

The background image is a composite. The left side shows the side of a large truck, with its wheels and chassis visible. The right side shows a road stretching into the distance towards a sunset over rolling hills. A vertical blue bar separates the two images.

Verband der Reibbelagindustrie e.V.  
Federation of European Manufacturers of Friction Materials

“Imagination  
is the only thing  
you can’t brake”

**VRI**

Verband der Reibbelagindustrie e.V.

**FEMFM**

Federation of European  
Manufacturers of Friction Materials







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*Horst Bruhnke,  
Chairman of  
the VRI*







Dear readers,

Trust and responsibility – two powerful words that epitomise the most important pillars of the work of the Verband der Reibbelagindustrie: on the one hand, we see our task as ensuring and promoting the safety of road users across Europe. On the other hand, we want to future-proof the friction lining industry.

For today's society, the issue of "automobility" is more important than ever before. Climate policy, social changes and challenges call for innovative ideas and bold visions. Only a well-connected and strong industry can realise the visions of our globally active companies and thus remain relevant for coming generations. Our member companies are part of a dynamic network that stands for quality and safety in road and rail traffic. The customer-specific demands have not only grown with regard to product properties such as low noise and low wear, but also with regard to the ever more stringent environmental requirements and ecological responsibility.

In the coming years, we will focus on continuing to promote international exchange that supports forward-looking developments and strategies. The Verband der Reibbelagindustrie e.V. aims to continue to be a leader in the design of safety standards and, as always, to stay cutting-edge.

We hope you will enjoy reading this brochure.

Best

Your VRI management

*To improve readability, we use the generic masculine. Nonetheless, all sexes are implied.*

# » VRI-Verband der Reibbelagindustrie e. V.

Sharing experiences, reinforcing important values and future-proofing the industry: German friction lining manufacturers began cooperating as early as 1947 in what was then called the “Reibbelagausschuss” (RBA), which was part of the “Wirtschaftsverband Asbest”.

The European umbrella organisation FEMFM – Federation of European Manufacturers of Friction Materials – was founded in 1971 on the initiative of the Reibbelagausschuss (RBA). In 1982, the group split up, and the friction lining manufacturers founded their own association, the VRI-Verband der Reibbelagindustrie e. V.. The VRI closely collaborates with other renowned national associations such as the Verband der Automobilindustrie e. V. (VDA) or the Bundesverband der Deutschen Industrie (BDI).

Without intervening in business operations, the purpose of the Verband der Reibbelagindustrie e. V. is to:

- » Promote and further the perception of the general and non-material interests of the friction lining industry.
- » Promote collaboration between the friction lining manufacturers on an international level, as well as ensure the quality standard of the friction linings, since they significantly contribute to the road safety of vehicles – this is done in cooperation with national and international legislative and supervisory bodies.
- » Help formulate standards for the protection of the environment and employees in the workplace in the responsible committees and offer support to the friction lining manufacturers with implementing corresponding legal requirements.
- » Use, disseminate and further develop the WVA system (Waren-Vertriebs-Artikel-Nummern-System), which assigns specific numbers to certain products.

Members of the association can be natural and legal persons as well as associations of individuals who run a friction material manufacturing company, provided they have their place of residence or place of business in Europe.

The friction material manufacturers must fulfil the following conditions:

- » Those responsible for production and quality assurance within the company do not report to one another.
- » To ensure quality assurance, friction coefficient checks are carried out regularly.
- » As part of product development, friction tests are carried out on a full lining.
- » Appropriate testing facilities are used for regular raw material checks.
- » The manufactured friction linings are marked clearly to identify the manufacturer.







# » History of the associations VRI/FEMFM

The cooperation of the German manufacturers of friction materials already began 1947 as an independent group called, the “Reibbelagausschuss” (RBA), as part of the “Wirtschaftsverband Asbest” in Hamburg, who then, in 1954, moved to Frankfurt after the exit of the manufacturers of asbestos cement. In 1971, five European national associations under the leadership of the German Reibbelagausschuss founded the European umbrella organization Federation of European Manufacturers of Friction Materials, with the UNECE in Geneva by means of a liaison status and thus to actively participate in the preparation of vehicle type approval regulations. Not only Geneva, but also the access to institutions of the European Union and to international associations was open. In 1982 the German manufacturers of friction materials formed their own association, the “VRI-Verband der Reibbelagindustrie e.V.”. The VRI was the first and, for a very long time, the only corporate member of the “VDA-Verband der Automobilindustrie”. From 1982 until today, the different working groups of the VRI handled many issues, following the list of the most important ones of the last 50 years:

## — 1971, JUNE

Foundation of FEMFM.

## — 1971 – 1979

Development and fine-tuning of the FEMFM Constitution.

Type approval: Amendments to directive EG 71/320.

First participation in a GRRF session in Geneva.

Agreement on procedures for bench and car testing.

Development of standards for shear, heat and compressibility tests (ISO 6310-6314).

First amendments of the European Regulation ECE R90 for replacement brake linings.

Discussions on patent rights and COP requirements.

## — 1982, JUNE

Founding meeting of VRI in Dusseldorf.

## — 1982 – 1989

Collaboration on the FEMFM Quality Manual.

Coordination of programs for test bench and vehicle tests, as well as dyno performance and hot wear tests.

Development of fitting instructions for brake linings in 5 languages.

Development of several ISO-Standards (ISO 6310-6314).

Development and maintenance of the ECE R90 concerning e.g., speed sensitivity test and bedding procedure.

Specification of components and marking of brake linings.

Statement on asbestos substitutes in brake linings and the enforcement of acceptable transition periods in asbestos law.

Discussion on tolerances of “hammerhead” backing plates.

## — 1990 – 1999

Collaboration on FEMFM Glossary of terms und FEMFM Catalogue of characteristic features.

Development of the Euro-/Global-Spec for brake linings.

Further amendments to the ECE Regulation No. 90 (Speed Sensitivity).

Development and maintenance of several VRI/FEMFM recommendations.

Regulation on end-of-life vehicles directive ELV 2000/53/EC – Exceptional extension of the time limit for plumbiferous linings.

Negotiation of acceptable transition periods and realistic tolerances in asbestos law.

## — 2000 – 2009

Danish lead law – Negotiation of transition periods and problem solving.

IMDS material data sheet: VRI presents percentage data and imposed a 10% control for specific commodities.

Transfer of the Euro-/Global-Spec to the International Standard ISO 15484 “Product definition and assurance”.

Collaboration on the development of the new international Standards ISO 26865, 26866, 26867 and 27667.

Preparation of a defence paper with the title “Usage of copper and copper alloys in brake and clutch linings (friction materials)”.

Revision of the FEMFM fitting instructions and preparing of the 24 language versions with copyright protection.

Development of the International Standard ISO PAS 22574 for the visual inspection of brake linings.

GRRF Ad-hoc working group on ECE R90 – Requirements for e.g., Grandfathering.



VRI commissioned an expert to determine the market price for royalties concerning patent rights on backing plates and accessories for brake pads.

#### — 2010 – 2019

Development of the “VRI/FEMFM REACH Guide” for a better understanding of the REACH requirements and procedures with specific information for the friction material industry and agreed exposition scenarios.

VRI and FEMFM have reached that brake linings (friction material) are articles with no intended release of substances to save expenditures in a five to six-digit amount for each friction material manufacturer.

An OE identical replacement part does not require any testing. An approval is granted on the basis of documented evidence presented to the technical service or approving authority.

Promotion Project-LäGiV – Noise Reduced Freight Transport through Innovative Composite Brake Blocks (V-BKS) was approved with a budget of around €15 million. VRI supports the project members in the LäGiV Steering Committee and Advisory Board.

FEMFM and VRI proposal concerning OE identical brake linings to amend ECE R90 was agreed by the Executive Committee WP29 in Geneva and will come into force.

VRI and FEMFM have worked out a Safety Flyer to sensitize traders and customers on behalf of R90's safety and type approval requirements.

FEMFM and VRI developed the combined fitting instruction for discs & drums for passenger cars and light commercial vehicles (translated into 26 languages).

It is obligatory to fit with all discs and drums of vehicles subjected to ECE R13 and R13H type approvals starting from 1 November 2016.

All language versions of all fitting instructions, inclusive for drum brake linings > 3.5 tons (128 pages booklet), have been technically updated and brought to 26 language versions by adding Arabic, Serbo-Croatian as well as Bulgarian language.

#### — 2020 – 2022

The combined version of the fitting instructions for disks and drums for passenger car and commercial vehicle applications was completed and translated into 26 languages and released for printing.

In a joint effort, FEMFM and CLEPA have achieved the reinstatement of missing reference data that was removed in the 2019/2144 revision of the European “General Safety Regulation”, saving the European aftermarket money in the 6- to 7-figure range by waiving otherwise mandatory type approvals of obsolete brake components.

A joint letter from AECA and FEMFM on the current status of the test methodology for the recording of brake dust emissions for the new EURO 7/VII Directive was sent to the EU Commission.



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# » Licence for a high standard of quality: the WVA licence

The VRI is the intellectual owner of brake, clutch and other friction linings registered with the German Patent and Trademark Office, which are predominantly used in road vehicles, but also in mechanical engineering. Only member companies of the VRI and its licensees are authorised to use the WVA system. The friction linings are organised and documented by the WVA system, allowing friction lining manufacturers and licensees around the world to compare their own number ranges with those of the WVA system and to assign them to the various vehicle applications. The 5-digit WVA number is used around the world and forms the basis for cooperation and information exchange between friction lining manufacturers, dealers and customers. About 350 new numbers are assigned every year.





## Using WVA numbers

The WVA system is the intellectual property of the VRI. It may only be used if the VRI has granted a licence. When granting a licence, we distinguish between two groups of holders of rights of use:

The first group – pure trading companies or institutions that do not manufacture friction linings themselves – only needs to know the existing WVA numbers and their intended purposes to inform their customers.

The second group – manufacturers of friction linings – needs to be able to apply for new WVA numbers for brake or clutch linings that they wish to place on the market.

# MAKES IDEAS VISIBLE



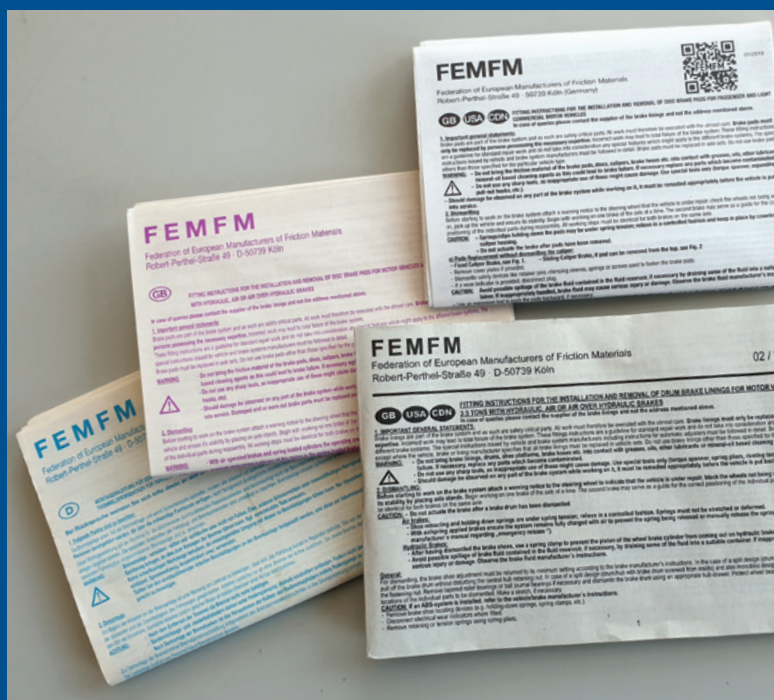
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# » Assembly instructions by the FEMFM – a service for more safety and product liability





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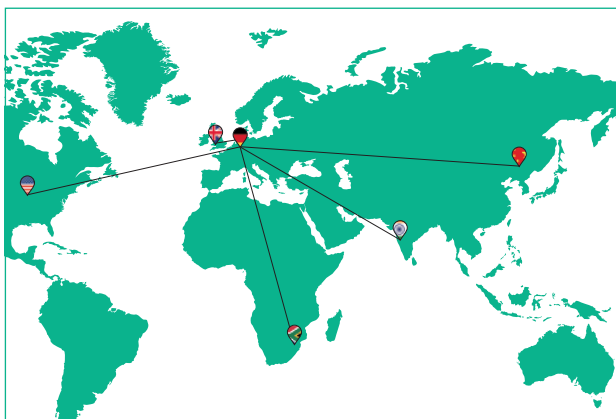
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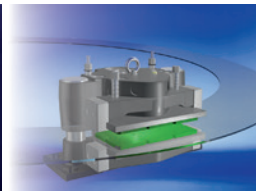
An important area of responsibility of our association is the standardisation, development and updating of so-called assembly instructions. Every year, over 40 million copyright-protected FEM-FM assembly instructions are used by the friction lining industry around the world. Together with international partners, we can offer our customers a kind of “user manual”, an additional service providing product liability and added security. For more information on FEMFM fitting instructions, continue reading on pages 20 and 21.



Brakenhof 7  
31629 Estorf  
Tel.: +49 5025 / 978-0  
e-mail: [info@bremskerl.com](mailto:info@bremskerl.com)  
Internet: [www.bremskerl.com](http://www.bremskerl.com)

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Der Spezialist für Brems- und Kupplungsbeläge  
The specialist for brake and clutch linings



**Bremsen brauchen Bremskerl**

# » Commitment to a common future

The member companies of VRI/FEMFM are fully committed to contributing to a healthy environment. That is why, over the last decade, the friction material industry has been collaborating to develop a better understanding of the fate and possible effects of particles generated during braking.

The European friction industry is fully engaged in the environmental challenges of brake linings including the need for development of a reliable test methodology to measure brake dust emissions effectively, a work already initiated by the industry, in dialogue with the UNECE “World Forum for Harmonization of Vehicle Regulation (WP.29)” and Institutions of the European Union.

The impact of brake wear particle emissions on total particle emissions (from all sources) is relatively small, but we recognise the contribution and industry is committed to address brake wear emissions in a proportional and cost-effective way.

## Environmental mindfulness

Brake linings are high-performance products which, even in the most extreme conditions (speed, temperature, humidity, overloading, aging), ensure that vehicles are braked in the shortest possible time. The use of brake systems in conjunction with friction linings and their extremely high performance allows vehicles of all types to be roadworthy, which is the essential aspect of road safety and therefore they are classified as safety products.

On top of that, they must also have good braking comfort, no noise or vibrations, and as little wear as possible.

To brake a vehicle, friction needs to be caused and this leads to abrasion of both the friction lining and brake disc, generating particles, known as wear debris. Wherever two surfaces slide or roll against each other, there will be frictional resistance, and wear will occur.

Friction wear debris is a mixture of inorganic raw material fragments from the brake lining and brake disc surface elements, such as iron and metal oxides. These particles are commonly referred to as brake dust because of their size and composition.

According to the definition of the „ECHA-Guidance on Requirements for Substances in Articles“, friction linings are articles with no intended release of substances.



Driving Advancements in Global Mobility

As a leading global supplier, Tenneco Braking offers one of the broadest brake pad portfolios on the market for passenger cars, commercial vehicles and railway.

[www.tenneco.com/Braking](http://www.tenneco.com/Braking)



# » Quality brake linings: Zimmermann tests at motor racing level

By collaborating with racing teams at the Nürburgring, brake specialists not only want to show what is possible, but also test and further develop their own products under extreme conditions. Throughout the last racing seasons, Zimmermann's in-house brake lining developments designed for motor racing were tested on the Nürburgring. A whole range of specifications needs to be taken into account when developing your own brake linings. Linings designed for racing need to display optimum friction properties. A stable friction coefficient, both in long-distance use and in a wide braking temperature range, is just as important as braking behaviour that is easy to control.

The economic requirements of very low brake disc and brake lining wear must also be met so that a 24-hour race can be driven with just a few changes on the brakes. These high quality requirements are considered a benchmark for brake lining development. The renowned brake parts manufacturers for the aftermarket produce linings in OE-comparable quality. Not only small batch series are manufactured at the lining production site in Sinsheim. In fact, the product and quality parameters for all Zimmermann linings are also defined and monitored there. The know-how is not just based on many years of expertise, but also on the site's proximity to motorsport. The experiences gained from motor racing are, of course, exploited for the continuous product development by brake manufacturers, allowing them to further enhance the high quality of their products.



Otto Zimmermann GmbH / Deutschland

[info@otto-zimmermann.de](mailto:info@otto-zimmermann.de)

[otto\\_zimmermann\\_official](#)

[www.otto-zimmermann.de](http://www.otto-zimmermann.de)

# » Revival of the drum brake in e-vehicles



Interview with Vincenzo Di Caro, Senior Manager Vehicle Programme at TMD Friction, manufacturer of Textar brake linings

*E-vehicles stand for the technical advancement of the automotive industry. Why are these cutting-edge vehicles often fitted with drum brakes, which seem old-fashioned?*

Electric cars frequently use their e-motor for braking because it acts as a generator (recuperation). This means that the wheel brakes are used less often and are more susceptible to rust. This is why Volkswagen, for example, uses drum brakes on the rear axle of the ID.3 and ID.4, which are factory-fitted with our friction linings. Not only is this type of brake cheaper than disc brakes, but the encapsulated design offers better protection against environmental influences and minimises brake dust emissions. Other advantages are lower weight and lower residual friction torque. This further reduces rolling resistance, which has a positive effect on range.

*Over the past few years, more and more disc brakes have been used on the rear axles of smaller vehicles. Is this trend over now?*

Not over, but change is in the air. Drum brakes have proven themselves very reliable in many vehicle applications over the past decades. Despite this, there has been a trend towards disc brakes in recent years, even on compact vehicles. But the drum brake is making a comeback, especially in mid-range cars. We believe other manufacturers will follow Volkswagen's example, since the lower thermal load capacity of drum brakes is less critical in e-cars due to recuperation and the limited top speed.

*Is the braking power comparable to that of a disc brake?*

The braking power is indeed comparable to that of disc brakes, but the feel is significantly different and needs a little getting used to on the driver's part. In addition, the lower thermal load capacity of the drum brake must also be taken into account. Downhill driving and subsequent braking could become an issue.

*If corrosion on e-vehicle brake discs is a problem, why not use stainless brake discs?*

Several types of rust-free brake discs could indeed be considered. There are, for example, the hard metal-coated brake discs that are already being used by some German vehicle manufacturers – however, they currently are still very expensive to manufacture. Brake discs could, of course, also be made of stainless steel. But for manufacturing reasons, it would be impossible to create ventilated brake disks. That said, ventilated brake discs may no longer be necessary in an e-vehicle, and solid stainless steel discs could possibly be used, provided the generator is appropriately dimensioned.

*How does the operational life span of drum brakes compare to disc brakes?*

Thanks to new materials, the drum brakes that are fitted as standard in the VW ID.3 and ID.4 are designed to last the life span of the vehicle. In future, it may no longer be the wear but the age of the brake components that is key for determining when to replace them. In principle, the same level of servicing work is needed as before.



# TMD FRICTION

A NISSHINBO GROUP COMPANY

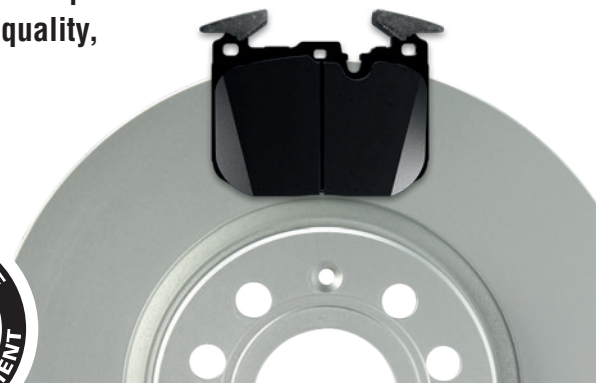


## MILLION REASONS WHY

**AS A GLOBAL MANUFACTURER OF BRAKE PADS AND LININGS, WE PRODUCE 1.2M FRICTION PRODUCTS PER DAY.**

By designing, developing and testing our products in-house, we have complete control over the manufacturing process to guarantee consistent high quality, all created and approved to 100% TMD Friction standards.

This is one of the many reasons why TMD Friction is trusted by vehicle manufacturers, distributors and workshops worldwide.



[www.tmdfriction.com](http://www.tmdfriction.com)

# Friction pairing expertise

**Knorr-Bremse was quick to recognize the importance of friction pairings for achieving new levels of braking system excellence. Since then, the company has steadily expanded its activities in this area. Today, Knorr-Bremse supplies customized, application-specific friction pairings for all types of trains and global rail standards – offering bespoke performance, durability, and life-cycle costs. And equally suitable for OEM and aftermarket customers.**



The little piles of powder in various shades of red, yellow, gray and black wouldn't look out of place in an oriental spice market. But if you mix these ingredients together in the right proportions using the correct procedures, what you actually get is top-quality brake pads or brake blocks for rail vehicles.

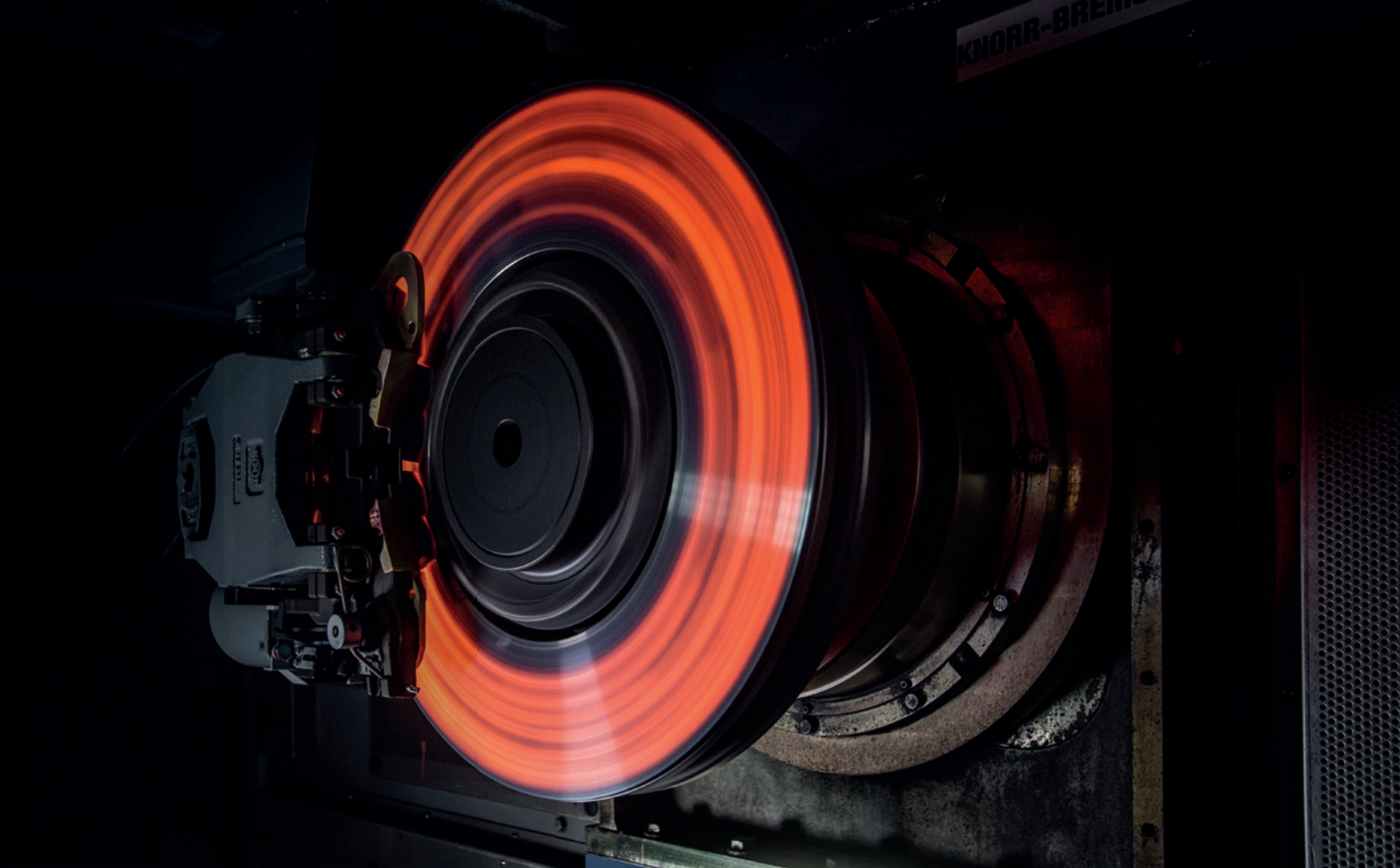
How friction pairings behave in specific applications is a science in its own right. Even tiny changes in the blend of materials or production process can cause major changes in friction behavior. And for those striving to boost sustainability and minimize noise pollution (here, let's just whisper the words "whisper brake"), the perfect combination of friction material, geometry and braking system represents the proverbial match made in heaven. Only a company with the appropriate testing infrastructure and expertise can supply the optimum friction pairing for a given application – in freight or passenger trains, metro or high-speed trains. But even this is only part of the story.

## **Strategic expansion of friction materials development and manufacturing skills**

Let's take a look at the other part. Only by developing braking systems and brake pads in a fully integrated process can you obtain optimum braking performance and durability while minimizing your life cycle costs. This insight is what prompted Knorr-Bremse to enhance and expand our expertise in the development and production of friction materials.

In 2008, the company acquired Anchor Brake Shoes, North America's leading manufacturer of brake shoes for locomotives and freight cars. Two years later, Knorr-Bremse launched the ICER Rail joint venture. In 2016, this was followed by the acquisition of the rail transportation business of brake pad specialists TMD Friction, along with the remaining shares in the ICER Rail venture. And two years after that, we took another major step forward by acquiring the entire knowledge base and intellectual property rights relating to the development and production of friction materials for rail vehicles from DRIV, formerly Federal-Mogul.





An important aside: Knorr-Bremse supplies products that are fully compliant with the UIC standard, which requires them to deliver precisely identical performance so they are 100% interchangeable. Knorr-Bremse has actually extended the UIC quality specifications to meet our own high standards.

#### **Consolidation of friction materials expertise at Knorr-Bremse Pamplona**

In line with our growing integration of new friction technologies (and the significant expansion of our in-house production and development capabilities), Knorr-Bremse decided to consolidate all friction materials expertise at the site of the former ICER Rail joint venture in Spain, renamed Knorr-Bremse Pamplona. As a result, Knorr-Bremse can now offer customized, application-specific friction pairings of brake pads, brake blocks and brake discs for any type of train and all global rail standards. In short, we're a full-line supplier of friction materials, with in-house production facilities and engineers who are equally capable of designing optimized friction pairings for OEM or aftermarket customers. To do so, they can draw on a vast range of brake disc, brake pad and brake block products featuring a wide variety of geometries and materials. Knorr-Bremse has yet another advantage here: the international composition of our in-house development team.

#### **Strict renaming of individual material designations**

To make our portfolio more transparent for our customers in particular, Knorr-Bremse organized a stringent review of the individual product designations. Brake discs – in each case available as axle-mounted or wheel-mounted products – are now divided into three product groups under the following brand names: UltraDisc, standing for steel brake discs; ProDisc, standing

for gray cast-iron or nodular cast-iron discs, and LightDisc, for discs made out of weight-saving aluminum. Similarly, friction materials – sintered and organic pads and blocks – are now bundled into three product segments under our Friction Technologies brand: ProPad, ProBlock and UltraPad.

In our brake pad and brake block ranges, the prefix "Ultra" denotes sintered products, while "Pro" denotes products based on organic friction materials. The naming scheme also uses industry-standard numbered suffixes – so the ICER P16 is now the ProPad P16. Other products that have been folded into the Knorr-Bremse portfolio since the acquisition include, for example, the ProBlock J816M and ProBlock J847.

Just as the key to a perfect braking system lies in a perfect blend of friction materials, so the key to an effective development project lies in the seamless interaction of the many different specialists involved. In short: Knorr-Bremse would be delighted to discuss your needs and our solutions with you!

**[rail.knorr-bremse.com](http://rail.knorr-bremse.com)**



**KNORR-BREMSE**

# » Facts about FEMFM fitting instructions

26 language versions, created by friction industry specialists, legally verified – and still discussed

Interview with Andreas Jandl,  
Managing Director of VRI and FEMFM

*Does Original Equipment Spare parts (OES) need to add fitting instructions together to the product?*

The legal situation is as follows: In the case of OES brake linings that are type-approved in accordance with UNECE Regulations No 13/13H, product responsibility lies with the vehicle manufacturer as the owner of the original spare part and holder of the respective type-approval. In this case, the product does not have to be accompanied by fitting instructions. In return, the OES part must be marked with the corresponding logo and spare part number of the vehicle manufacturer. Required installation or maintenance descriptions of the spare part are part of the vehicle documentation (operating instructions), where they must be bindingly stated.

*What are the legal requirements for replacement brake pads type-approved according to UNECE Regulation No 90?*

If the OES or AM brake lining is type approved according to Regulation No 90 (or under the equivalent EU Directive 2019/2144), the fitting instruction must be placed physically together with the product in the box. The product responsibility (and therefore the product liability) lies with the type-approval holder, which is normally the brake lining manufacturer and not the wholesaler.

*Product Managers of brake linings are often asking, if it is mandatory to include the FEMFM fitting instructions on paper support into their brake lining boxes or if they could dematerialize them and upload them on a dedicated website?*

Because this topic carries far more weight than just being a “useless piece of paper” in a box, FEMFM believes that no one should have an interest in changing a perfectly working system.

The FEMFM, as well as the UNECE and the EU, do not think of converting the physical fitting instructions into a digital system (QR code) for safety and liability reasons. The fitting instructions are part of the product, not only to explain how to remove or fit brake linings; they are an important part of the product to regulate the exclusions of liability in case of traffic accidents, but also in case of accidents during the fitting and/or removal of these spare parts. The principle is the same as for the instructions for use of medicines, electronic devices of all kinds and other consumer products. The type-approval holder, in most cases the manufacturer of the friction material and in some cases the commercial distributor (wholesaler), must ensure that the end user of the friction material product always has direct access to the instructions for use – and this can only be achieved by a hardware solution placed in the immediate vicinity of the product in the packaging.







*Andreas Jandl,  
Managing Director  
of VRI and FEMFM*

*What advantages do you see in using a hardware-based system for fitting instruction versus a digitized system?*

A hardware-based system makes you independent of e.g., reader devices (QR) or difficulties in handling such as electronic devices (thinking in older or not skilled people), antenna and signal coverage, power supply for operating the device and/or charging the battery etc. From a legal point of view, it is not possible to contractually force the type-approval holder to replace fitting instructions with an electronically processed (QR codes) system instead of physically enclosing them with the product as required by law.

*What about intellectual property and what happens if it is infringed?*

FEMFM fitting instructions are the intellectual property of the FEMFM - Federation of European Manufacturers of Friction Materials. FEMFM, together with the experts from member companies and legal advisors, constantly reviews and improves the content of the fitting instructions. This requires updates in 6 product applications, each with more than 26 language versions. Additional applications of fitting instructions are in progress and will be published soon. The FEMFM fitting instructions are the most widely used in the world. To protect and preserve the originality of our products, no part of the publications may be copied, translated, reproduced on microfiche or stored and processed electronically without the permission of FEMFM (owner of the intellectual property). Infringements will be prosecuted and claims for damages will be enforced.

# » TecSA

To research, develop and test friction materials, reliable laboratory equipment and test benches are essential. Here we would like to introduce one of the few companies that manufactures such test equipment. TecSA S.r.l. has more than thirty years of experience in the field of test bench control and manufacturing of test benches especially for brake systems.

Its activities include the production of new machines as well as the retrofitting or renewal of existing test benches.

## What do they make?

- » Dynamometer test benches for motorbikes, passenger cars, racing sector and electric vehicles (E.V.)
- » Dynamometers test benches for light commercial vehicles (LCV)
- » Dynamometers test benches for truck and railway sector (high speed trains included)
- » FQT (Friction Quality Test) for quality control, conformity of production and aftermarket development
- » SST (Shear Strength Test) to measure shear strength of pads and the detachment of friction material from the backplate
- » Alternate torque test benches



## Research & Innovation

The capabilities of their machines include implementation of profiles (from telemetry – LAP racing) and WLTP; KERS applications; Dust survey and analysis; NVH; EPB system (electric park brake); Sprinkling on brake: water, salt water, snow; Regenerative brakes (electric and hybrid vehicles).

- » Brake System Mountings;
- » Four different typologies of mountings: Simple mounting, with wheel hub, with corner and with axle;
- » Options available;
- » Climatic System: -40° C/+50° C;
- » Hand Brake (Parking Brake): max. 5000 N;
- » Sprinkling System: water, salted water, snow;
- » Static Friction: max. 6000 Nm, 20 rpm;
- » NVH (Noise Vibration Harshness);
- » EPB (Electric Parking Brake);
- » Electric Wheels; WLTP (Worldwide Harmonized Light Vehicles Test Program);
- » DTV (Disc Thickness Variation): 2–6 channels;
- » Absorption Tests.

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In addition to the contractual warranty, TecSA and its after-sales service centers provide programmed and preventive support, regular and extraordinary maintenance, and spare parts service for all machines worldwide.





TecSA S.r.l. has more than thirty years of experience in the field of braking system testing laboratories.

Our activities include the manufacture of new machinery and the revamping / renewal of existing test benches.

**Dynamometers for motorbikes, passenger cars racing sector and electric vehicles (E.V.)**

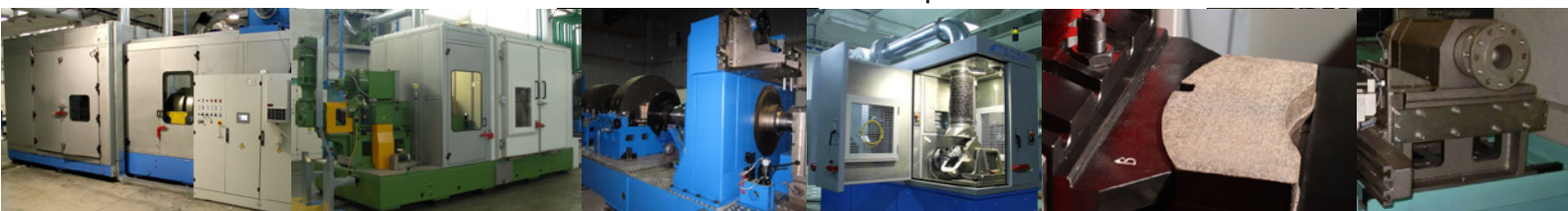
**Dynamometers for light commercial vehicles (LCV)**

**Dynamometers for truck and railway sector (high speed trains included)**

**FQT (Friction Quality Test) for quality control, conformity of production and aftermarket development**

**SST (Shear Strength Test) to measure shear strength of pads and the detachment of friction material from the**

**Alternate torque**



#### Research & Innovation

The capabilities of our machines include: implementation of profiles (from telemetry - LAP racing) and WLTP; KERS applications; Dust survey and analysis; NVH; EPB system (electric park brake); Sprinkling on brake: water, salt water, snow; Regenerative brakes (electric and hybrid vehicles).

#### Brake System Mountings

Four different typologies of mountings: Simple mounting, with Wheel Hub, with Corner and with Axle.

#### Options available

Climatic System: -40° C/+50° C; Hand Brake (Parking Brake): max. 5000N; Sprinkling System: Water, Salted Water, Snow; Static Friction: max. 6000 Nm, 20 rpm; NVH (Noise Vibration Harshness); EPB (Electric Parking Brake); Electric Wheels; WLTP (Worldwide Harmonized Light Vehicles); DTV (Disc Thickness Variation): 2-6 channels; Absorption Tests.

In addition to the contractual warranty, TecSA and its assistance centers offer programmed and preventive assistance, regular and extraordinary maintenances and spare parts services for all our machineries, wherever in the world.

## » Safe validation of brake dust emissions on the LINK flywheel simulation test station

The European Commission is planning to present a legislative proposal for the Euro 7 emission standard in 2022 and to decide on its introduction from 2025. The primary goal of the standard is to further reduce fine dust emissions from motor vehicles. Since the engines of motor vehicles are becoming ever cleaner, and fine dust emissions are further reduced – especially through the use of electric engines – the proportion of wear from tires and brakes in the overall vehicle emissions is increasing in relative terms.

Until now, vehicle braking systems have been developed and approved for to their durability, efficiency, noise generation and wear behaviour. Due to the new requirements, braking systems will in future also have to meet emission load requirements to be validated. We perform the validation with an internationally harmonised test cycle on LINK flywheel mass simulation test benches, which are equipped with special housings and also with the LINK M6330 particle measurement technology for a reliable assessment of particle number (PN) and particle mass (PM). In addition to the particle number and mass, we can also assess particle size distribution. These additionally recorded parameters (PN, PM, size distribution) of the friction materials pairing in the braking system allow us to draw early conclusions on any changes that may be necessary.

The test cycle is based on the exhaust gas validation cycle (WLTP) and includes 303 brake actions that correspond to the driving profile of an average driver. With this test cycle, braking systems can be evaluated and compared in terms of emission tendency, particle mass PM2.5 and PM10 in mg/km as well as particle number (PN).

Due to the advancing electrification of the drive trains and the possibility of recovering the braking energy (recuperation), the measuring and testing technology also needs to be updated. With regenerative braking, the vehicle is not or not only decelerated by the friction torque of the vehicle brakes, but by a regenerative braking torque of the electric motor. The electric motor, which now works as a generator, converts the vehicle's kinetic energy into electrical energy, which is stored in the vehicle battery.

The ProLINK© control of the test benches allows different recuperation characteristics to be taken into account during the brake action. Those characteristics vary depending on the charge condition of the battery or on how and how much the vehicle has been used. If the characteristics are not available, control units (ECU) and software algorithms as hardware-in-the-loop (HIL) and software-in-the-loop (SIL) may be incorporated.

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About LINK ENGINEERING:  
As part of the Link Group, alongside Link Engineering Company, Link Industries manufactures customised, high-precision cutting tools, while Tesco develops and markets complex environmental simulation systems.

Test smarter Link Engineering Company GmbH



Recuperation contributes both to energy recovery and to a reduction in brake dust emissions. Brake dust emissions are additionally reduced by brake dust collection or isolation systems. It is therefore of the utmost importance to consider all parameters on the test bench.

Brake dust emission tests on the test bench should ideally be carried out after the residual grinding torque has been validated with the LINK M5002 system, because unwanted power loss due to residual grinding torque in unconfirmed braking status inevitably leads to an increase in brake dust emissions.

The forthcoming EURO 7 legislation will compel vehicle braking systems to make a sustainable contribution to meeting air pollution control targets and reducing the pollution of our environment.

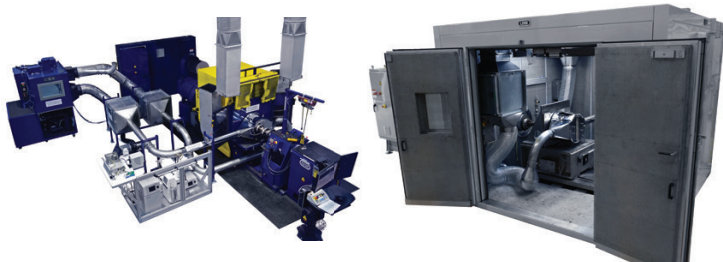
In addition to comprehensive testing in the lab and in the vehicle, the development, manufacture and maintenance of complex, high-precision assessment, research, simulation and quality control test benches are key. We guarantee a safe and reliable service – from our corporate headquarters in Plymouth, Michigan (USA), to our test centres and sales and support teams in Europe, Asia and North and South America.

Link Engineering Company is among the leading manufacturers and developers of customer-specific testing solutions (test equipment and software) for research, development, quality control, and equipment for environmental simulations. Simultaneously, LINK offers worldwide customer support, testing, and examination services for the testing of vehicle components and the conduction of driving trials.



### BRAKE EMISSION TESTS

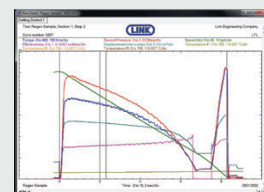
The LINK Brake Emissions Test System Model 6330 was developed on the basis of the current international requirements. This system meets all requirements of ISO 9096, EPA Method 1A, and 40 CFR 1065, as well as the current recommendations of the Particle Management Program (PMP) of the EU Commission.



### TESTS OF REGENERATIVE BRAKE SYSTEMS

Through the development of RegenSim, LINK is in a position to simulate regenerative brake actions on inertia dynamometers.

With RegenSim, the LINK control system, ProLINK, can function as an electronic control unit (ECU) of a vehicle and divide the braking work between the friction brake and the regenerative



### FRICTION MATERIAL TESTS (RWS100B)

The Friction Material Test (Krauss) Machine Model 1000 was developed and built for quality control of friction materials. This test station has set the standard in the friction layer industry for many years.



# » BREMSKERL, responsible for your safety!

As an experienced family business, we have been dealing with brake and friction linings since 1929. We aim to follow an organic process when manufacturing brake linings. Our cutting-edge braking systems are used in the renewable energies sector, e.g. in wind power technology. In yaw brakes and yaw drives, our linings ensure the safe alignment of the nacelle of wind turbines – silent and low-maintenance.

## Asbestos-free for over 30 years.

We are aware of our responsibility to people and the environment. Which is why we maintain the highest safety standard and top product quality in the areas of industrial, rail and commercial vehicles.

## Innovation for the environment with: Safety. Longevity. Reliability.

In recent years, we have also focussed on further developing our products made of sintered material – these are used by our customers for high-energy applications.

“Sintered linings” extend the operational lifespan, reduce downtime and minimise the risk of fire in high-speed scenarios and provide solid predictability in the area of life cycle costs.

## OUR QUALITY: for your assurance.

Permanent monitoring, testing and further development ensures that we always maintain the same high quality and safety standards. We take pride in our many test options as well as our test area with full lining test benches for rail and commercial vehicles and a test bench for industrial applications.



## Applied Innovation

IAG Special purpose machinery  
and automation technology

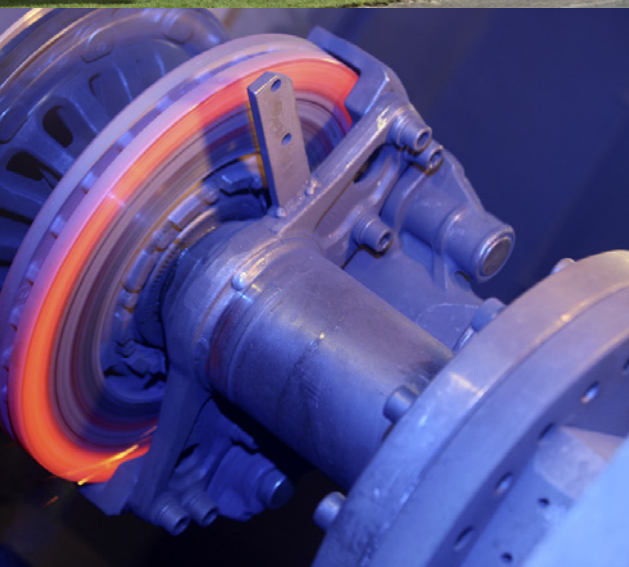
- Special purpose machinery
- Press technology
- Weighing and dosing technology
- Industrial oven technology
- Service & After-Sales



IAG Industrie  
Automatisierungsgesellschaft m.b.H  
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# » Becorit

## Fine dust

At every time in human history, dust pollution from traffic flows has been an issue. One solution for this was the paving of the roads, which not only prevented sinking into the mud, but also led to a reduction in dust pollution in dry conditions. Although this approach led to an increase in traffic noise, especially in narrow ancient cities, it has prevailed in the long term.

In addition to paving or later asphaltting the roads, the advantage of lower dust pollution for passengers was also seen in the 19th century with the introduction of the railway. For this, the non-traveling residents had to endure the burden of the emissions of steam locomotives.

However, even for travelers, a tunnel passage could lead to a large particle load. At the latest with the introduction of subways, the issue of air quality in such more or less closed systems arose. Thus, already at the beginning of the 20th century, scientific papers can be found that deal with the hygienic problems, but also with the air quality in tunnel systems.

The electrification of the railways seemed to solve this problem. However, at the latest since the beginning of the 20th century, detailed studies on particulate matter pollution in metro systems have been carried out again. Current studies are no longer only concerned with the mass concentrations or particle numbers, but also with the type of particles found.

However, medical research on this is still in its infancy. So it remains exciting for the developers of friction materials which measuring methods and limit values will ultimately prevail. However, one thing is clear. Even if the proportion of emitted particles with a high proportion of electrodynamic brakes continues to decrease, the industry is still willing to invest in research and development in order to make a contribution to the health of all.

## History of EN 15328:2020

With the publication of EN 15328:2020, considerable questions have arisen with regard to the eligibility of brake pads for approval in upcoming and future vehicle registrations.

The background here is the clear differentiation of the applications, which are defined by the energy classes.





## Example of some energy classes

Class	Max. Energy [MJ]	Speed [km/h]	Braked mass [t]	Application
A1	6.3	120	11.25	Freight wagon
B1	7.9	160	8	XMU
B2	9.9	160	10	XMU
C0	10.3	200	6.7	Passenger coaches
C1	12.3	200	8	XMU
C2	15.4	200	10	XMU
C3	18.5	200	12	Locomotive

In the past, the UIC approval of brake pads, in the category for passenger coaches (C0), was also used for use in other applications such as XMU's or locomotives. This is no longer possible in EN 15328, here the specifications and tolerances of the respective class must be met, or can be proven with vehicle-specific data according to the test program acc. EN 15328 Appendix E.

## Implementation of EN 15328

In 2010, the UIC working group B126.3 determined that significant changes were required in the then UIC 541-3. As a result, the work of the new UIC Working Group B 126/541-3 began in March 2011. The working group consisted of train manufacturers, system providers, friction lining manufacturers and members of the UIC working group B126.3.

In the implementation of the creation of UIC 541-3 (8th edition), the new designs of braking systems, especially for high-speed trains, XMU and locomotives, were taken into account. The completed UIC 541-3 (8th edition) was published in June 2016, the detailed information on the preparation and references can be found in UIC B 126/RP 49.

In 2017, the CEN/TC 256 working group started the preparation of EN 15328. As a basis, the published UIC 541-3 (8th edition) was transferred by the working group to EN 15328. After the corresponding publication of the pre EN 15328 and the associated checks and objections, EN 15328 was published in 2020, as EN 15328:2020.

In Q1-2021, EN 15328:2020 was returned to working group CEN/TC 256/SC3 after various comments on requirements that could not be fulfilled in part. Work has begun and various proposed amendments will be reviewed and voted on in 2022. A possible publication, the revised EN 15328, could possibly take place in 2023 from our point of view.

Ultimately, the current EN 15328 is not a hasty or quickly created specification, but was created over 10 years with the help of many experts from the railways and manufacturers.

We are convinced that the revised version of EN 15328 will meet the requirements as a guideline for the future-oriented use of brake pads in modern rail vehicles.





## THE BLUE LINE

Pollution from atmospheric copper is a real issue – and brake wear is a major contributor. We have known for years that brake wear from vehicles is a significant source of atmospheric copper in Europe, contributing to the deposition fluxes of copper on surface waters such as rivers and lakes.

Recent studies estimate that copper emissions due to brake wear total several kilotons every year. Indeed, in Western Europe, brake wear emissions account for the majority of total copper emissions, and they are thought to be responsible for up to 75% of the atmospheric copper in the North Sea.

Preserving the quality of the air we breathe and the water we drink is a global challenge. Our industry can play its part through the development of new friction materials that dramatically improve the situation. Leveraging momentum generated by the requirement for new railway brake pad materials to fulfil the upcoming changes in UIC 541-3 8th edition and EN standard 15328 Wabtec is proud to introduce a new product family that meets this aim. A unique performance in dry and wet supports an easy setup of the brake system. The excellent wear behaviour optimizes the life cycle cost and is contributing to the low particle emission during brake activation.

Blue Friction technology products have been developed without using substances that are potentially harmful for aquatic life. Zinc- and copper-free materials are now available to comply with the new standard's requirements.





**Wabtec**  
CORPORATION

# DRIVING A MORE SUSTAINABLE FUTURE

## THE GREEN LINE

When it comes to developing new friction materials, the challenge lies in finding innovative options that generate low particle emissions without compromising performance, durability and safety. Wabtec's Green Friction solution fulfills all these criteria.

Green Friction technology is the product of both Wabtec's expertise in friction materials and the company's massive investment in the methodology for measuring braking particle emissions. Our cutting-edge solution is expected to reduce particle emissions from friction braking on metro trains by up to 90%.

To go a step further and shrink the carbon footprint of such solutions, they need to be recyclable. This helps lower associated transport emissions and avoids scrapping valuable materials. At Wabtec, we offer recyclable brake pad systems, such as the Becorit Modular Brake System BMBS. Pad recycling can be performed by Wabtec, and we also support our customers with tools and training to enable them to take on the task in house.

**Accelerating the future  
of transportation**

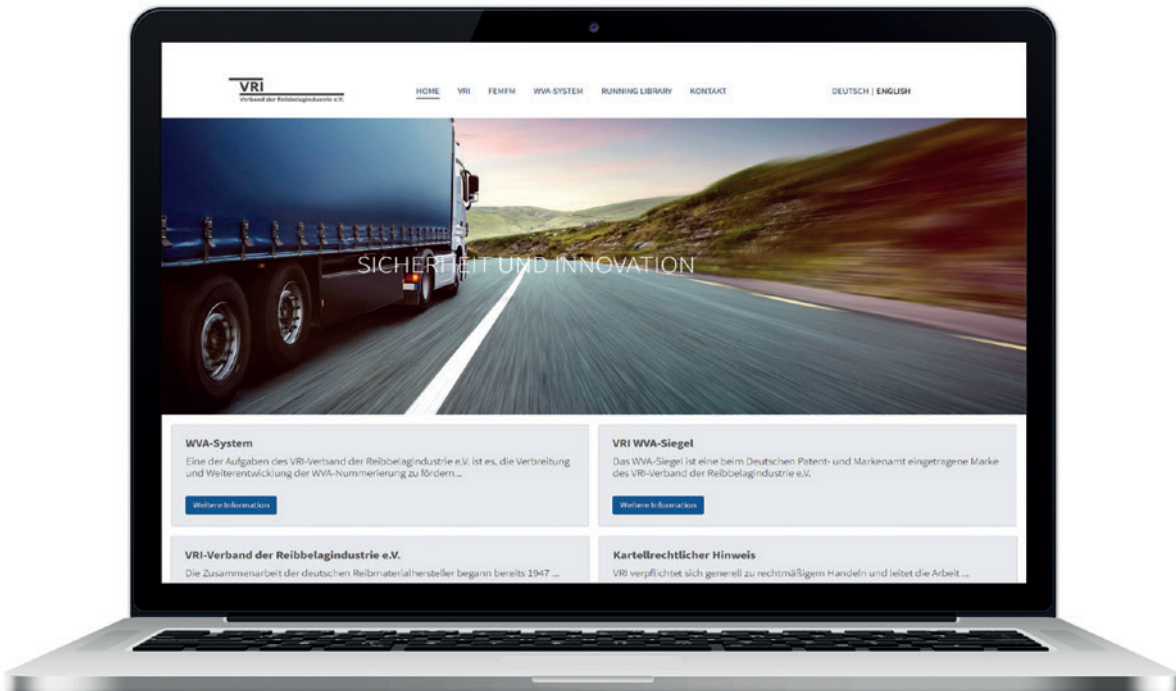


# » Antitrust law

The VRI/FEMFM generally undertake to act lawfully and to scrupulously comply with German and European competition law. In the interest of the VRI/FEMFM and their member companies, their committees are obliged to avoid any possible violation of competition law in all activities of the respective association.

In particular, agreements and coordinated behaviour that aim to prevent or restrict competition are prohibited. Competition law prohibits agreements that include, among other things, price fixing, agreeing on terms and conditions and the disclosure of sensitive company or market data. It also prohibits coordinated efforts by companies that can lead to similar outcomes. Before every meeting, a fixed agenda shall be drawn up and documented. These rules are binding for everyone involved in the work of the associations and serve to protect the VRI/FEMFM and their member companies.





(Complete Version is published on both VRI and FEMFM websites)

## Best Anniversary Wishes from TecAlliance!



TecAlliance is FEMFM's authorized agent in Asia Pacific for Brake Pad and Brake Disc Fitting Instructions for Passenger Vehicle, Light Commercial Vehicle and Heavy Commercial Vehicle.

Having a Fitting Instruction in each package of brake lining products and brake discs & drum is legally required by ECE R90:

- Clause 6.1.4.: Each package shall contain fitting instructions in an official ECE language, supplemented by the corresponding text in the language of the country where it is sold.
- Clause 6.2.1.4.: Each package shall contain fitting instructions in the language of the country where it is sold.

The FEMFM Fitting Instruction contains multiple languages, which can meet the demands of different markets.



### The FEMFM Fitting Instruction is applicable to

All the manufacturers or traders of brake discs/ brake drums/ disc brake pads who:

- have export business to European countries and/ or
- wish to provide the Fitting Instruction in the above-mentioned products for Asia Pacific markets.

### Applicable Fitting Instruction Types

For Europe:

- Supports 25 European languages
- For the installation and removal of brake discs/ brake drums/ disc brake pads for Passenger Vehicle and Light Commercial Vehicle, and that of disc brake pads for Heavy Commercial Vehicle

For Asia Pacific:

- Supports 9 Asia Pacific languages
- For the installation and removal of disc brake pads for Passenger Vehicle and Light Commercial Vehicle

For China:

- Supports one language: Chinese
- For the installation and removal of disc brake pads for Passenger Vehicle and Light Commercial Vehicle

### About TecAlliance

TecAlliance, established back in 1994, was formerly known as TecDoc. At present, TecAlliance Asia Pacific has already set up subsidiaries in Chinese Mainland, Taiwan, the Republic of Korea, Malaysia, Thailand, and Vietnam, providing data, services and comprehensive solutions to the local markets.

We are committed to providing standardized data and data standardization services for the automotive aftermarket. The TecDoc data standard now became the recognized data standard in the global automotive parts industry, representing the authoritative data quality certification.



# » Certified to ECE R90 – for more safety on road traffic

VRI and FEMFM are proud to support a European initiative for better safety regarding road traffic: ECE R90 certified replacement brake linings, which are the only authorized brake linings in the EU for road traffic.

R90 Regulation (ECE R90) applies to the basic braking functions, like design, construction and performance requirements of replacement disc brake and drum brake lining assemblies. ECE R90 states that replacement brake linings comply with European braking requirements for dynamic braking performance, fade and hot/cold performance.

According to EU GSR (General Safety Regulation), replacement brake lining assemblies offered for sale in EU must comply with ECE R90. The sale of replacement brake lining assemblies without ECE R90 approval and the information to use it only outside EU is not legal. Braking performance of replacement brake linings has to stay within a tolerance band of 15% to the original equipment brake lining. Not ECE R90 certified replacement brake linings might not reach such performance levels and therefore can compromise road safety heavily.

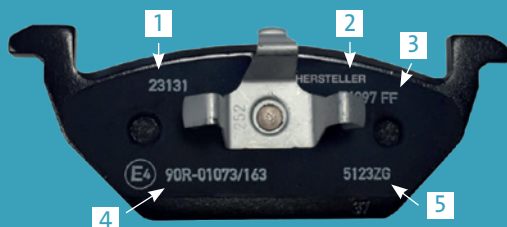
The minimum requirements on physical or mechanical properties are standardized and part of the type approval procedure.

## How it works

All types of brake linings for automotive vehicles are safety relevant parts. The performance characteristics of a brake lining, the production conformity and the labeling and packaging of spare parts are the main requirements of the ECE R90.

### — BRAKE LINING —

1. Make and type of replacement brake lining assemblies
2. Manufacturers name or trademark
3. Readable lining type
4. Type approval or certification number
5. Date of manufacturing or batch number



### — PACKAGING —

1. Seal
2. Type of approval or certification number E1 90R – 01234/056
3. FEMFM multi language fitting instruction inside







## » The recommendations by the VRI/FEMFM

As an additional service provided by our associations, recommendations shall be made by experts from the member companies collaborating in special committees. These are to promote the dialogue with customers, suppliers and public authorities. Of course, the VRI/FEMFM recommendations cannot replace the individual responsibility of the member companies when it comes to contract negotiations, judicial or extrajudicial disputes with public authorities or delivering statements.



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A Member of MAT Holdings, Inc.

[WWW.MATHOLDINGS.INC](http://WWW.MATHOLDINGS.INC)

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Manufacturers of  
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VRI-Verband der  
Reibbelagindustrie e. V.

Robert-Perthel-Str. 49  
50739 Köln  
Germany

Phone: +49 221 93 88 08-0

Fax: +49 221 93 88 08-29

Mail: [office@vri.de](mailto:office@vri.de)

**[www.vri.de](http://www.vri.de)**