

4th edition, December 2010

Translation

O R

Brakes - Brakes with composite brake blocks - General conditions for certification of composite brake blocks

*Frein - Freins avec semelles de frein en matériau composite - Evaluation de conformité - Conditions
générales*

*Bremse - Bremsen mit Bremsklotzsohlen aus Verbundstoff - Allgemeine Bedingungen für die
Zertifizierung von Verbundstoffbremsklotzsohlen*



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

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Summary

This leaflet contains the general conditions for tread brakes with composite brake blocks. It describes the required properties of the composite brake blocks, their coefficients of friction and geometry requirements, and furthermore the mechanical, physical and chemical features for both organic and sintered composite brake blocks.

It describes the procedure for the issuing of a UIC label for composite brake blocks, and the related test programmes and acceptance criteria to be complied with.

This UIC procedure is intended to usefully apply the expertise of UIC experts in assessing braking components via the award of a UIC label. In order to avoid duplication of work, this certificate may then be used by accredited or notified bodies to underpin their own work.

The procedure for issuing a UIC label only involves the assessment of safety aspects for the suitable use of the brake blocks and specifies their scope of application (for example 1Bg, 1Bgu, 2 Bg, 2 Bgu, wheel diameter, etc.). The service tests that must be carried out only provide limited information about the LCC for each particular type of use. UIC labels are not issued for specific use of a brake block on a particular vehicle (*UIC Leaflet 541-00*).

The procedure for issuing a UIC label is described in *UIC Leaflet 541-00*.

Brake blocks and test benches which comply with the provisions of this leaflet are listed on the UIC website.

Definitions, test methods and measurements to be performed complete the leaflet.

o 1 - Tread brakes with composite brake blocks

Composite brake blocks of vehicles which are brought into use after the entry into effect of this leaflet must fulfil the conditions of this leaflet. (Please refer to point 3.5 - page 18 for the specifications of composite brake blocks on older vehicles).

1.1 - Use of tread brakes with composite brake blocks

Vehicles with tread brakes fitted with composite brake blocks are certified in international traffic.

The permitted field of use for wagons is defined in point 1.2.1.

The permitted field of use for coaches is defined in point 1.2.2.

The permitted field of use for motive power units is defined in point 1.2.3 - page 3.

1.2 - Use of composite brake blocks

1.2.1 - Use in wagons

The basic technical field of use (key values) for composite brake blocks is defined as

- $V_{\max} = 120 \text{ km/h}$,
- maximum wheelset load 22,5 t,
- brake block design in accordance with the UIC standard,
- area of use: all lines in the UIC area up to a maximum gradient of 40 ‰.

The composite brake blocks to be used are certified according to the clauses of point 3 - page 13.

The standard programmes defined in this leaflet (e.g. in Appendices A.1 - page 21 and A.2 - page 30) are based on the aforementioned key values. Composite brake blocks may be used under different key values if suitable demonstration has been provided (e.g. by performing a test programme with the structure of programmes A1_a / A2_a and adapted parameters/key values). This also applies to extending the scope of application of a product which has already been certified according to the standard basic conditions.

1.2.2 - Use in coaches

The technical use of these composite brake blocks on coaches is restricted to a combined disc/block braking system, and is defined for $V_{\max} = 200 \text{ km/h}$ and a proportional wheel mass of 2.3 t in the 1xBg configuration (design as per UIC standard). Area of use: all lines in the UIC area up to a maximum gradient of 40 ‰.

The composite brake blocks to be used are certified in accordance with the provisions of point 3 - page 13.

1.2.3 - Use in motive power units

Reserved.

1.3 - Suitability for use

The suitability for use of the composite brake blocks to be used must be demonstrated in service tests. The conditions applicable to this are contained in point [3.3 - page 15](#).

1.4 - Brake performance

The brake performance of vehicles with composite brake blocks is determined in accordance with the procedure specified in *UIC Leaflet 544-1* ([see Bibliography - page 102](#)). The results of tests using reference vehicles may be used. The details are given in "Design rules - Composite (K) Brake Blocks" and/or in "Usage guidelines for composite (LL) brake blocks" (see www.uic.org: Activities/Topics - Technology & Research - Products - Guidelines).

1.5 - Vehicle marking

Vehicles with composite brake blocks are marked K, L, or LL according to the friction coefficient. The design must comply with *UIC Leaflet 545, Appendix F* ([see Bibliography - page 102](#)).

This marking is applied immediately after the abbreviated marking of the brake design type.

1.6 - Protection against incorrect use

Composite brake blocks with friction coefficient K must be fitted with protection against incorrect use according to point [2.4.3 - page 9](#).

Composite blocks with friction coefficients L and LL have no such protection.

2 - Features of composite brake blocks

2.1 - General

- R 2.1.1** - This specification defines the properties required for composite brake blocks of organic and sintered materials for the tests prescribed.
- R 2.1.2** - Composite brake blocks may be used in bilateral or unilateral brake block configuration with double block (2 x Bgu or 1 x Bgu) and single block (2 x Bg or 1 x Bg). The content of this specification relates exclusively to the use of composite brake blocks acting on the treads of the wheels.
- O 2.1.3** - The composition of the material and the method of production of the composite brake blocks in series production must be identical to those of the composite brake blocks used for the approval process.

The batches of blocks supplied for use in prototype testing must undergo tests as per point **2.5.1 - page 10**, which shall serve as a reference for the assessment of the blocks' conformity with the prototype during series production.

- R 2.1.4** - The material composition of the composite brake blocks must be selected so as to ensure the best compromise between:
 - friction properties,
 - aggressiveness against the wheel tread,
 - effect on the adhesion value between wheel and rail,
 - compatibility with signalling systems (track circuits),
 - wear and the life of composite brake blocks,
 - further certification requirements.
- O 2.1.5** - The material used for the composite brake blocks must be homogenous over its entire active thickness, ensuring brake performance irrespective of wear.

2.2 - Friction requirements

O 2.2.1 - General

2.2.1.1 - The test on friction features on a test bench comprises the following tests:

- behaviour of instantaneous and mean friction coefficients,
- behaviour under the effect of humidity,
- tendency to form metallic inclusions,
- behaviour when simulating a brake failure,

- own and counter-wear behaviour when simulating real braking load collectives,
- winter braking properties,
- compatibility with signalling systems (track circuits),
- determination of static friction coefficient.

2.2.1.2 - The behaviour of the friction coefficients must, in relation to the dependency on temperature, weathering influences, and for type K also surface pressure, move within the permitted tolerances given in the chapters which follow. Depending on vehicle category, friction coefficient and block configuration, the frictional requirements must be tested using the allocated test programme and the suitability demonstrated using certification criteria.

2.2.2 - Friction requirements for wagons

- **2.2.2.1 -** During the bedding in process the coefficient of friction may not deviate by more than $\pm 15 \%$ from the average coefficient of friction (μ_m) of the last 5 bedding in brake applications.

To ensure a satisfactory service braking behaviour, the mean friction coefficients (definition, see Appendix [O - page 100](#)) of level K for dry brake applications with block arrangements 1 x Bg, 2 x Bg and 2 x Bgu must lie within the spread limits given in [Appendix B - page 60](#).

To guarantee braking distance safety, the mean friction coefficients related to the highest contact force for the simulated load states, for the range of initial braking speeds, 100 km/h and 120 km/h, must lie within the spread limits in [Appendix C - page 75](#).

The spread limits to be observed for dry brake applications at friction levels L and LL are given in [D - page 76](#) and [Appendix E - page 78](#).

- **2.2.2.2 -** The instantaneous friction coefficients determined in bench tests (definition see Appendix [O - page 100](#)) must ensure that from a fully developed contact force, the resulting braking moment has a constant development which rises towards the end of the brake application.

An example diagram of requirements is given in [Appendix F - page 79](#).

- **2.2.2.3 -** The average of the mean wet friction coefficients at maximum contact force (both empty and laden) in the range of initial braking speeds, 100 km/h and 120 km/h, may not deviate by more than -15% and $+15 \%$ from the mean dry friction coefficients determined under the same conditions (m , v , F_B).

For all other brake applications, the maximum permitted deviation is $\pm 30 \%$.

- **2.2.2.4 -** The friction properties are tested under winter conditions either in a test run (for the test programme, see [Appendix G - page 80](#) or on a friction test bench as per Test Programme A5_a - [page 47](#). The tests only need to be performed in one of the relevant prescribed block configurations, in which case a positive test result also applies to the other block configurations.

During bench testing as per Test Programme A5_a, the average brake distances determined during brake applications at 100 and 120 km/h may not vary by more than -15% to $\max. + 15 \%$ in relation to the average braking distances (s_0) determined under dry conditions (see Test Programme A5_a).

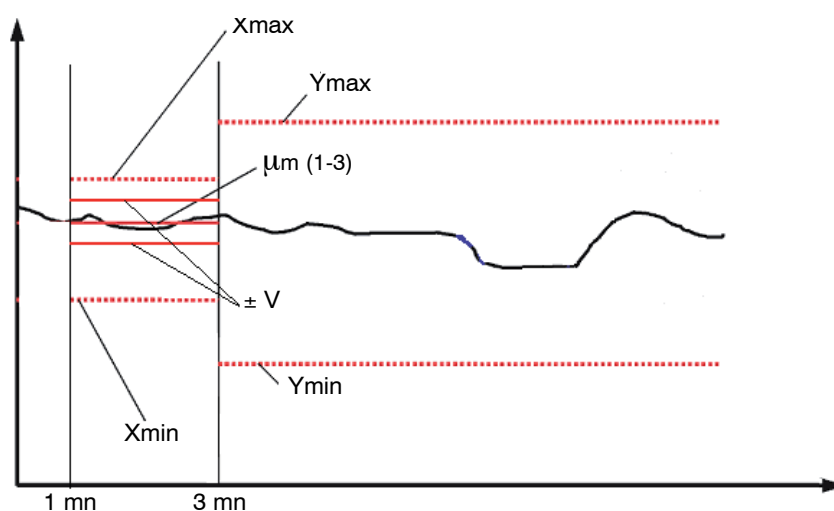
In order to be classed as suitable for winter conditions, a block type must meet the following requirement in test runs as per Appendix G - page 80:

The average variation in braking distances **in the simplified braking distance tests** may not exceed 10 percent (for speeds of both 100 km/h and 120 km/h).

Further details on the performance of the tests are given in Report *UIC B 126 / RP37* (see Bibliography - page 102).

O 2.2.2.5 -

1. On brake applications to a stop at high initial temperatures ($\geq 110^\circ\text{C}$) (hot brake applications), under otherwise identical conditions, the average friction coefficient may not deviate by more than $\pm 15\%$ from the average mean value of the friction coefficients of brake applications in cold ($\leq 60^\circ\text{C}$) and dry conditions.
2. For drag braking (simulated downward gradient) the coefficient of friction must comply with the following conditions (see diagram):



$\mu_m(1-3)$	Average coefficient of friction between first and third minute	(See Table 2 - page 7)
$\pm V$	Tolerance of $\mu_m(1-3)$	$\pm 10\%$ of $\mu_m(1-3)$
Xmin	Minimum permitted instantaneous coefficient of friction between first and third minute.	$\mu_m - 30\%$
Xmax	Maximum permitted instantaneous coefficient of friction between first and third minute.	$\mu_m + 15\%$
Ymin	Minimum permitted instantaneous coefficient of friction after third minute.	$\mu_m - 15\%$
Ymax	Maximum permitted instantaneous coefficient of friction after third minute.	$\mu_m + 15\%$ for K blocks $\mu_m + 30\%$ for LL blocks

Table 1 : General conditions for brake applications on a downward gradient

Programme	Block type	Configuration	$\mu_m(1-3)$
A1_a	K	2Bgu	0,25
A1_a	K	2Bg	0,25
A1_a	K	1Bgu	0,23
A2_a	LL	2Bgu	0,15
A2_a	LL	2Bg	0,15
A3_a	K	1Bg	0,26

Table 2 : Average coefficients of friction between the first and third minute

The maximum deviation of the average coefficient of friction μ_m , before and after simulation of the downward gradient, must be $\leq \pm 15 \%$ at $v \geq 100$ km/h and $\leq \pm 30 \%$ at $v < 100$ km/h.

These conditions apply both to 45 and 40 kW under programmes A1_a and A2_a.

In programmes A1_a and A2_a, the additional programme at 40 kW for 30' only needs be conducted if the results at 45 kW for 34' (including comparison of the brake applications to a stop before and after the drag braking) were not satisfactory.

- **2.2.2.6 -** The effect of friction material under unusual thermal stresses on the wheels (e.g. locked brake) is tested as per Test Programme A6 - [page 59](#).

The following acceptance criteria apply for suitable behaviour:

Wheel temperature [°C] ^a		
< 600	> 600	> 700 and ≤ 850
OK	not OK ^b	not OK ^c

a. measured 9 mm below the tread, the upper envelope of the 3 individual measurements applies to the assessment.

b. if the cumulative duration of excess is more than 25 min

c. if the cumulative duration of excess in the temperature range 700 to 850 °C is more than 5 min. Under no circumstances may the upper limit of 850 °C be exceeded.

The acceptance criteria apply to the 2Bgu, 2Bg, 1Bgu and 1Bg configurations combined with nominal wheel diameters of 920 to 680 mm.

A validation for the 2Bg configuration with a 920 mm diameter wheel also validates the various 2Bgu, 2Bg, 1Bgu and 1Bg configurations combined with nominal wheel diameters of 920 to 680 mm.

If a validation is performed in another configuration, only the tested configuration is considered valid. In this instance, the test must be performed as per Test Programme [A.6 - page 59](#)

- **2.2.2.7 -** The static friction coefficient μ_{stat} to ensure adequate holding force on downward gradients is tested as per Test programme [A.12 - page 70](#). The results have to be demonstrated for each level of the applied force. The average value of five measurements of each applied force must achieve the following values:

- $\mu_{stat K} \geq 0,20$

- $\mu_{stat LL} \geq 0,20$

If the validation of the static coefficient of friction is conducted as per Appendix A.12 - page 70, it shall be valid for all other configurations and wheel diameters.

- O 2.2.2.8** - The tendency to form metallic inclusions when used on wagons is tested as per Test Programme A.4 - page 44. During interim inspections, metallic inclusions may not be present in over 5 % of the contact surface; after the end of the bench tests, this value must be below 1 % of the contact surface.

If the test is conducted in the 2xBgu configuration, its results shall also apply to the other configurations.

If the test is conducted in a different configuration, its results shall only apply to the configuration tested.

The result of the tests shall apply to all wheel diameters of 680 mm and above.

- R 2.2.2.9** - To assess the economic feasibility of the composite block/wheel pairing, the bench tests "Own and counter-wear behaviour while simulating real operational braking conditions" as per Test Programme A.11 - page 66 may optionally be performed.

The results for the specific brake block and wheel wear must be enclosed with the certification documents.

2.2.3 - Friction requirements for coaches

2.2.3.1 - The tolerance ranges for the average coefficients of friction and the tolerance ranges for the mean value of the averaged coefficients of friction (for definition see Appendix O - page 100) for all brake applications to a stop are indicated in the graphs in Appendix D, Fig. 3 and 4 - page 77.

2.2.3.2 - The tolerance ranges for the instantaneous coefficients of friction (for definition see Appendix O - page 100) with a dry disc are indicated in the diagrams in Appendix D, Fig. 5 and 6 - page 79.

For bedding in, see point 2.2.2.1 - page 5.

2.2.3.3 - For brake application to a stop initiated at high temperatures ($\geq 110^\circ\text{C}$, hot brake applications), the average coefficient of friction may not deviate from the tolerance range of average coefficients of friction indicated in the diagram in Fig. 1 - page 76; the instantaneous coefficients of friction may not deviate from the tolerance range indicated in the diagram in Fig. 5 - page 79.

2.2.3.4 - For drag braking (on downward gradients) with a power of 30 kW per block, the instantaneous coefficient of friction must comply with the following conditions:

- after two minutes of braking: $\mu_{\min} = 0,12$ and $\mu_{\max} = 0,30$
- for the duration of the brake application: $\mu_{\min} = 0,10$ $\mu_{\max} = 0,32$ and $\Delta\mu_a \leq 0,15$

In addition, the coefficient of friction may not have any sudden variations which would make the brake more difficult to operate and control. Over one minute, the instantaneous coefficient of friction may not increase or decrease by more than 15 %.

2.2.3.5 - Verification of the static coefficient of friction is not required by the UIC approval procedure for L blocks.

NB : Normally, the handbrake acts on the disc brake. In specific cases where the handbrake acts on the tread brake, the operator must verify that the required holding force is achieved with the L block.

o **2.2.4 - Friction requirements for motive power units**

Reserved.

o **2.3 - Requirements for compatibility with track circuits**

2.3.1 - Requirements for wagons (K and LL blocks)

The compatibility with track circuits is tested either by test runs (for the test programme see Appendix J - page 92) or on a friction test bench in accordance with the provisions of *B126/RP33 and B126/RP39* (see Bibliography - page 102). The requirements to be observed for performance of test runs are given in Appendix J. The requirements for bench tests are contained in the aforementioned reports. The tests only need to be conducted in one of the relevant prescribed block configurations; a positive result is then valid for the other configurations.

2.3.2 - Requirements for coaches (L blocks)

Compatibility with track circuits is tested during test runs (for the test programme, see Appendix J). The requirements to be observed for the performance of test runs are given in Appendix J.

NB : the limit values for bench testing compatibility with track circuits are not yet validated.

2.3.3 - Requirements for motive power units

reserved.

o **2.4 - Geometric features of composite brake blocks**

2.4.1 - Composite brake blocks of standard length, 320 mm, should preferably be used for brake block configuration Bg, and 250 mm for brake block configuration Bgu. The preferred width for brake blocks is 80 mm and the preferred thickness 60 mm.

For design examples see Appendix H, Fig. 10 - page 85.

2.4.2 - The contour of the block surface facing the wheel tread must be designed to guarantee optimum adaptation to both the nominal wheel diameter and to the wheel diameter in worn state. The transverse profile of the block surface must be designed with a slope of 1:40.

For design examples see Appendix H, Fig. 11 - page 86.

2.4.3 - K composite brake blocks must, on the side of the backing plate facing the brake block, be fitted with protection against incorrect use to Appendix H, Fig. 12 - page 87.

2.4.4 - The construction of the composite brake blocks must allow even wear to a block thickness of 10 mm without parts of the reinforcement or backing plate coming into contact with the wheel tread.

2.4.5 - The composite brake blocks must have 2 permanently legible wear limit marks in the area of the brake block ends of the sides facing away from the flange, where the marks have a distance of 10 mm from the rear of the backing plate.

For a possible design see Appendix H, Fig. 13 - page 88.

2.4.6 - The composite brake blocks may in no case deform under the influence of heat or humidity such that they can no longer be inserted or removed.

o 2.5 - Mechanical, physical and chemical features

2.5.1 - Obligations of manufacturers in terms of proof (product specification)

The brake blocks used for the prototype testing must undergo tests meeting the requirements contained hereafter, which shall then serve as a reference demonstrating that the blocks subsequently manufactured during series production correspond to the prototype.

Tests marked "A" must be conducted with a test product from one of the batches used for the prototype testing.

Tests marked "B" must be conducted with a test product from each of the batches used for the prototype testing.

	Organic blocks	Sintered blocks
Chemical composition ^a	A	A
Macrostructure		A
Durability	B	B
Coefficient of friction (small-scale bench tests for pads)	B	B
Density	B	B
Resistance to high temperatures		A

a. The UIC expert entrusted with assessing the prototype must ascertain that the analysis has been conducted and that the manufacturer has archived the data for any subsequent comparative analysis.

The test results must accompany the assessment reports. The manufacturer is free to choose which method is used to assess the product's features; however, the method selected must be described in the test report. The results of the analysis of the chemical composition are confidential to the manufacturer and are thus not enclosed in the test report.

Durability, coefficient of friction (small-scale bench tests for pads) and density must be tested with

1. Test samples taken from an area near the contact surface,
2. Test samples taken from an area near the wear limit.

Comparison of the results from 1. and 2. must show that the material is homogeneous and retains its properties across the entire active thickness.

2.5.2 - Health effects of materials used

The use of asbestos and other fibres that are health hazards is prohibited.

The rules applying to the use of hazardous materials in force at the time of the blocks' manufacture are to be complied with.

In addition, the manufacturer must present a safety data sheet as per *EU Directive 1907/2006/EC* (Reach Directive, see Bibliography - [page 102](#)).

2.5.3 - Health effects of substances released during braking

As far as possible, the use of materials, in any form or compound, liable to result in the emission of dust, particles and/or gases during operation and/or handling of composite brake blocks and thus pose a health or environmental threat, is to be avoided. The manufacturer must assess the health effects of the substances released during proper use, and include this information in the safety data sheet as per point [2.5.2](#). The test and acceptance criteria to be applied remain to be defined.

2.5.4 - Mechanical requirements

2.5.4.1 - Shear strength

The backs of the brake blocks and the method of connection between the backing plate and friction material must be designed so that any stresses occurring can be safely resisted. The method of connecting the friction material with the backing plate is free. The connection is tested using the test device shown in Appendix I, Fig. [15 - page 90](#) with a test force of 15 kN.

After the end of the test, no damage may have occurred to the friction material/ backing plate connection.

2.5.4.2 - Bending strength

The bending strength is tested according to the method shown in Appendix I, Fig. [16 - page 91](#). After the end of the test there may be no visible surface or through cracks and no detachment from the backing plate except for surface and through cracks on the expansion joint.

2.5.5 - Thermal requirements

The friction material must not cause heat damage to the wheel treads. Also, it must not damage the friction surface or have a tendency to form metallic inclusions.

During friction bench testing and test runs (with the exception of Program [A.6](#) - "Simulated locked brake"), the following may not be observed on the brake blocks: flames, exudation of binding agents, continuous squeaking and strong odours. Further, the blocks may not display blow-outs or exfoliation over a large area, nor may they display any damage jeopardising their mechanical strength, leading to significant material deposits on the wheel tread or creating unusual levels of wear.

o 2.6 - Marking of certified composite brake blocks

Certified composite brake blocks must bear the following markings on the back plate:

- designation of brake block type,
- name or symbol of manufacturer,
- date of manufacture (week and year),
- batch number,
- UIC and friction level (K, L, LL),
- customer item number or customer-specific marking (e.g. colour marking) - optional.

These markings are embossed, engraved or punched, and must be applied so that each composite brake block can still be identified in service after complete wear.

For design example see Appendix H, Fig. 14 - page 89.

3 - Certification of composite brake blocks

3.1 - Certification process

3.1.1 - General

The certification process includes performance of the bench tests prescribed in this leaflet, demonstration of suitable braking performance, and service tests. The UIC product certification procedure for vehicle components set out in *UIC Leaflet 541-00* applies.

Overview of all tests to be performed for certification (completely new product)

Vehicle category	max RSL (t)	Block configuration				Test Programme/appendix necessary for certification
		1xB g	2xB g	1xB gu	2xB gu	
Wagon composite brake blocks (K)	18,0	X				A3, A4, A5/App. G, A6, A7/App. J, App. I, A11 (opt.), A12
	22,5		X	X	X	A1, A4, A5/App. G, A6, A7/App. J, App. I, A11 (opt.), A12
Wagon composite brake blocks (LL)	22,5	--	X	--		A2, A4, A5/App. G A6, A7/App. J, App. I, A11(opt.), A12
		--		--	X	
Coach composite brake blocks (L)		X				A8
Wagon (extra tread brake)						
						reserved
Locomotives						
						reserved

In performing adapted tests, the use of a friction material under different boundary conditions/key values, for example in terms of the wheelset load, is permitted - see point 1.2.1 - page 2.

3.1.2 - Bench tests

The type and scope of bench tests to be performed are described in points 2.1 - page 4 to 2.3 - page 9.

3.1.3 - Slip tests to determine braking power

The type and scope of slip tests to be performed are set out in *UIC Leaflet 544-1*. Observation of the specified braking performance level and maximum permitted spread of braking distances must be demonstrated.

3.1.4 - Service test

Satisfactory behaviour relating to:

- Development of brake block wear,
- Tendency to form metallic inclusions,
- Occurrence of surface and through cracks, detachments and crumbling,
- Frequency of occurrence of wheel damage,
- Aggressiveness towards the wheel treads, and,
- Checking of acoustically-relevant surface conditions of the wheels

must be tested in operations.

A detailed report of the service test must be produced.

3.1.5 - Certification

The certification must be conducted as per *UIC Leaflet 541-00*

Composite blocks certified against the rules applying as of the 3rd edition of this leaflet are listed in Appendix M - page 98, which is published on the UIC website (www.uic.org).

Composite blocks certified against the 1st or 2nd edition of this leaflet are listed in Appendix N - page 99, which is published on the UIC website (www.uic.org).

3.2 - Conditions for bench certification tests

o 3.2.1 - Test benches

The test benches used for the certification tests must be certified in accordance with the applicable UIC rules and meet the provisions of *B 126/RP18* and *DT 408*. The test procedures of the laboratories conducting the tests must comply with *ISO EN 17025* (see Bibliography - page 102).

o 3.2.2 - Test blocks

The brake blocks used for the tests must be those of original size which correspond to series production. Each test programme must be performed with new blocks from the same delivery batch.

R 3.2.3 - Terms

Appendix O - page 100 defines the abbreviations and formulae used in the text and appendices.

o 3.3 - Conditions for line certification tests

3.3.1 - Test wagons/coaches

The wagons/coaches to be used for the braking performance and service tests must correspond to the latest state of the art in terms of running and braking systems and, where relevant, comply with the provisions of the K manufacturing guidelines or the LL application guidelines (see www.uic.org: Activities/Topics - Technology & Research - Products - Guidelines).

3.3.2 - Braking performance

Only products which have proved compliance with the braking weight to *UIC Leaflet 544-1* may be used for the operational test.

3.3.3 - Service tests

It must be demonstrated during the service tests that the composite brake block type corresponds with the conditions of use indicated in the application for certification, that it causes no damage to wheels or blocks, and that it does not impede operations.

For wagons, the test must be performed

- on at least five wagons per brake block configuration and braking regime (S/SS-braked) requested,
- under various weather conditions, for 12 months without interruption,
- for a distance of at least 60 000 km in an individual vehicle.

If a brake block type has only passed the gradient simulation test (see point 2.2.2.5 - page 6, test programmes A1_a, page 21 and A2_a, page 30) with 40 kW of braking power, a service test in trains running regularly on tracks with heavy slopes has to be performed with this type of block.

The following operations are to be performed:

Operation	Start	After 1/3 of test time	After 2/3 of test time	End
S1	all	-	all	all
S2	all	all	all	all
R1	all	-	2 wagons	all
R3	all	all	all	all
R4	all	all	all	all
R5	all	-	-	2 wagons

Definition of inspections and additional measures:

Operation	Description
S1	Status of bedding in/block thickness measurement
S2	Inspection of block condition
R1	Profile measurement
R3	Visual inspection of the tread (thermal cracks, etc.)
R4	Inspection of wheel condition
R5	Measurement of out-of-roundness

Operation S1 is always accompanied by operation S2.

Status of bedding in: percentage of friction surface in contact with the tread.

Block thickness: three values to be determined, the thickness at each extremity and the thickness in the centre. Thickness is measured at the edge of the block opposite the wheel flange.

Inspection of block condition (S2) and tread (R3) in accordance with the Damage Catalogue criteria.

Measurement of out-of-roundness (R5): the shape and amplitude are to be determined and, inter alia, presented in the form of a graph.

For coaches, this test must be performed:

- on at least four vehicles, of which two may optionally be fitted with one bogie with cast-iron blocks and one bogie with the blocks being tested,
- under variable atmospheric conditions over a 12-month period or more, without interruption, and
- over a distance of at least 120 000 km per vehicle.

The following operations are to be performed:

Operation	Start	30 000 km	6 months	End
S1	all	-	all	all
S2	all	all	all	all
R1	all	-	2 coaches	all
R3	all	all	all	all
R4	all	all	all	all
R5	all	-	-	2 coaches

Definition of inspections and additional measures:

Operation	Description
S1	Status of bedding in/block thickness measurement
S2	Inspection of block condition
R1	Profile measurement
R3	Visual inspection of the tread (thermal cracks, etc.)
R4	Inspection of wheel condition
R5	Measurement of out-of-roundness

Operation S1 is always accompanied by operation S2.

Status of bedding in: percentage of friction surface in contact with the tread.

Block thickness: three values to be determined, the thickness at each extremity and the thickness at the centre. Thickness is measured at the edge of the block opposite the wheel flange.

Inspection of block condition (S2) and tread (R3) in accordance with the Damage Catalogue criteria.

Measurement of out-of-roundness (R5): the shape and amplitude are to be determined and, inter alia, presented in the form of a graph.

o 3.4 - Duration of certification validity

Composite blocks for tread brakes are in principle licensed for 10 years unless major changes in the requirements of this leaflet raise doubts about their suitability earlier.

If a manufacturer wishes to renew the certification of a brake block, a corresponding application must be submitted to the UIC at least one year before expiry of this period. The renewal procedure must observe the provisions of *UIC Leaflet 541-00*.

The brake block must meet the requirements of the leaflet applicable at the time of application.

The following documents must be presented for certification renewal:

- The manufacturer's confirmation that the composition and manufacturing methods have not changed,
- The user's confirmation that the block is fit for service,
- Repetition of bench tests as per programmes **A.1**, **A.2** and/or **A.3** or **A.8** (demonstration of friction characteristics),
- Performance of bench tests in accordance with all programmes which have been modified or newly introduced since the last approval.

If a brake block is no longer able to meet the requirements of the currently valid edition of the leaflet, it may continue to be used on vehicles on which it is already fitted until a replacement product is available with which the vehicles can be retrofitted at an acceptable cost.

Otherwise, re-certification must be requested in the following cases:

- modified production methods or constituents of brake blocks,
- modified requirements.

The validity of the blocks certified under the conditions of this leaflet is given in Appendix **M** - page 98.

o 3.5 - Continued use

Vehicles which were in use before the date of effect of the currently valid edition of this leaflet and which are fitted with composite blocks may still be used provided the composite brake blocks are listed in Appendix **N** - page 99 and cannot be replaced by block types in Appendix **M** without modification of the brake system.

In the case of changes to the brake systems of these vehicles, these must be converted to brake block types of Appendix **M**.

4 - Quality control process

4.1 - Manufacturer's quality control

The manufacturer should have a quality control system equivalent to *ISO-Norm 9001* (see Bibliography - page 102).

Brake blocks may only be produced by manufacturers who are regarded as suitably qualified by the customer according to a method the latter has determined.

4.2 - Securing and monitoring of production quality

The manufacturer must have a system to assess the type conformity in series tests during production. In particular, the results of the type conformity tests as per point 2.5.1 - page 10 are to be used as a reference.

The procedure for examining the manufacturing quality is to be approved by the customer.

Appendix A - Test Programmes A1 to A12

Test Programme A1:	Composite brake blocks (K) - Demonstration of friction properties:
Programme A1_a:	Performance programme
Programme A1_b:	Simulation "Braking assessment" 2 x Bg (2 x 320) or 2 x Bgu (4 x 250)
Test Programme A2:	Composite brake blocks (LL) - Demonstration of friction properties:
Programme A2_a:	Performance programme
Programme A2_b:	Simulation "Braking assessment" 2 x Bg (2 x 320) or 2 x Bgu (4 x 250)
Test Programme A3:	Composite brake blocks (K) - Demonstration of friction properties:
Programme A3_a:	Performance programme
Programme A3_b:	Simulation "Braking assessment" 1 x Bg (1 x 320)
Test Programme A4:	Formation of metallic inclusions: 1 x Bg (1 x 320) or 2 x Bg (2 x 320) or 2 x Bgu (4 x 250)
Test Programme A5:	Demonstration of winter braking properties
Test Programme A6:	"Locked brake" simulation 2 x Bg (4 x 320)
Test Programme A7:	Demonstration of compatibility with track circuits 1xBg (1x(320x80)) (reserved)
Test Programme A8:	Composite brake blocks (L) - Extra tread brake, coaches 1xBg (1x(320x80))
Test Programme A9:	Composite brake blocks (L) - Extra tread brake, wagons (reserved)
Test Programme A10:	Composite brake blocks (K) for locomotives (reserved)
Test Programme A11:	Simulation of real usage conditions
Test Programme A12:	Definition of static friction coefficients 1 x Bgu (2 x 250) or 2 x Bg (2 x 320) or 2 x Bgu (4 x 250)

A.1 - Test Programme A1 for composite brake blocks (K) - Demonstration of friction properties for S and SS (S/SS)-braked wagons ($v_{\max} = 120 \text{ km/h}$)

A.1.1 - Test Programme A1_a: Performance Programme

CBB material	organic or sintered of design type K
Type of brake block per wheel	2 x Bg (2 Blocks x 320 x 80 $\left(\begin{smallmatrix} +1 \\ -2 \end{smallmatrix}\right)$ mm) or 2 x Bgu (4 Blocks x 250 x 80 $\left(\begin{smallmatrix} +1 \\ -2 \end{smallmatrix}\right)$ mm) or 1 x Bgu (2 Blocks x 250 x 80 $\left(\begin{smallmatrix} +1 \\ -2 \end{smallmatrix}\right)$ mm)
Wheel type	Compliant with <i>UIC Leaflet 510-5</i> (see Bibliography - page 102) (wheel rim internal diameter 820 mm)
Wheel diameter	870 $\left(\begin{smallmatrix} +5 \\ -0 \end{smallmatrix}\right)$ mm - The precise diameter must be given in the test report.
Mass per wheel (axle load)	2.5 t 9.0 t 11.25 t

Brake application No	V	F _B	θ ₀	M	Weigh after	Comments
	[km/h]	[kN]	[°C]	[t]	Nr.	
1.1 to 1.X see indications under provisions for performance of test	100	24	20 - 100	9,0	1.X ^a	Braking to a stop, dry, to bed in blocks to min. 85 % contact; running-in edges must support, measure wheel roughness
1 3 5	100	38	50 - 60	9,0		Braking to a stop, dry after cooling-down phase
2 4 6	120	38	50 - 60	9,0	6 ^a	
7 to 26	100	7	20 - 100	2,5	26 ^a	Braking to a stop to condition the blocks
27 39	100	7	50 - 60	2,5		Braking to a stop, dry, after cooling down phase
28 40	30					
29 41	120					
30 42	60					
31 43	100	5				
32 44	30					
33 45	120					
34 46	60					
35 47	100	9				
36 48	30					
37 49	120					
38 50	60					
51	70	-		-	51 ^a	Drag braking, dry, 10 kW for 15 min directly following brake application no. 50, without a pause for cooling, to eliminate residual wheel stresses

Brake application No			V	F _B	θ ₀	M	Weigh after	Comments								
			[km/h]	[kN]	[°C]	[t]	Nr.									
52	64	76	100	7	20 - 30	2,5		Braking to a stop, wet, after cooling down phase								
53	65	77	30													
54	66	78	120													
55	67	79	60													
56	68	80	100	5					20 - 30	2,5		Braking to a stop, wet, after cooling down phase				
57	69	81	30													
58	70	82	120													
59	71	83	60													
60	72	84	100	9									20 - 30	2,5		Braking to a stop, wet, after cooling down phase
61	73	85	30													
62	74	86	120													
63	75	87	60													
88	92		100	38	20 - 30	11,25		Braking to a stop, wet, after cooling down phase								
89	93		30													
90	94		120													
91	95		60													
96			70	-	50 - 60	-		Drag braking, dry, with a power of 10 kW for 15 min, to dry the blocks directly after brake application no. 95; without cooling down phase								
							96									
97	109		100	24	50 - 60	11,25		Braking to a stop, dry, after cooling down phase								
98	110		30													
99	111		120													
100	112		60													
101	113		100	9					50 - 60	11,25		Braking to a stop, dry, after cooling down phase				
102	114		30													
103	115		120													
104	116		60													
105	117		100	38									50 - 60	11,25		Braking to a stop, dry, after cooling down phase
106	118		30													
107	119		120													
108	120		60													
121			100	38	110 - 120 ^b	11,25		Braking to a stop, dry, after cooling down phase								
122			30		110 - 120											
123			120		110 - 120											
124			60		110 - 120		124 ^a									
125			100	24	50 - 60	11,25		Braking to a stop, dry, after cooling down phase								
126			30													
127			120													
128			60				128	Measurement of wheel roughness								
129			70	-	20 - 60	11,25		Simulation of a downhill brake application ^c with a power of 45 kW for 34 min.								

Brake application No	V	F _B	θ ₀	M	Weigh after	Comments
	[km/h]	[kN]	[°C]	[t]	Nr.	
130	70	38	-	11,25	130	Braking to a stop, dry, without cooling down phase directly after brake application no.129
131 to 140	120	24	50 - 60	11,25		Brake applications for reconditioning
141 145	100	38	50 - 60	11,25		Braking to a stop, dry, after cooling down phase
142 146	30					
143 147	120			11,25		
144 148	60					
149	70	-		-	149	Drag brake application releasing 10 kW over 15 min, performed immediately after brake application n°148 without cooling-down phase to reduce residual wheel stresses Measure wheel roughness

Brake build-up time 4 s ± 0.2 s

- This weighing, conducted during empty tests and under wet conditions, is optional.
- If the temperature after brake application nos 120 and 122 is below 110 °C, brake applications nos 121 and 123 are to be conducted straight away at this temperature.
- Simulation of a downhill run is performed at constant power and speed.

A.1.2 - Additional programme, Programme A1_a for K blocks

Verification of block suitability for wagons braking downhill

Blocks	Organic or sintered, type K
Block configuration	2 x Bg (2 blocks measuring $320 \times 80 \begin{pmatrix} +1 \\ -2 \end{pmatrix}$ mm) 2 x Bgu (4 blocks measuring $250 \times 80 \begin{pmatrix} +1 \\ -2 \end{pmatrix}$ mm)
Type of wheel	Compliant with <i>UIC Leaflet 510-5</i> (inner rim diameter 820 mm)
Wheel diameter	$870 \begin{pmatrix} +5 \\ -0 \end{pmatrix}$ mm - Indicate precise diameter in documents
Mass per wheel	9 t and 11,25 t

Brake application no.	Initial speed	Total F _B per wheel	Initial temperature θ ₀	Braked weight per wheel	Weighing after	Remarks			
	[km/h]	[kN]	[°C]	[t]	No				
Tests to be conducted using a set of new blocks									
1.1 - 1.X	100	24	20 - 100	9,0	1.X	Brake applications to a stop, dry, to bed-in blocks to a contact pattern of at least 85 %, the edges applied to the wheel must bear the load			
1 3 5	100	38	50 - 60	9,0		Brake applications to a stop, dry, after a cooling-down phase			
2 4 6	120	38	50 - 60	9,0					
7 11	100	38	50 - 60	11,25		Brake applications to a stop, dry, after a cooling-down phase			
8 12	30								
9 13	120								
10 14	60								
15 19	100	9							
16 20	30								
17 21	120								
18 22	60								
23	70	-	50 - 60	11,25		Simulation of a downhill brake application ^a , 40 kW released over 30 min			
24	70	38	-	11,25		Brake application to a stop, dry, immediately at end of brake application no. 23, without cooling-down phase			
25 to 34	100	24	50 - 60	11,25		Reconditioning brake application			
25 29	100	38	50 - 60	11,25	32	Brake application to a stop, dry, after a cooling-down phase			
26 30	30								
27 31	120								
28 32	60								

a. Simulation of a downhill run is performed at constant power and speed.

A.1.3 - Conditions for performance of the Test Programme A1_a

Ventilation conditions

	v	Test bench speed (km/h)		Cooling air speed (km/h)	
		dry	wet	dry	wet
During braking with	≤ 80 km/h	v	v	v/2	10
	> 80 km/h	v	v	40	10
Between brake stops		100	50	40	10

The cooling air speed must be adjusted while complying with the conditions of *ERRI Report B 126/DT 408* (see Bibliography - page 102).

Bedding in

The minimum number of bedding-in applications 1.X is

- 40 brake applications for organic blocks
- 80 brake applications for sintered blocks,

in order to condition the wheel appropriately.

Wear

The individual wear of the blocks is measured for information purposes. The wear to each individual block and the overall wear is to be recorded in cm³/MJ.

Roughness index of wheel tread

The wheel roughness is measured after brake applications nos 1.X, 128 and 136 (Ra and RZ to be measured in accordance with *ISO 4287* (see Bibliography - page 102); the use of a replica made of resin is permitted).

Interruptions

During the tests, interruptions of maximum 3 days are permitted only before tests Nos 1, 7, 27, 97, 125 and 131.

In the case of interruption before test No. 52, to maintain the wet conditions a brak application identical to test No. 50 must be performed outside the programme.

Temperatures

After the brake applications, the temperature must always be reduced to the initial value again.

The braking to a stop (test No. 130) which immediately follows the drag braking must be performed without a cooling-down phase, at the temperature reached at the end of this drag braking.

The drag brake applications (tests nos 51, 96, 149) must be performed without a cooling-down phase at the temperature reached at the end of the braking to a stop.

For brake applications nos 1, 27, 97, 125 and 131, an initial temperature of 20 °C to 60 °C is permitted.

Wet conditions

The brake applications under wet conditions must be performed with a total water quantity of 14 litres per wheel per hour.

In wet brake applications, application of water to the wheels in the cooling phases must not be interrupted between tests nos 52 to 95.

After brake application No. 51 spraying begins only when the wheel temperature has reached 80 °C.

Accuracy of braking parameters

The accuracy required for the individual braking parameters is given in *ERRI Report B 126/RP 18* (see [Bibliography - page 102](#)).

Other conditions

The brake applications must be performed chronologically in the sequence given.

The number of bedding-in brake applications required to achieve a contact pattern of at least 85 % of the block friction surface must be given in the test report.

Test wheels

Both wheels used in service and new wheels can be used.

Before fitting on the test bench, the wheel diameter must be brought to the value shown in the Test Programme.

A.1.4 - Test Programme A1_b: Simulation brake assessment

Blocks	organic or sintered
Type of brake blocks per wheel	2 x Bg (2 blocks measuring 320 x 80 $\left(\begin{smallmatrix} +1 \\ -2 \end{smallmatrix}\right)$ mm) 2 x Bgu (4 Blocks measuring 250 x 80 $\left(\begin{smallmatrix} +1 \\ -2 \end{smallmatrix}\right)$ mm)
Wheel type	Compliant with <i>UIC Leaflet 510-5</i> (wheel rim internal diameter 820 mm)
Wheel diameter	870 $\left(\begin{smallmatrix} +5 \\ -0 \end{smallmatrix}\right)$ mm - The precise diameter must be given in the test report.
Mass per wheel (Axle load)	2,5 t 11,25 t (5,0 t 22,50 t)

Brake application No	V	F _B	θ ₀	M	Comments
	[km/h]	[kN]	[°C]	[t]	
1.1 to 1.X	Drag braking for bedding in at 60 km/h, 20 kW				
1 to 19	100	9	20 - 100	2,5	Braking to a stop to condition the blocks
20 to 24	100	9	50 - 60	2,5	Wagon S + SS Braking to a stop, dry, after cooling-down phase
25 to 29	120	9	50 - 60	2,5	
30 to 34	100	9	50 - 60	2,5	
35 to 39	100	9	20 - 30	2,5	
40 to 44	120	9	20 - 30	2,5	S + SS wagon Braking to a stop, wet, after cooling-down phase ^a
45 to 49	100	9	20 - 30	2,5	
50	70	-		-	Drag braking with 10 kW for 15 min to dry the blocks
51 to 55	100	24	50 - 60	11,25	S wagon Braking to a stop, dry, after cooling-down phase
56 to 60	120	24	50 - 60	11,25	
61 to 65	100	24	50 - 60	11,25	
66 to 70	100	38	50 - 60	11,25	SS wagon Braking to a stop, dry, after cooling-down phase
71 to 75	120	38	50 - 60	11,25	

a. This test is performed for information.

A.1.5 - Conditions for performance of the test Programme A1_b

Rotation and ventilation conditions

	v	Test bench speed (km/h)		Cooling air speed (km/h)	
		dry	wet	dry	wet
During braking at	≤ 80 km/h	v	v	v/2	10
	> 80 km/h	v	v	40	10
Between brake applications		100	50	40	10

The cooling air speed must be adjusted while complying with the conditions of *ERRI Report B 126/DT 408*.

Bedding in

Bedding in takes place by drag braking at 20 KW at 60 Km/h (maximum temperature between 60 °C and 250 °C) to at least 85% contact pattern.

Roughness index of wheel tread

The wheel roughness is measured before brake application 1.1 and after brake applications nos 1.X and 75 (see recommended method from *ERRI Report B 126/RP 18*).

Interruptions

During the tests, interruptions of maximum 3 days are permitted only before brake applications nos 1, 20, 35, 51 and 66.

In the case of interruption before tests nos 1, 20, 35, 45 and 66, identical brake applications as before, nos 1X, 19, 34, 50 and 65, must be repeated.

Temperatures

After the brake applications the temperature must always be reduced to the initial value again.

Wet conditions

The brake applications under wet conditions must be performed with a total water quantity of 14 litres per wheel per hour.

After brake application No. 34 spraying begins only when the wheel temperature has reached 80 °C.

Accuracy of braking parameters

The accuracy required for the individual braking parameters is given in *ERRI Report B 126/RP 18*.