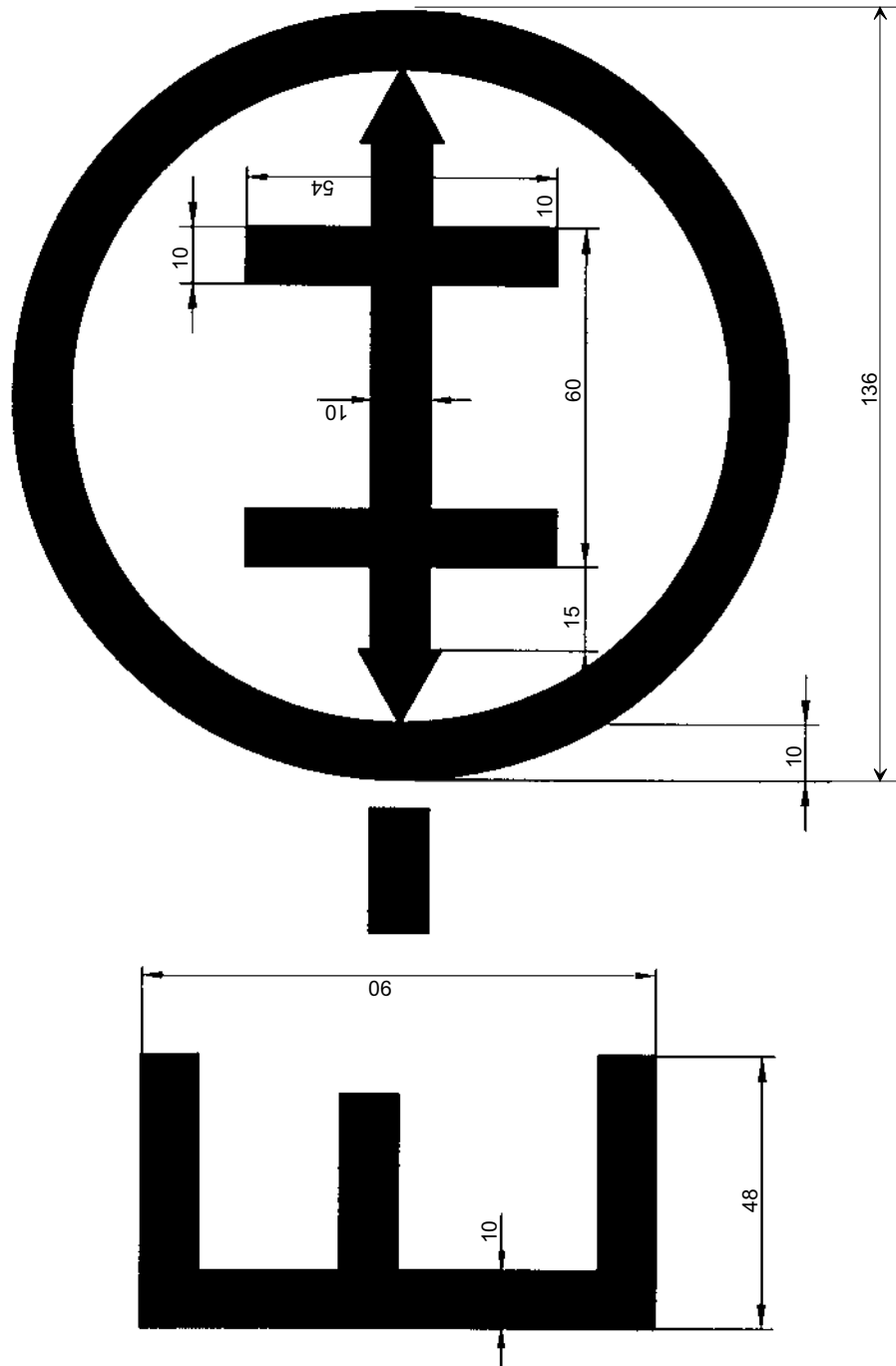
Appendix A - Running gear incorporating axles with automatic gauge changeover



Appendix B - Wagons incorporating axles with automatic gauge changeover from 1435 mm to 1520 mm and vice versa



Appendix C - Wagons incorporating axles with automatic gauge changeover from 1435 mm to 1668 mm and vice versa



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Leaflet 533 : Protection by the earthing of metal parts of vehicles, 2nd edition of 1.1.77 and 4 Amendments

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Leaflet 810-2 : Technical specifications for the supply of rough tyres for tractive and trailing stock - Tolerances, 4th edition of 1.1.85

Leaflet 811-1 : Technical specifications for the supply of axles for tractive and trailing stock, 4th edition of 1.1.87 with sulphur prints

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2. Minutes of meetings

International Union of Railways

Rolling Stock Committee (Question 45 B 42 - Variable-gauge wheelsets. Leaflet 510-4 "Variable-gauge running gear for 1435 mm/1520 mm and 1668 mm". Approval of the leaflet), Prague, April 1997

Infrastructure Commission (Question 45 B 42 - Variable-gauge wheelsets. Leaflet 510-4 "Variable-gauge running gear for 1435 mm/1520 mm and 1668 mm". Approval of the leaflet), Florence, November 1997

3. European standards

EN 50126

Railway applications. The specification and demonstration of reliability, availability, maintainability and safety (RAMS), January 2000