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ADDITIVE MANUFACTURING

Useful opportunities for the rail vehicle industry

FROM SPARE PARTS SUPPLIER TO BUSINESS PARTNER

The steadily growing RailServices portfolio

MAKING TRAVEL ACCESSIBLE

The new entrance system for intercity
and high-speed applications

EDITION
59

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Rail Vehicle Systems



KNORR-BREMSE

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Member of the Management Board,
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Schienenfahrzeuge GmbH

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On August 9, 2019, unnoticed by the general public, a workshop owned by rail operator Hamburger Hochbahn installed two new suspension brackets in a DT4 vehicle (car 130, axle three). Shortly afterward, the vehicle went back into regular operation. But unlike the general public, experts were following the new installation with great interest: The two suspension brackets were among the very first components produced by an industrial 3D printing process to be used in a safety-critical application aboard a rail vehicle in Germany. They were developed, produced, approved and installed by Approval in Rail – a working group in the Mobility goes Additive e.V. network with a multidisciplinary profile. Members include Deutsche Bahn, two Fraunhofer Institutes, Hamburger Hochbahn, Photon, SBB, Siemens, TÜV SÜD and Knorr-Bremse.

What I aim to show by citing this example is that our industry has more experience of 3D printing, acquired over a longer period, than many people realize. In this issue’s Spotlight feature, we discuss the current status of Knorr-Bremse’s “design for function” approach. In the interview, my colleagues Bernhard Winkler and Attila Kovács explain how they are using industrial 3D printing to turn conventional manufacturing logic on its head. Their efforts are giving our development teams much greater freedom when designing new components or optimizing existing ones.

Our teams have been quick to take advantage of this new freedom, developing new, slimline pneumatic control modules for a multiple-unit application commissioned by state-owned French rail operator SNCF. In terms of performance and durability, the new modules are a 1:1 match with previous panels – but in terms of design, they have been customized for SNCF’s AGC



HARALD SCHNEIDER,
Member of the Management Board, Knorr-Bremse
Systeme für Schienenfahrzeuge GmbH

vehicles and are consequently 25 percent lighter. Several of the new panels will be starting field trials in the near future.

Customization is also an apt keyword for our second Spotlight feature, which focuses on our specialist aftermarket unit, RailServices. In anticipation of the impending mobility transition, rail operators are seeking exceptionally high levels of availability and predictability. Our RailServices portfolio provides them with all they need to achieve such levels – and our technical solutions, customized premium offerings and optimized processes are helping them to make their fleets even more profitable, speedy and efficient.

Now read on to find out more!

Warm regards,
Harald Schneider

Innovative technologies and systems competence from a single source

Knorr-Bremse Rail Vehicle Systems offers an impressive variety of customized solutions for braking and onboard systems.



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MONTAGE OF THE DAC in Skellefteå, Sweden | © Rail Sweden at Lindholmen Science Park

Data and automation

All major railroad standards have already made the transition to modern freight car couplers – and yet Europe still uses manual coupling. But now, testing of the new Digital Automatic Coupler (DAC) is picking up speed. A brief summary of progress to date.

At the end of 2023, Knorr-Bremse's DAC achieved a major milestone. After countless tests and coupling operations, performed in close collaboration with DAC4EU at speeds of up to 12 km/h on a TÜV SÜD test track in Görlitz in the German federal state of Saxony, Deutsche Bahn finally awarded the DAC a safety certificate – representing official approval. Since then, Knorr-Bremse has been allowed to use the DAC in demo trains running on Germany's public rail network. This approval will also serve as the basis for future approvals in other European member states.

Testing of the DAC's primary function kicked off in the summer of 2023 aboard Deutsche Bahn's TrainLab in Berlin, under the aegis of the EU research and technology program EU Rail FP5-TRANS4M-R. For the first time, a Knorr-Bremse DAC equipped with an automatic decoupling function (DAC Type 5) was actually decoupled. In this instance, the DAC was controlled by push buttons on the side of the railcar, but in the future, it will also support remote decoupling. This feature will significantly speed up freight train coupling and shunting processes, and – when combined with the Knorr-Bremse automation system – will also support a broad range of smart process automation functions, including telematics.

The DAC4EU project ran throughout 2023, funded by Germany's Federal Ministry of Transport and Digital Infrastructure – a key Knorr-Bremse partner. In particular, the two organizations worked closely together on the approval tests at TÜV SÜD and the testing of the DAC's electric contact coupler. In early 2024, Knorr-Bremse's railcars were included in the DAC4EU train and will be taking part in the upcoming field trials.

Headed up by Swiss Federal Railways (SBB), field trials of Knorr-Bremse's electric coupling system (e-coupler) were launched in Switzerland in August 2023 as part of the EU Rail FP5-TRANS4M-R project; they were brought to a successful conclusion in early 2024. The results have reaffirmed Knorr-Bremse's choice of design, which sets new benchmarks for durability and safety in particular. The "DAC+" digital freight train pilot was used to test multiple functions, including the onboard communication system, as well as future digital applications such as automatic brake testing, railcar sequencing and electric decoupling.

A large station in Sweden in early 2024: A train operated by CFL Cargo and fitted with Knorr-Bremse's DAC started field trials under the supervision of Trafikverket, a Swedish partner in the EU Rail FP5 TRANS4M-R project. The aim is to gather several hundred thousand kilometers of operating experience by 2025. Northern Europe's harsh winter conditions are regarded as the ideal stress test for the complex but highly robust DAC system.

Knorr-Bremse at InnoTrans 2024

On September 24, InnoTrans 2024 will open its doors again! During the four-day event, Berlin's exhibition center will be transformed into a top venue for the global rail industry – with Knorr-Bremse and its Group brands at the center of things.

We look forward to many friendly conversations!

Visit us in Hall 1.2, Booth 250.*



*** Visit the booths of our group brands Selectron (Hall 27, Booth 410) and Zelisko (Hall 25, Booth 120).**

Knorr-Bremse is selling Kiepe Electric

KNORR-BREMSE is optimizing its portfolio with the sale of Kiepe Electric and is continuing to consistently align its business with its core competencies and performance. | © Knorr-Bremse



With its focus on electrical vehicle equipment, Kiepe Electric has shown itself to be an efficient, dynamic business unit. But overall, it has proved difficult to achieve more than limited synergies between Kiepe Electric and the Rail Vehicle Systems division, hence Knorr-Bremse's decision to sell the company. The sale of the entirety of Kiepe Electric's business activities to Berlin-based Heramba GmbH was successfully finalized at the end of January.

For Knorr-Bremse, the transaction represents an important step forward under the company's BOOST program. Knorr-Bremse as a whole is aiming to achieve sustainable, profitable growth over the next few years by engaging in a series of strategic actions and initiatives. Knorr-Bremse will retain a 15-percent equity stake in Kiepe Electric. But with Heramba as the company's new owner, Kiepe Electric will now be able to concentrate on its own strengths and core business.

Focus on fleet availability and optimization

Left to right: Markus Schumann (KB), Andreas Schiessl (KB), Michael Bross (VBK), Sven Rehder (VBK), Sabine Auer (KB) and Claudio Giorgi (KB)



As the city of Karlsruhe's public mass transit organization, Verkehrsbetriebe Karlsruhe GmbH (VBK) operates the LRV and bus network in the German metropolis – and in the future, will be highly reliant on Knorr-Bremse's service specialists to keep its City-Link low-floor streetcars (NET2012) up and running.

RailServices will be responsible for servicing the vehicles' hydraulic braking equipment and air supply systems for the duration of their service lives. Similarly, RailServices will supply the spare parts required for preventive maintenance. This will guarantee reliable, end-to-end support and planning from a single source over the long term, including fast, efficient maintenance and servicing workflows.

As part of the joint project, the two organizations will also cooperate on a condition-based maintenance (CBM) system. By analyzing operating data, RailServices can help VBK to extend the intervals between overhauls, which will also support the further development of the LRV fleet from an economic and commercial perspective.

Coupling system for new regional train platform



IN-HOUSE testing infrastructure for coupling systems at Knorr-Bremse's Budapest facility

Having successfully won its first orders for metro coupling systems, Knorr-Bremse recently received more good news from the mainline segment: The company will be supplying automatic center-buffer coupling systems for a new regional train platform, currently poised for its official launch by a major European manufacturer.

The order covers the supply of automatic center-buffer couplers with Type 10 mechanical heads. It also includes Knorr-Bremse's electric contact coupler (e-coupler) design, developed and manufactured

entirely in-house. Knorr-Bremse markets the automatic center-buffer coupler under the brand name AutoLink. Development, in-house testing and production all take place at Knorr-Bremse's Budapest facility, which is capable of manufacturing over 1,000 couplers per year.

Prior to delivery, the coupling systems are put through the proverbial grueling, in-depth tests on Knorr-Bremse's own testing infrastructure. The company also has suitable rigs for carrying out most of the type tests required for product validation. By concentrating development, testing and production on the same site, Knorr-Bremse is able to significantly reduce time to market thanks to greater flexibility, shorter distances and direct lines of communication.

Knorr-Bremse Rail Systems UK and VTG Rail UK win Rail Business Award

This year's "Innovation of the Year" award, one of the categories in the UK's Rail Business Awards, has gone to Knorr-Bremse Rail Systems UK and VTG Rail UK for a jointly developed system that prevents wheel flats and digitally monitors freight cars. Installed on VTG railcars operated by Tarmac, Hanson and Mendip Rail, the system has been undergoing trials on various routes in Scotland and England since last October.

The innovative development combines mechatronics, state-of-the-art sensor technology and data analytics with a fully integrated automation concept. The intention is to further improve the safety, performance and reliability of freight cars: The integrated Wheel Flat Prevention (WFP) function helps to prevent costly repairs to wheelsets and extend their service lives. The Brake Condition Monitoring (BCM) function keeps an eye on other braking system parameters, opening up new opportunities for predictive maintenance. More generally, the real-time monitoring of axle rotation further improves safety levels. Axle-mounted generators produce the electric current required to power

the Wheel Flat Prevention and Axle Lock Detection functions, and for parking brake, temperature and impact monitoring functions. They will also power possible future applications, such as the monitoring of harmonics and vibration frequencies. All operating data captured by the sensors is packaged and uploaded to the cloud for subsequent analysis and visualization in the form of heat maps.

REPRESENTATIVES OF VTG Rail UK and Knorr-Bremse Rail Systems UK accept the Innovation of the Year Award.



Knorr-Bremse joins Alstom Alliance



FORMAL SIGNING
of the Alliance Charter by Knorr-Bremse and Alstom

Alstom's motto for the company's Global Supplier Day 2023 was "Drive Performance Together", perfectly encapsulating the aim of the event in Casablanca, Morocco. Working with selected suppliers, Europe's largest rail technology manufacturer used this opportunity to enhance the supplier network's understanding of market needs and demand, as well as innovative approaches to relevant solutions.

Knorr-Bremse was represented at the event by Mario Beinert (Member of the Management Board of Knorr-Bremse Systeme für Schienenfahrzeuge GmbH), Frank Uder (Vice President RailServices) and Jean-Marc André (Lead Key Account Manager Alstom). They were also in Casablanca to finalize arrangements for Knorr-Bremse's formal signing of the Alstom Alliance Charter.

Alstom launched the Alliance with the aim of developing long-term, win-win partnerships with selected suppliers. Jean-Marc André is delighted: "We're proud that from now on, we'll be working closely with Alstom on the entire vehicle life cycle as a strategic, trusted supplier within the Alstom Alliance," adding that "this underscores our commitment to long-term, transparent collaboration based on mutual benefit."

Welcoming VDB's Managing Director

Sarah Stark, Managing Director of the Verband der Bahnindustrie in Deutschland (VDB) e.V. (German Rail Industry Association), and Dr. Peter Radina, Member of the Rail division's Management Board, were in perfect agreement: Modern rail logistics requires an efficient infrastructure supported by smart vehicles, operational processes harmonized at European level, and improved transportation policies.

During Ms. Stark's visit to the Knorr-Bremse Forum in Munich, Dr. Radina introduced her to the company's impressive capacity for innovation. "Our aim should be to put an intelligent, flexible freight train on the rails so we can handle rail freight more effectively and efficiently," explained the senior manager. In his view, "the solution lies in a three-pronged, technology-based approach that includes digitized freight cars, digital automatic couplers and other automation options such as automatic brake testing and remote decoupling." The technologies are ready, he continued, but to implement them, there is an urgent need for more investment and planning certainty.

VDB Managing Director Stark shared his views and underscored the importance of political tailwinds: "The shift to rail would stimulate economic growth and protect the climate. But to achieve the necessary capacity and make it more attractive, lawmakers must support appropriate innovation by putting in place research and funding programs, resilient investment strategies, and systematic migration policies."

DR. PETER RADINA, Member of the Management Board of Knorr-Bremse Rail Vehicle Systems, welcomes Sarah Stark, Managing Director of the German Railway Industry Association (VDB), to Knorr-Bremse's Munich head office.



Groundbreaking, as well as cutting-edge

Knorr-Bremse has just inaugurated a new training center in Suzhou. Customers benefit from direct product demonstrations and simulations.

As one of the Rail division's main development facilities, the Suzhou site plays a key role in the Asia-Pacific region's innovation-focused activities. In the future, this will also apply to training: Knorr-Bremse launched the facility's new Training Lab in January.

"Our customers benefit across the board," explains Managing Director Frank Qian. "Previously, they usually had to go to Europe for multi-day training courses. Now we offer comprehensive, local training using real products and systems." Even better, Chinese participants can ask questions in their own language, which improves communication and understanding. The training portfolio also includes distance learning, as Qian explains: "We're able to transfer knowledge directly from Suzhou to our customers so that train drivers, for example, can familiarize themselves with new braking system features."

Local hub for new products, in-house expertise and services

The plan is to gradually expand the training concept to include tailored learning sessions and training courses. Typically, the new models will enable the center to cover

the benefits of, for example, predictive and condition-based maintenance. This ongoing development will be accompanied by pilot projects organized jointly with customers. Ultimately, the Training Lab hopes to present Knorr-Bremse's entire product portfolio – hardware, software and services. "Looking ahead, we're aiming to transform our Training Lab into a hub for presenting new products, expertise, services and 'direct experiences' of our various offerings in the region," says Qian.

According to Qian, a groundbreaking training center is nothing without digitalization. "We need to be able to educate employees throughout our customers' organizations about the benefits of digital services and their applications. That's why we're working with the software department to find practical ways of making this digital technology visible."



DR. NICOLAS LANGE, Member of the Executive Board with worldwide responsibility for the Rail Vehicle Systems division, tests the possibilities of a simulator for train drivers himself.

The Suzhou Training Lab at a glance

- **Inauguration: October 2023**
- **Surface area: 200 m²**
- **Offers: technology demonstrations, test opportunities and training services**
- **Exhibits: braking, entrance and climate control systems, as well as signaling technology**



“In situations like this, 3D printing comes to the rescue”



An interview with Bernhard Winkler and Attila Kovács

Together, they're driving forward the adoption of industrial 3D printing by the rail vehicle industry. As VP Production Rail, Bernhard Winkler in Munich is responsible for, among other things, Knorr-Bremse Digital Manufacturing, while Attila Kovács, Director Mechanical Design Engineering, masterminded the development of the first components produced by additive manufacturing at the company's Budapest site.

Mr. Winkler, when we first talked about the potential of additive manufacturing in the rail industry, some four years ago, you brought a 3D-printed spare part to our meeting ...

Winkler: ... I did, didn't I? We were very proud of it at the time – our first additively manufactured component to have actually been installed in a rail vehicle.

Tell us about it!

Winkler: Well, a major European operator was missing a very special spare part for an elderly, much-used vehicle that was actually still in good working order. The previous component had already been discontinued; there weren't even any tools or jigs available for machining the blanks. So we used 3D printing to give the 40-year-old vehicle another few years of life on the rails. No question about it – a classic niche application. But our solution certainly got the job done!

Is it really as simple as that?

Kovács: Sadly, no! Just making it through to the prototype stage is very complex process, full of crucial questions: What's the best design for delivering the required functionality? Which printing process is the best match for this specific application? And what about material composition? Finally, monitoring the actual printing process and its many parameters – such as temperature, printing speed, thickness of the layers and so on – is vital if you want to produce consistent, reliable components. And then, once you've finished printing, you need special test procedures to validate the mechanical properties, durability and performance of the printed product. Before we could finally install the spare part in that particular project, we put ourselves through an enormous, multidisciplinary learning process. So now we have a very good understanding of the technology, as well as the processes behind it.

But just manufacturing spare parts isn't a great business case – or is it?

Winkler: Oh, I wouldn't go so far as to generalize! If you want to produce small quantities of special components economically, your only realistic option is to use additive instead of conventional manufacturing techniques. While I'm sure additive manufacturing won't replace existing processes, it can certainly bridge gaps in design scenarios that push traditional casting or milling processes to their limits.

Such as?

Winkler: For example, when you need to manufacture components with complex configurations that may have been optimized using bionics. Sometimes it's apparently minor details that push conventional manufacturing to its limits – an air duct, for example, which needs to be shaped in a particular way for a specific application and can't be created by drilling. That's the sort of situation where 3D printing comes to the rescue.

Kovács: Let's be honest – we're unlikely to be able to additively manufacture a complete brake disc in the foreseeable future, simply because brake discs have to cope with extreme stresses. Even so, by using this process, we're turning classical manufacturing logic on its head. Instead of milling a workpiece out of a single block of metal, we use a laser to fuse together ("sinter") a special metal powder, creating the required shape layer by layer. We call it our "design for function" approach, and it gives our development teams much greater freedom when they're designing new rail vehicle components or optimizing existing components. Increasingly, the rail industry in particular wants complex, robust components that are also small and lightweight.

Kovács: Depending on the specific component, it's not unrealistic to expect additive manufacturing to reduce its weight by anything up to 80 or 90 percent. Plus the other benefit: The component will be significantly smaller. We're helping vehicle manufacturers to install increasingly advanced components in ever smaller spaces.

You've already supplied 3D-printed spare parts.

So what's the next step?

Kovács: Our colleagues in Budapest and Reims have just delivered the first pneumatic control module for a project in France. Again, it's a retrofitting project, but it has enormous potential for our OEM business. One thing is certain: We're now at the stage of moving on from purely niche applications.



More function, less bulk: downsizing control panels

Industrial 3D printing is opening up interesting new possibilities for the rail vehicle industry. Knorr-Bremse will install its first additively manufactured auxiliary panels in vehicles for France's SNCF.



ONCE THE PRINTING PROCESS is complete, the product is removed and cleaned.

Control modules have always been sturdy – mounted as they usually are on aluminum machined panels, they include various pneumatic and electropneumatic components, interconnected via numerous holes and air ducts. A manifold supplies each module with compressed air. “From a purely functional viewpoint, there’s quite a lot of superfluous weight and bulk in today’s rail vehicles,” explains Clément Coquerel, an industrial 3D printing specialist working at Knorr-Bremse France.

The same performance and strength as conventional panels – but 25 percent lighter and smaller

The control module that will be installed in an Autorail à Grande Capacité (AGC for short), a rail vehicle used by state-owned railroad operator SNCF, looks very different – it is substantially more compact, with an aspect more reminiscent of a lightweight cast part. Many of the ducts now run directly between the components rather than being drilled on several levels, as they were before.

“In terms of performance and strength, it’s a 1:1 match for the previous component,” asserts Coquerel. “But thanks to additive manufacturing, we’ve been able to slim it down so it’s purely functional and 25 percent lighter than conventional control panels.” The panels will be mounted with standard series equipment before being subjected to the full range of functional test sequences and approval tests on the train.

Attractive scenarios include low-floor and high-speed applications

SNCF operates around 700 AGC vehicles across the French Republic in various configurations, including diesel, electric and dual-power versions. “The first of them went into service back in 2004. Now they’re being given a midlife overhaul, so it’s exactly the right time to install new components,” explains the engineer. Two

control panels are installed on each train. In three trains, one of the two panels will be replaced by the new, 3D printed variant. The trial is scheduled to run for two years minimum – the first SNCF field trial to involve a component produced by additive manufacturing.

Although this is still a retrofit project, the situation is expected to change in the long term. “With this field trial, we aim to prove that these 3D-printed panels are just as easy to install in new vehicles,” says Coquerel, who is already looking forward to more ambitious projects.

The really important question here is whether 3D printing could also optimize other train components by reducing their weight and bulk. “We can easily imagine other attractive scenarios for this technology, such as the restricted installation envelope in low-floor vehicles or in future high-speed applications.”

In continuous operation for the sixth year running

In 2018, the “Approval in Rail” working group of the Mobility goes Additive e.V. network was formed with the aim of producing – for the first time – a safety-critical brake component for the rail sector using an additive manufacturing process, and then installing it in a rail vehicle. The component selected for this pilot project, a suspension bracket, connects the brake pad holder to the bogie frame. During the braking process, it absorbs the resulting tensile and compressive forces and transfers them from the brake pad holder to the bogie frame. Previously, Knorr-Bremse manufactured the component out of sheet steel using conventional oxyfuel cutting. For the additive manufacturing pilot, a new material was chosen: 1.4404 stainless steel. In summer 2019, the component was installed in a DT4 vehicle operated by Hamburger Hochbahn and is now in its sixth year of successful continuous operation.



FOR THIS PROJECT, the modules will be printed in batches of three.



From spare parts supplier to business partner

Sell, deliver – then simply disappear? That is not how the global rail technology market works. Train fleets are expected to run for decades, safely, economically and energy-efficiently. In turn, this requires long-term service solutions – which is where Knorr-Bremse comes in.

A good ten years ago, before Knorr-Bremse bundled its aftermarket activities for the rail industry in the RailServices unit, the world of rail was very different. “RailServices was mainly involved in supplying the spare parts and maintenance activities operators needed to keep their vehicles running safely,” remembers Kathrin Moder, now Director RailServices. “It was already a solid business back then, but the real innovations were coming from other departments.” Today, the innovative service unit generates at least half of the Rail division’s global revenues, thanks to its many new service models.

The threefold RailServices slogan: “Sustain – Enhance – Accelerate”

Over time, RailServices has added other high-priority operator needs to its portfolio of services, such as greater environmental compatibility, extended vehicle service lives and optimized processes. “That’s how we transformed ourselves from a simple supplier into a serious business partner,” says Moder. “We want our customers to know – and feel – that ‘if we buy Knorr-Bremse systems, as well as the services we need to keep them operational, our rail vehicles will stay up and running.’” For customers, this should be front of mind not just when they buy Knorr-Bremse’s core product, braking systems, but also when they need to buy other mission-critical systems such as train doors, climate control systems and couplers.

The three-point slogan driving this shift in attitudes is “Sustain – Enhance – Accelerate”. “Sustain” by providing technical solutions that enable trains to stay operational over decades. “Enhance” by providing customized premium offerings to ensure that fleets are always in tip-top condition and ready to go. “Accelerate” by optimizing processes to make fleets even faster, more efficient and more economical.



» If asked,
we're ready to act
as an independent
service provider. «

Kathrin Moder,
Director RailServices

Valuable support for customers interested in the potential of modernization to extend their vehicles' life cycles

Ironically, the shortage of skilled workers in industrialized nations is driving the unit's growth. "By expanding our range of service offerings, we can take a lot of the work involved in train maintenance out of our customers' hands and make the whole process of keeping trains in operation less complex," explains Moder. "What's more, it's clear that cost efficiency and sustainability are key factors for operators. They need to keep a firm grip on costs and energy budgets, so they're keenly interested in safe, long-lived, energy-efficient trains."

In particular, extending vehicle life cycles by modernizing or upgrading existing stock, or adding digital features, gives operators increasingly flexible opportunities to address the growing demand for mobility even as they systematically invest in new vehicles. Climate control systems, for example, are vital for making travel attractive and comfortable, but they are also the second-largest onboard energy consumer after the main drive. By opting for Knorr-Bremse's new, retrofittable climate control solutions, operators can cut energy consumption by up to 30 percent – while simultaneously improving performance.

"If asked, we're ready to act as an independent service provider."

Knorr-Bremse's service activities have long ceased to be limited to the company's own components, products and systems. Moder explains why this is: "In any maintenance or modernization project, Knorr-Bremse systems must work alongside products from other providers," including equipment from other manufacturers for which the customer may not have been able to obtain any service, or at least not the level of service they wanted. "That's why we already work as an independent service provider if customers ask us to – not a problem, thanks to our



FINAL COMPRESSOR ASSEMBLY

The dynamism of RailServices is also reflected in the unit's steadily growing footprint. This includes recently opened service hubs in Ankara and Budapest, as well as Italy and Poland.

certified process and systems management competence. We carry out well-established tests and inspections to ensure that third-party products are properly overhauled."

The extent to which these services are used depends very much on the local operators concerned. Many of them carry out much of the servicing of onboard Knorr-Bremse technologies themselves, while others do less, depending on their resources, willingness and expertise.

40 service centers and more than 2,000 technicians ready for action worldwide

At the center of the proverbial web stands Knorr-Bremse's head office in Munich. "This is where we develop the global RailServices framework and what you might call 'product concepts,'" explains Moder. Local sites use these as the basis for service offerings tailored to specific markets and regions. The team regularly discusses new services, business partners and best practices, as well as changes or enhancements to the service portfolio. Information flows in both directions as a matter of course. "Often, our local offices spot a local need, or evaluate it and put forward their own ideas for satisfying it."

The dynamic growth of RailServices is also reflected in its steadily expanding footprint: 40 service centers and more than 2,000 service technicians and engineers stand ready to respond to customers worldwide. The network includes recently opened service hubs in Ankara, Budapest, Italy and Poland. RailServices has also acquired and integrated two major local service specialists – DSB Component Workshops in Denmark, a unit with extensive experience of maintaining and repairing a wide variety of components, and Westcode, a service provider in the UK.

But global diversification is not an end in itself. "With respect to service projects, operators prefer to work on a very local basis, because they're often inviting tenders for regional contracts," Moder explains. "To win these orders, deliveries – whether by us or third parties – must often include a significant proportion of local content; that is, provide much of the added value in the country itself. That's why customers appreciate our local presence."

Process Optimization – how Knorr-Bremse RailServices helps customers to improve their service processes:

Faster throughput times and optimized service processes significantly increase the availability of customers' vehicles and fleets. Knorr-Bremse experts help customers to enhance their workflow in many



different ways, ranging from field service support and on-site visits through to training courses. In return, operators gain expertise in digital and automated maintenance processes, improve their service quality, avoid vehicle downtime, and save time and costs.

Environmental Improvements – how Knorr-Bremse RailServices helps to improve the environment: Transportation companies are increasingly focused on the sustainability of their new and existing vehicle fleets – for commercial, political and social reasons. This involves reducing energy consumption, as well as carbon and noise emissions, by implementing suitable upgrades and retrofits. It also involves improving the quality of air for passengers and reducing water consumption.

Availability Solutions – how Knorr-Bremse RailServices helps to optimize rail operations: In addition to the unit's traditional maintenance and spare parts business, RailServices focuses on monitoring subsystems and actively managing their obsolescence. Obsolescence management is all about ensuring that long-serving vehicle fleets remain safely and reliably operational with the help of Knorr-Bremse's expertise and products.

Lifetime Expansion – how Knorr-Bremse RailServices helps customers to extend the service lives of their fleets: As rail traffic continues to grow, operators must respond faster and more flexibly to new demands. How can they keep their vehicle fleets in good working order and prolong their service lives? Solutions range from product upgrades and connectivity enhancements through to the modernization of entire vehicles.

Magic 8-day limit

In Spain, whenever passenger numbers on Madrid Metro's rapid transit network fall over the summer vacation, the company's maintenance work on climate control (and other) systems skyrockets. Fortunately, Knorr-Bremse RailServices is capable of doubling its capacity in response!



While it would be something of an exaggeration to talk about a summer shutdown, there is definitely a slowdown, confirms RailServices manager Juan Carlos López Bravo: "During the summer vacation period, there's a drop in demand for Madrid Metro services," he explains, "so the organization aims to use the resulting extra capacity as efficiently as possible for scheduled vehicle maintenance."

This also applies to the new 7000 (AnsaldoBreda, today Hitachi) and 8000 (CAF) series rail vehicles ordered by the Consorcio Regional de Transportes de Madrid (Madrid Regional Transportation Consortium), deliveries of which started back in 2002. One of their unique features is that passengers can easily walk from one end of the trainset to the other. The onboard climate control systems are supplied by Knorr-Bremse brand Merak – and when they are due for maintenance, it has to happen fast!

RailServices can easily switch its exclusive service line to two-shift operation

"Logically enough, operators only hold a very limited inventory of parts for systems that only need overhauling every few years," explains López Bravo, "so to keep things running smoothly, it's essential that maintenance throughput times are kept to an absolute minimum."

Processes on the project-exclusive line have now been optimized to such an extent that the overhauled systems are back with the customer after just eight days. "If we blew our deadline, the operator would have to take the trains out of service," says López Bravo. But if required and as an element of the long-lasting strategic cooperation between Metro de Madrid and Merak, depending on the number of systems to be serviced, RailServices can easily switch its dedicated service line in Getafe over to two-shift operation, instantly doubling capacity.

Comprehensive overhaul, including multiple upgrades

Despite the eight-day timeframe, the systems are given a comprehensive overhaul, including multiple upgrades: The simple pressure switches installed previously are replaced by new, state-of-the-art units that are much more reliable and accurate, and new transducers are installed that facilitate maintenance by enabling digital pressure readings on an external display. All these components are brazed in place to avoid threaded connections that could result in leaks. New software supports better temperature regulation and fault notification, among other improvements.

And RailServices is always looking to the future: As part of the contract, the company includes ten prototypes that use a new, more eco-compatible type of refrigerant, as well as twelve prototypes of a new, state-of-the-art electronic control unit that fully resolves the obsolescence of the unit currently mounted on the equipment.

DEDICATED MERAK production line in Getafe, seen here retrofitting systems for Metro Madrid.

Night sleeper across the steppes



ASTANA, capital of Kazakhstan

Working with international partners, countries in Central Asia are rapidly expanding their rail networks. Knorr-Bremse is one of the major players in the region – and is now supplying equipment for more than 500 new passenger cars ordered by Kazakhstan’s national rail operator KTZ.

The figures alone are enough to hint at the scope of this project. Kazakh state rail company KTZ has ordered 537 sleeper and couchette cars, including generator cars, from Stadler Rail. The manufacturer will also maintain and service the vehicles over a period of at least 20 years. This order is worth a total of EUR 2.3 billion, as the Swiss company announced at the signing ceremony just over a year ago.

Long-distance connections

“The region’s political decision-makers are increasingly prioritizing passenger rail services in particular,” explains Stanislav Knyazev, Deputy Managing Director of Knorr-Bremse Kazakhstan. “In total, the tracks operated by KTZ cover more than 16,000 kilometers, of which at least 4,200 kilometers are electrified.” Unlike in Europe, the rail network is not dense – but it does link together the major centers of the world’s ninth-largest country (by area) over very long distances. This

explains KTZ’s plans for the 537 new sleeper, couchette and generator cars.

The last of the standard passenger cars is expected to leave the final assembly line in less than seven years’ time. Knorr-Bremse is supplying the braking systems, as well as TCMS technology. Both systems are capable of operating in temperatures ranging from -50°C to +45°C.

Kazakhstan – a transcontinental hub for rail freight

This huge project is by no means unique in the region. Kazakhstan in particular is clearly in the process of becoming a transcontinental hub for rail freight traffic.

In 2022, a Finnish logistics company opened a new container route running through what is known as the Middle Corridor and East Asia. Starting in Chongqing in China, trains pass south of Russia to end up in Kouvola in southern Finland, which is also a major rail junction. A joint venture between KTZ and Georgia’s national rail company, Georgia Railway LLC, has started to build a new container terminal – complete with rail connec-

tions – near the Georgian port of Poti on the Black Sea. And last year, China’s largest rail vehicle manufacturer, CRRC, launched a feasibility study into a new rail link that could connect China to Uzbekistan via Kyrgyzstan.

Local presence

Knorr-Bremse is another big name in the region that stretches between Georgia and Mongolia. A total of 147 KZ8A double locomotives for freight trains and KZ4AT passenger train locomotives currently use Knorr-Bremse braking systems, complete with state-of-the-art wheel slide protection – and about the same number of locomotives are due to be delivered over the next three years. KTZ has also commissioned the installation of numerous Knorr-Bremse products in 57 TEP33A diesel-electric locomotives – specifically brake control systems, BP air supply units with oil-free VV270-T compressors, and wheel slide protection.

Based in Astana, the teams headed by Managing Director Dmitry Danilenko look after the entire Central Asia region. The regional center is also responsible for countries like Armenia, Azerbaijan, Mongolia, Kyrgyzstan, Uzbekistan and Georgia. “Thanks to the many localization options we offer, we’ve created an attractive environment for our customers,” confirms Danilenko.

Metros for India's megacities



KNORR-BREMSE is a key partner in the further development of India's rail networks. The company's braking and climate control systems are being installed in Alstom trains destined for the new metro systems in Bhopal and Indore. | © Alstom

Bhopal and Indore are building new public transit networks. Knorr-Bremse programmed large parts of the vehicles' brake control systems locally, and has fitted the climate control systems with a special fresh air supply function.

Recent news from India's rail transit market has often focused on the Vande Bharat Express, an impressive intercity project that reflects the subcontinent's ambitious goals – to rebuild its rail infrastructure and connect together all major cities via high-speed electric rail links. But India is also modernizing its rail services in other ways, unrelated to such large-scale projects. Examples include the new metro lines in Bhopal (31 kilometers, 30 stations) and, some 200 kilometers away, Indore (first construction phase: 33 kilometers, 29 stations); both projects aim to provide reliable services for commuters in these fast-growing cities. India's new networks have been dubbed Mass Rapid Transit Systems (MRTS).

Madhya Pradesh Metro Rail Corporation Limited (MPMRCL) has ordered 52 trains from Alstom's Movia family – a total of 156 cars – for the two lines in Bhopal and Indore. The first trains are due to go into passenger service on the overground and underground metro routes before the end of this year.

Braking systems supported by on-site expertise

Knorr-Bremse's high-quality system solutions have already proved their worth in the Delhi and Mumbai metros, and now they are playing a key role in this project. The brake control system features leading software expertise garnered from Knorr-Bremse's Technology Center in Pune (TCI). TCI, which was expanded just a few months ago, will soon have enough space for 1,300 specialists. Thanks to this strong local presence, Knorr-Bremse is in a perfect position to help numerous customers to expand their transit systems by providing direct, on-site support.

As for climate control systems, MPMRCL opted for a variant that features the energy-saving Free Cooling function and CO₂ sensors, plus a "smart" mode that regulates the train's fresh air intake. Originally, this function was simply intended to reduce energy consumption. But following the Covid-19 pandemic, two new features were swiftly included – thanks to the control system's flexibility. First, the inflow of fresh air was enhanced to improve air quality, and second, the fresh air is now blown in through the ceiling of each compartment and then extracted through the floor. This vertical downflow of air reduces the risk that passengers sitting or standing next to one another will pass on airborne infections.

CITYLINK the essence of flexibility



Stadler is supplying six local mass transit companies in Austria and Germany with at least 246 light rail vehicles (LRVs) based on the CITYLINK platform, as part of a joint order. The order is also a perfect example of how Knorr-Bremse can adapt its systems to meet the needs of specific operators and operating locations.

CITYLINK LIGHT RAIL VEHICLES destined for six local mass transit companies in Austria and Germany are being equipped with innovative system technologies supplied by Knorr-Bremse. | © Stadler

Knorr-Bremse is equipping the streetcars with fully hydraulic braking systems in which key component interactions have been further optimized – such as those between, for example, the magnetic track brakes, their new hydraulic mountings and the new hydraulic power units. Together with other enhancements, this further improves the braking systems' configurability in different operating conditions and on routes with differing requirements.

Six local mass transit companies order at least 246 vehicles

This approach is no coincidence – Stadler's CITYLINK LRVs are genuinely some of the most ingenious vehicles to service the local mass transit sector. Essentially streetcars, the vehicles can also be used as interurban light rail vehicles if configured appropriately. On streetcar networks, the vehicles are electrically powered, but on main lines they can run either on electricity or on diesel, at speeds of up to 100 kilometers per hour.

The major "VDV TramTrain" order is a joint project by six public mass transit companies in Austria and Germany, with Verkehrsbetriebe

Karlsruhe (VBK – Karlsruhe's municipal transit authority) acting as the project manager. Between them, the companies have ordered at least 246 LRVs, but the contract includes options for up to 258 more vehicles. The three-car rail vehicles feature designs that vary slightly by operator and intended operating location.

Heat pump function using CO₂ as natural refrigerant

Another unique selling point of the new vehicles? Climate control systems from Knorr-Bremse brand Merak that supply clean air at pleasant temperatures to both

passenger compartments and the driver's cab. These highly energy-efficient systems, which include a heat pump function, use CO₂ as a natural refrigerant.

Stadler is also relying on Knorr-Bremse RailServices to provide another key element: life cycle management. The service contract, which covers a 32-year period, includes the delivery of spare parts and maintenance services for the various Knorr-Bremse system technologies aboard the vehicles. Vehicle deliveries started at the end of 2023 and are scheduled to continue through to 2031.

Braking technology makes an electrifying leap

With decades of development behind them, electropneumatic braking systems have proven their worth in millions of trains on railroads all over the world. Now a new kind of technology has entered the scene: the electromechanical (EM) braking system.



» We expect the new braking system to weigh up to 15 percent less. «

“The electropneumatic brake is a highly reliable system – the result of decades of continuous development,” says Josef Baier, Director Brake Domain Systems at Knorr-Bremse Rail Vehicle Systems. But more recently, the attention of most developers in the transportation industry has shifted to focus on electrification, networking and eco-efficiency. “In the case of braking systems, we can only fulfill some of these criteria by making another technological leap forward,” explains Baier.

He is talking about Knorr-Bremse’s decision to develop an EM braking system. Instead of using electricity and compressed air to generate and transmit braking signals and braking energy, the EM brake uses electricity for both – in the form of brake-by-wire technology.

The EM brake transfers braking force faster, develops it more dynamically and controls it more precisely

“We expect the new braking system to weigh up to 15 percent less,” adds Baier, “with additional weight and space saved as a result of eliminating compressed-air lines and reservoirs.” This means that every time the train stops, the traction system has less weight to accelerate back up to travel speed. The reduced bulk also means that more space is available for other train systems, giving vehicle manufacturers more latitude to arrange other components and systems inside the train. And because the new brakes rely on fewer individual components, their installation costs – as well as their maintenance costs over decades of service life – are also reduced.

Another advantage is the EM braking system’s potential for reducing braking distances, because it delivers braking force faster, more precisely and more dynamically – a potent combination. This improved

performance offers opportunities to optimize existing functions, such as wheel slide protection designed for low-adhesion conditions. The EM brake could also optimize the time-consuming, labor-intensive inspection procedure that forms part of today’s mandatory brake test, speeding up the process of preparing trains for departure.

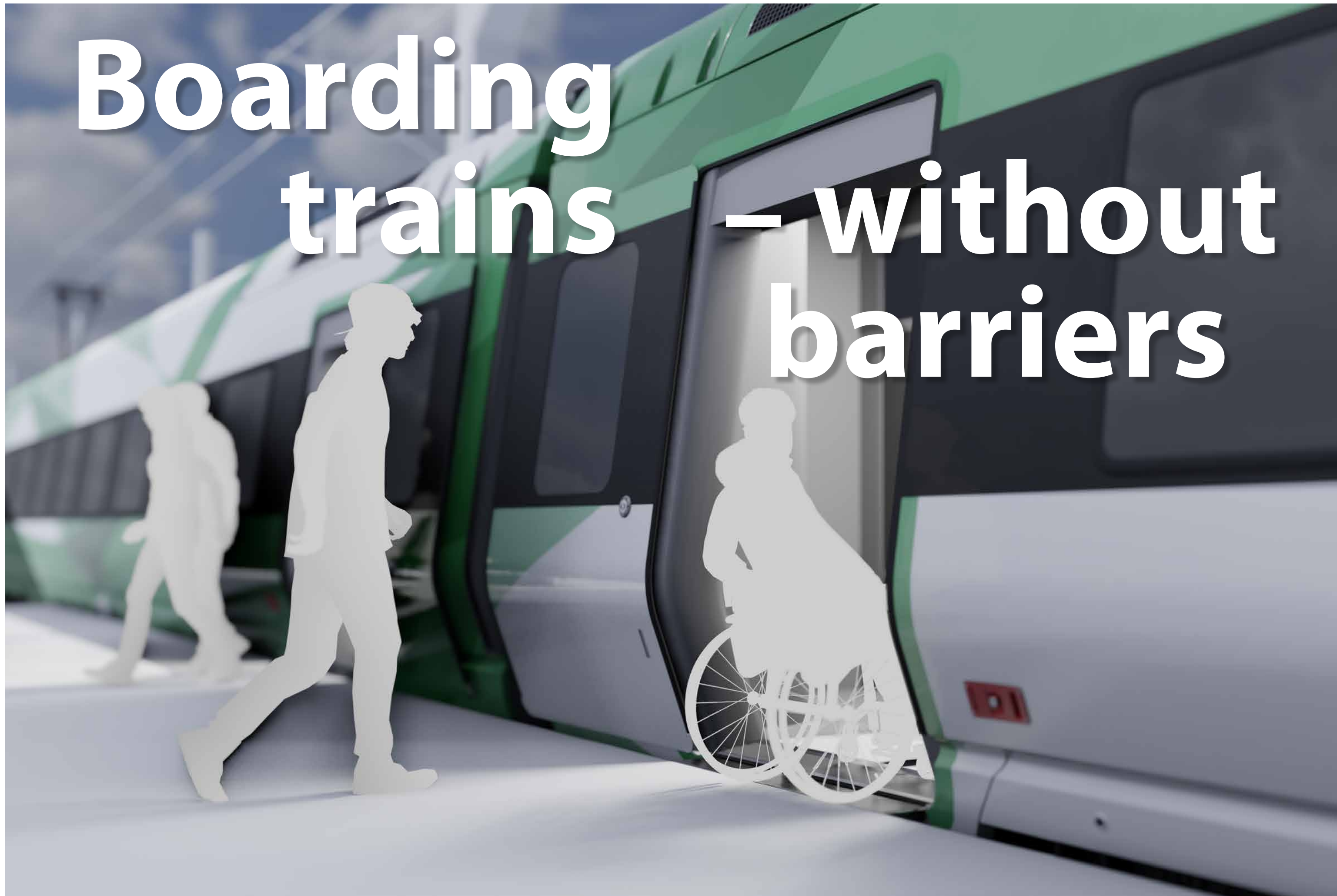
Rather than replacing mature electropneumatic braking systems, EM brakes represent an attractive alternative

“To start with, EM brakes will probably be used in mainline train services – especially regional and commuter trains, as well as metros,” believes Martin Strobel, representing Brake System Family Management. “These trains already have the key prerequisites for installing EM brakes, including end-to-end electric power supplies and standardized, train-wide communication systems.” Knorr-Bremse is designing the EM braking system in such a way that the mechanical interfaces with the bogie remain unchanged, making it easier to integrate with existing vehicle platforms.

Josef Baier,
Director Brake Domain Systems
Knorr-Bremse Rail Vehicle Systems

Will EM brakes replace pneumatic systems? Strobel thinks not. “The electropneumatic brake will remain the backbone of train braking technologies for a very long time to come,” he predicts. “But the EM brake brings another innovative technology to market with new features that represent an attractive alternative in certain areas of application.”

Boarding trains – without barriers

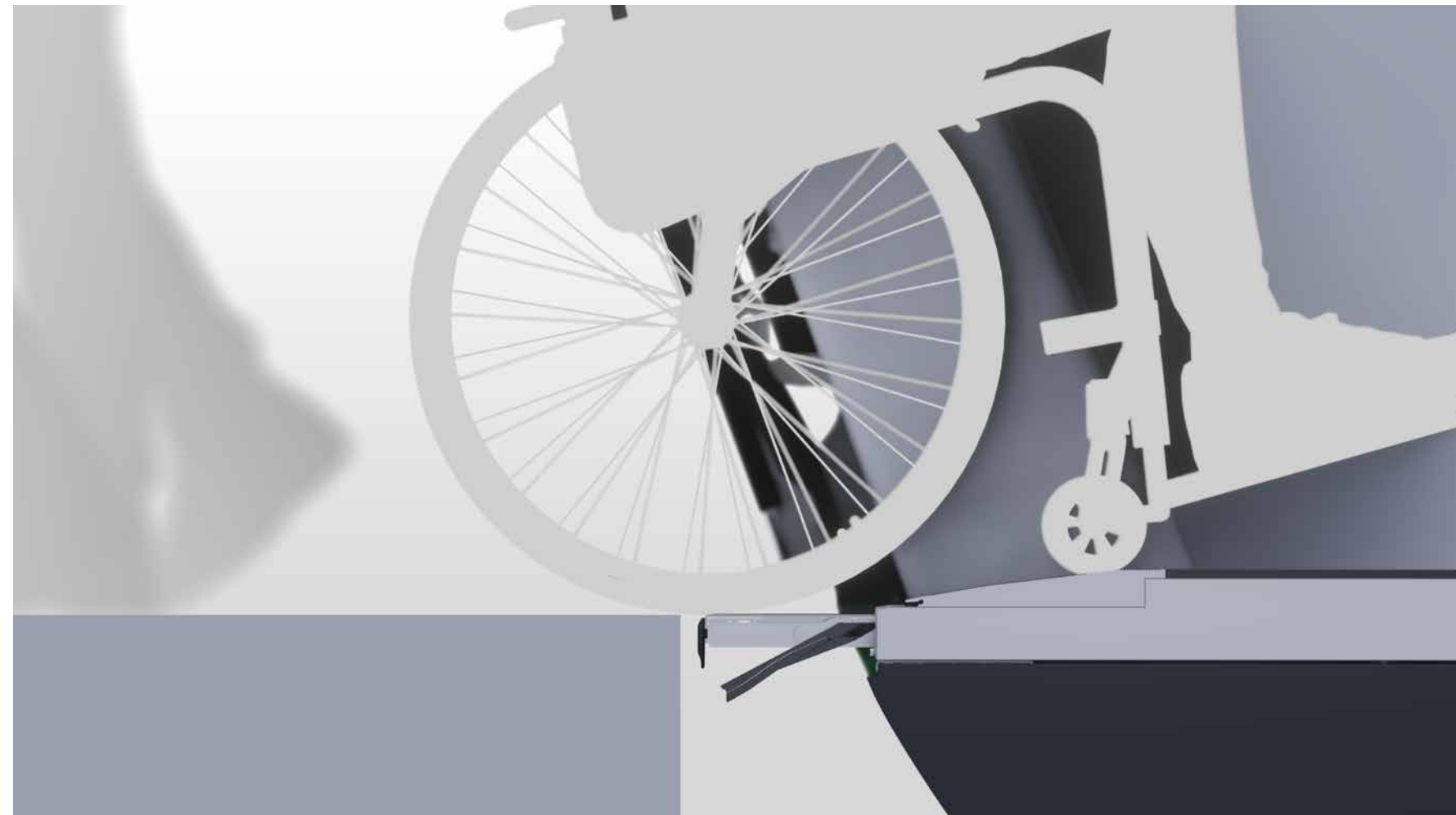


Most of us know how hard it is to climb aboard a train with a wheelchair, stroller or large suitcase. Intended for long-distance trains, the new ZeroStepBoarding system from Knorr-Bremse company IFE solves the problem by providing almost barrier-free access.

Sometimes there really is nothing to discuss. Take, for example, the Americans with Disabilities Act (ADA) in the USA. To make it easier for people with reduced mobility to use public mass transit services, the rules are very clear: The maximum permitted height for the step from platform to vehicle must not exceed six millimeters.

“In design terms, this is extremely challenging – the major obstacle being the brush strips and door seals used to protect railcar interiors against contamination,” explains Johann Wilflinger, an entrance systems developer working for Knorr-Bremse company IFE. However, the company is on the verge of launching series production of an almost stepless solution that does not exceed the ADA-mandated maximum height of six millimeters. The name of the new system? ZeroStepBoarding.

IFE ZEROSTEPBOARDING ENTRANCE SYSTEM consisting of pressure-tight E3D-e1 door and sliding step (rendering) | © IFE



BARRIER-FREE RELIABILITY:
The ZeroStepBoarding sealing system also withstands the stresses and strains of long-distance train travel (rendering). | © IFE

EASIER ENTRY, EASIER EXIT:
step-free access to the ICE L train of Deutsche Bahn produced by Spanish manufacturer Talgo. | © Deutsche Bahn AG / Oliver Lang



ZeroStepBoarding: no other active elements required

The solution is based on two brilliant ideas. “First, we replaced the brush strip with a step-on, ramp-shaped scraper,” Wilflinger continues. The next step was to add an even more advanced sealing system. “Despite the inclined ramp, the sealing system is still capable of building up sufficient pressure to protect the passenger car interior against, for example, the pressure waves created whenever trains pass each other or enter tunnels. And it does so without needing a second, counter-posed seal.”

Unlike other near-stepless approaches, ZeroStepBoarding does not require additional active elements such as hinged sealing flaps, platform lifts or inflatable gaskets. The development team also devised a solution for transforming the sealing flap from a ramp-shaped incline into a vertical door seal. By eliminating active elements that would otherwise consume energy, this totally passive approach also makes the solution much less complex, hence much more reliable. This in turn boosts availability.

Ideal for various types of entrance systems

Designed in particular for the proven, pressure-tight E3D-e1 entrance system used for intercity and high-speed applications, this newly developed solution also integrates with other systems in the IFE portfolio. For future high-speed trains, IFE will be offering ZeroStepBoarding capable of supporting maximum pressure loads of up to 6k Pa.

“Never before have passengers been able to board a long-distance vehicle so easily,” states Oliver Schmidt, CEO of Knorr-Bremse GmbH in Austria with global responsibility for Knorr-Bremse’s entrance systems business. Because the door strips are interchangeable, IFE will be able to offer optimized solutions that comply with barrier-free access regulations across multiple rail markets – including, of course, the TSI-PRM standard used in Europe.

 **KNORR-BREMSE**

 **NEW YORK AIR BRAKE**

 **IFE**

 **MERAK**

 **MICROELETTRICA**

 **SELECTRON**

 **EVAC**

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