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"Noise – technical and operational aspects to be considered when retrofitting existing freight cars with LL brake blocks" Guidelines developed by UIP Topical Committee Interoperability

Preamble

In April 2015 the UIP (Technical Committee "Economic Evaluation") provided its national members with the detailed report "Noise – State of play".

This report describes the status of the various initiatives taking place both at EU level and at member state level (including Switzerland) to reduce noise from rail freight traffic, and it contains appropriate recommendations for pursuing these strategies further at both levels. The report will be continually updated to reflect developments.

1. Introduction

The biggest source of rail traffic noise is rolling action. During braking, cast iron brake blocks roughen up the wheel tread, whereas composite brake blocks have a smoothing behaviour due to abrasive wear. When the vehicle is in motion, the rough wheel and the rough rail track combine at point of contact to generate vibrations that emit airborne noise from both the wagon and the track. Additional sources of noise are the power system, brake systems, ventilation, air conditioning, impacts and aerodynamic effects; both airborne noise and vibrations are perceived as unpleasant.

Apart from measures that can be applied to the infrastructure

- passive: noise barriers, insulating windows
- active: track grinding,

equipping freight wagons with composite brake blocks (or disc brakes) is acknowledged to be by far the most effective option for significantly reducing noise. As a rule of thumb, a reduction by 10 dB(A) halves the perceived noise level. To achieve that, however, every wagon in the train must be fitted with an appropriate brake technology. With a view to achieving the target formulated by the European Commission and a number of member states – which is to reduce or halve the noise emitted by freight wagons – there is a broad consensus that freight wagons whose noise emissions do not comply with TSI NOISE limits because they are equipped with cast iron brake blocks will have to be retrofitted with LL blocks in the foreseeable future. Wagons equipped with cast iron brake blocks can also be fitted with K blocks, but this option has been disregarded here because the required (financial) investment is too high[1].

Retrofitting freight wagons with LL blocks raises a number of technical and operational issues, and they are addressed in these Guidelines. The Guidelines are therefore intended to support keepers and ECMs who are planning to retrofit their relevant rolling stock with LL blocks.

[1] In addition to this, the regulator may require the brake system to be resubmitted for approval after a retrofit.

As the LL block is a comparatively new technology, these Guidelines will be updated when necessary to reflect new developments, especially those derived from operations.

2. Overview of currently approved LL blocks

Unlike cast iron brake blocks, composite brake blocks are manufactured from a mix of up to 25 different metallic and organic substances. Every manufacturer uses a specific mix, so every type of pad must be considered as a separate product. This creates additional requirements, especially when it comes to replacing one type of brake block with another.

Substances fall into two categories:

→ organic substances: based on rubber or synthetic resin

→ sintered substances: based on iron or copper

The currently approved LL (and also K) blocks are listed in Appendix M – *"Brake blocks accepted in international traffic"* – of UIC leaflet 541-4 "*Brakes with composite brake blocks – General conditions for certification of composite brake blocks – last update 01.08.2015"*.

This Appendix M is available on the UIC website (www.uic.org) at

- http://www.uic.org/IMG/pdf/e541x4_a_m_201508.pdf (English[2])

as a free download.

Appendix G of TSI WAG

> *COMMISSION REGULATION (EU) No 321/2013 of 13 March 2013 concerning the technical specification for interoperability relating to the subsystem "rolling stock — freight wagons" of the rail system in the European Union and repealing Decision 2006/861/EC, last amended on 8 June 2015 by Regulation 2015/924 and in force from 1 July 2015*

is published by the ERA on its website, but only in English, at

- http://www.era.europa.eu/Document-Register/Pages/CR-WAG-TSI.aspx

and should in essence be identical to Appendix M. However, at the time when this Version 1.0 was published, not all the LL blocks listed as approved by the UIC on August 1st 2015 in Appendix M to its Leaflet 541-4 had been included in Appendix G to TSI WAG; this will not happen until October / November 2015.

[2] UIC recently restructured their website; the German and French versions are not available for download, yet. The German and French versions (01.08.2015) will be attached as annex to these guidelines.

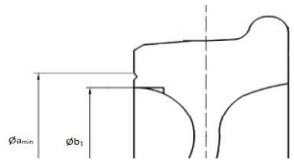
As of August 1st 2015 Appendix M of UIC Leaflet 541-4 lists the following LL blocks as approved:

Manufacturer	Type description and abbreviated designation (if different) (organic / sintered)	Nominal wheel diameter Ø [mm]	Min./ max. axle load [t]	Braking regime / speeds	Min./ max. force per block holder [kN]	Configuration	Certified as per leaflet edition no.	Remarks	Certification expires
CoFren	C952-1 (sintered)	920	3,6 22,5	s	6 50	2 x Bg	4	#1	30.04.2023
CoFren	C952-1 (sintered)	920	3,6 22,5	s and ss (up to 20 t)	6 50	2 x Bgu	4		30.04.2023
Icer Rail / Becorit	IB 116* (organic)	920	3,6 22,5	s	6 50	2 x Bg	4		30.04.2023
Icer Rail / Becorit	IB 116* (organic)	920	3,6 22,5	s and ss (up to 20 t)	6 50	2 x Bg and 2 x Bgu	4		30.04.2023
CoFren	C952-1 (sintered)	840	5 20	empty 120 km/h laden 100 km/h	12 45	2 x Bg	4	#1 #2 According B126 DT 444	31.01.2025
Icer Rail / Becorit	IB 116* (organic)	840	5 20	empty 120 km/h laden 100 km/h	12 45	2 x Bg	4	#1 #2 According B126 DT 444	31.01.2025
CoFren	C952-1 (sintered)	760	5 18	empty 120 km/h laden 100 km/h	12 40	2 x Bg	4	#1 #2 According B126 DT 444	31.01.2025
Icer Rail / Becorit	IB 116* (organic)	760	5 18	empty 120 km/h laden 100 km/h	12 40	2 x Bg	4	#1 #2 According B126 DT 444	31.01.2025

The following comments apply in particular to wagons with wheelsets that have a diameter of 840mm or 760mm:

#1: Until it has been shown that this block can be interchanged with cast iron blocks, brake assessment for this configuration must be performed in accordance with UIC 544-1 prior to fitting[3].

#2 The rim thickness relates to the diameter (calculated as minimum tread diameter $Øa_{min}$ minus inner wheel diameter $Øb_1$) and must not fall below 30 mm (issue: thermal limits of worn wheels).



The dates in the last column for when "certification expires" must be seen in the light of Article 8b of the above-mentioned TSI WAG:

1) *Until the expiry of their current approval period, "friction element for wheel tread brakes" interoperability constituents listed in Appendix G of the Annex do not need to be covered by an EC declaration of conformity. During this period, "friction elements for wheel tread brakes" listed in Appendix G of the Annex shall be deemed to be compliant with this Regulation.*

2) *After their current approval period expires, "friction element for wheel tread brakes" interoperability constituents listed in Appendix G of the Annex shall be covered by EC declaration of conformity.*[4]

[3] Comment #1 also applies to CoFren C 952-1 (sintered) in the 2xBG configuration for wheelsets with a diameter of 920mm.

At the time of publication of Version 1.0 of these UIP Guidelines, two further products were undergoing operational tests; it is therefore advisable, when retrofitting wagons with LL blocks, to check whether additional blocks have been accepted and whether the conditions attached to LL blocks that have already been cleared have since changed.

3. Usage Guidelines for composite (LL) brake blocks

When fitting LL blocks, it is essential to consult the "Usage guidelines for composite (LL) brake blocks". The currently applicable text of Version 1.0 of these Guidelines is the 10th edition published in August 2013.

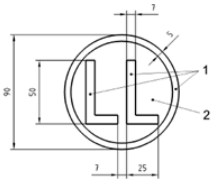
The Usage Guidelines are available for download on the UIC website:

- http://errac.uic.org/spip.php?article1266 (German)
- http://errac.uic.org/spip.php?article1524&lang=en (English)
- http://errac.uic.org/spip.php?article1514&lang=fr (French)

Part 1 of the Usage Guidelines contains the technical details to be observed when retrofitting wagons with LL blocks:

- **Exchanging blocks**:
  The LL blocks fit into the same mountings as cast iron blocks. There is no need for "non-interchangeable" features as with K blocks.

- **Marking "LL in a circle"**:
  The symbol depicted here shall be applied to the wagon alongside the brake type marking, as specified in EN 15877-1 (section 4.5.30.2.10, figure 73).



  Unlike with K blocks, the block type does not need marking, as all currently approved LL blocks are considered to be interchangeable. However, if blocks made of different materials are used in the same vehicle, each wheelset must only carry one type of block.

- **Marking for maximum permitted handbrake gradient:**

  For manually operated brakes, UIC still applies different values to cast iron and LL blocks. Therefore a new calculation is required to determine the maximum permitted gradient for a fully loaded wagon. If it is lower than 4%, this must be marked on the wagon in accordance with EN 15877-1 (section 4.5.25, figure 55).

Example: marking for handbrake gradient

- **Use of kink valves**:
  It is currently mandatory for wagons with "SS brakes" to have inflected curve (kink) valves. As the kink valve is fitted between the control valve and the load-sensing valve, the brake system must be retrofitted in a workshop and if necessary pipes or attachments will have to be adapted. A kink valve reduces the brake cylinder pressure during service braking (low settings). The aim is to ensure that in formations where wagons have different braking regimes ("S" / "SS"), and hence

[4] This applies to all composite blocks approved after 1 July 2015.

perform differently during service braking, especially during continuous braking on a gradient, the wagons with the greater braking efficiency ("SS") are not running under a persistently higher load than the other wagons. In terms of wear on wheels and break blocks, this is not always desirable. UIP is currently reviewing whether, and if so under what operating conditions, the mandatory use of kink valves might be abolished.

- **Wheels/Wheelsets**:
  Tyred wheels have not been approved for use with LL blocks, nor have wheels made from the materials R2, BV2, R8 or R9. Wheels must have a flange thickness of ≤30.5 mm (EN 13715 – S1002).

  It is mandatory for wagons in SS traffic to be fitted with wheels performing to high standards of thermal stability (marked with two white lines on the bearing cover).

Part 2 of the Usage Guidelines summarises the LL block requirements for brake operation, monitoring and maintenance. It explicitly points out, however, that an ECM can adjust these requirements to specific conditions of operation and use if backed by appropriate risk assessments.

- **In-service monitoring of brake blocks:**

  LL blocks are monitored in accordance with GCU. Damage is assessed on the basis of the Damage Catalogue (GCU, Appendix 10, Annex 4).

GENERAL CONTRACT OF USE FOR WAGENS APPENDIX 10

Appendix 10 - Annex 4

"K" BLOCKS: WHEN TO REPLACE AND NOT TO REPLACE

Extract from GCU, Appendix 10, Annex 4

- **Visual inspections:**

  Visual wheel inspections should focus on paint burn under the wheel rim, blue-coloured wheel rims, material deposits, heavy or irregular wear, wheel tread damage and heat cracks. If a brake locks (malfunction), the brake blocks must be exchanged and the equivalent wheel conicity must be established or, as an alternative, flange height must be verified (see next item).

- **Monitoring the wheels:**

  One major issue during LL-block approval was observing the effects on equivalent conicity. This is a calculated value which is used to assess how vehicles are running on the track. However, as it calls for complex measurements and calculations, UIC devised an alternative:

→ A reduced nominal flange thickness of less than or equal to 30.5 mm is to be used (wheel profile as in EN 13715-S1002). This permits equivalent conicity to be determined for a lower in-service flange height limit value of 32 mm and an inspection flange height limit value of 31 mm.

→ If new or reprofiled wheels are used when retrofitting LL blocks, the first inspection must be carried out after 100,000 km and thereafter every 50,000 km. This rule also applies when wheel treads have been reprofiled.

→ If LL blocks are retrofitted on wheels that have not been reprofiled, the first inspection must take place during the retrofit. The equivalent conicity value or, as an alternative, the flange height must then meet the requirements described above. The next inspection must be carried out after 50,000 km and repeated every 50,000 km.

These measurements can be performed – also by mobile teams – with a simple flange gauge tool. At a flange height >32 mm there is a risk that the limit value of 0.40 for equivalent conicity has been exceeded and the wheelset should then be replaced to be on the safe side.

If an ECM observes from the measurements that flange height is altering faster or slower as a result of changes in mileage and/or operating conditions, the intervals between measurements can be adjusted on a case-by-case basis at the ECM's own discretion by carrying out a CSM for risk assessment.

A freight wagon with running gear that has a maximum permitted operational speed of 120 km/h can be run without the need for this additional monitoring of wheel profiles if its **maximum operational speed is limited to 100 km/h**. In such cases, use must only be made of wheel profiles that comply with EN 13715 – S1002, i.e. with a flange thickness less than or equal to 30.5 mm.

Regardless of these UIC recommendations and requirements, wagon keepers who convert their vehicles from cast iron to LL blocks should record the change and the new data in the National Vehicle Register, and the ECM should – where necessary – adapt the maintenance files.

4. LL blocks: Costs of retrofitting and increased operating costs

LL blocks are currently about four times as expensive as cast iron blocks. When and how the brake blocks are exchanged are therefore important questions. It is impossible, however, to propose a common maintenance strategy for all wagons, as the wear on brake blocks and wheel treads is highly dependent on the operational use profile.

Experience with operating the EuropeTrain also shows that there is no standard value to express the service life of a brake pad or the reprofiling interval for wheels. There are too many different variables, such as:

→ type of brake (single, double, self-levelling load-proportional braking etc.)

→ type and number of braking events during operations

→ maximum speed

→ maximum wheelset load

→ route profile (flat, mountain, etc.)

→ climate conditions (especially during winter operations)

→ dynamic braking on the locomotive

→ driving style of the loco driver.

As part of the "Leiser Rhein" ("Quiet Rhine") project launched by the German Ministry of Transport in 2009, the participating associations[5] and companies[6] drew on insights from the EuropeTrain project and their own initial experience in order to estimate the costs of retrofitting LL blocks and the follow-on additional operating costs for a 4-axle reference vehicle:

- **Costs of retrofitting LL blocks**

  Compared with simply replacing conventional cast iron brake blocks, additional costs are incurred the first time a freight wagon is retrofitted with LL blocks: these are estimated to be approximately 2,000 euros for a four-axle wagon (without kink valves); this estimate includes the material, wage and ancillary costs for a workshop to replace 32 cast iron blocks with 32 organic LL blocks, as well as a flat rate for transport costs to/from the workshop and the cost of downtime while the wagon is out of operation.

- **Higher operating costs when using LL blocks**

  Apart from retrofitting costs, composite brake blocks incur significantly higher operating costs than conventional cast iron brake blocks, as wheelsets have to be inspected and reprofiled more frequently, and the LL blocks themselves are also considerably more expensive. The additional operating costs amount – if the wheelset inspections that may have to take place every 50,000km are factored in – to 0.7 euro cents/axle kilometre.

[5] VDV, VPI, ERFA

[6] DB Schenker Rail, DB Netz

5. Retrofitting existing freight wagons with composite blocks: national funding models and noise differentiated track access charge systems

The table below summarises the funding models and noise differentiated track access charging systems that have so far been established in Germany, the Netherlands and Switzerland. In the latter two countries, mileage-dependent bonuses are paid on a territorial basis directly to the transportation companies, i.e. the railway undertakings, for using freight wagons that have been fitted with composite blocks. Wagon keepers wishing to benefit from these bonuses must therefore conclude agreements with those RUs. In Germany, a two-stage model was introduced to coincide with the 2012 / 2013 switchover to the new timetable, and it will apply until the end of 2020.

Wagon type	"State" bonus	"Network" bonus	Affected by "Network" noise fee
"Noisy freight wagon"	**No**	**No**	CH: **Yes**[7] DE: **Yes, if** integrated in a train carrying less than 90% low-noise wagons; 2% mark-up on track access charges for the train NL: **No**
Newly acquired TSI Noise compliant freight wagon	**No**	CH: **Yes** DE: **No** NL: **No**	CH: **No** DE: **Yes, if** integrated in a train carrying less than 90% low-noise wagons; 2% mark-up on track access charges for the train NL: **No**
Wagon retrofitted before January 1st 2008	CH: **Yes** – K retrofit fully financed, **if** wagon was registered in CH in 2000 DE: **No** NL: **No**	CH: **Yes** DE: **No** NL: **No**	CH: **No** DE: **Yes, if** integrated in a train carrying less than 90% low-noise wagons; 2% mark-up on track access charges for the train NL: **No**
Wagon retrofitted after January 1st 2008 / December 9th 2012	CH: **Yes** – K retrofit fully financed, **if** wagon was registered in CH in 2000 DE: **Yes** – after **Dec 9th 2012** NL: **No**	CH: **Yes** DE: **Yes** – after **Dec 9th 2012** (not for wagons from third countries which funded the retrofit, e.g. CH) NL: **Yes** – after **January 1st 2008**	CH: **No** DE: **Yes, if** integrated in a train carrying less than 90% low-noise wagons; 2% mark-up on track access charges for the train NL: **No**

[7] Track access charges in CH are calculated on the basis of marginal costs; a mark-up is then added to reflect the total of foreseeable bonuses for low-noise wagons.

- **The "German model"**

As part of the noise-differentiated track access charging system now being introduced, at the 2012 / 2013 timetable switchover the German state began paying grants directly to wagon keepers who retrofit existing freight wagons registered before 9th December 2012 with LL blocks and subsequently operate these retrofitted wagons (at least partly) in Germany[8].
The Federal funds are granted following appropriate applications from wagon keepers domiciled in Germany and other countries; the grant-awarding agency is the Federal Railway Authority (EBA), which has issued Guidelines summarising the application procedure and providing all the necessary technical details:

- Download section (German): http://www.eba.bund.de/DE/HauptNavi/Finanzierung/laTPS/latps_node.html
- Download section (English, French, Italian, Dutch, Polish): http://www.bmvi.de/SharedDocs/DE/Anlage/VerkehrUndMobilitaet/Schiene/foerderrichtlinie-trassenpreissystem-in-den-sprachen-en-fr-it-nl-pl.html

The funding process is initiated when the wagon keeper applies for the issue of a preliminary notification. Once a positive decision is finalised, the retrofit can begin, without a bidding procedure / formal award procedure, either

→ in-house (i.e. in the wagon keeper's own workshops and workshops run by its group affiliates), or
→ as part of scheduled maintenance and inspection based on existing (framework) contracts with third parties for freight wagon maintenance, as long as these (framework) contracts also provide for the wear-induced exchange of brake blocks.
The conclusion of any new supply or service contracts with a view to retrofitting freight wagons with LL blocks, on the other hand, is subject to the German regulations governing the award of contracts.

The maximum amount the wagon keeper can receive directly from the EBA in the form of a retrofit grant is € 211 / axle (e.g. € 844 for a 4-axle wagon). The calculation is based on the following formula

number of axles x mileage x bonus (km / axis)

and the amount of grant per axle/kilometre is 0.5 cents.
Applications must be submitted to the EBA by 30th April of the year after the network schedule period for which the application is made (e.g. latest by 30th April 2016 for the year 2015). The application must include:

→ company data;
→ wagon data (wagon number, brake system, number of axles, date of retrofit, date of wagon registration);
→ mileage data (in km) after the retrofit, including data on RUs that have used or deployed the wagon in Germany.

[8] RUs which operate retrofitted wagons of this kind in their trains on the DB network also receive a maximum bonus of € 211/axle from the infrastructure manager for the period until the end of 2020; the terms and conditions can be viewed at http://fahrweg.dbnetze.com/fahrweg-de/produkte/trassen/trassenpreise/latps.html