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KNORR-BREMSE
120 YEARS
1905 - 2025

HIGH-TECH HUB:
Knorr-Bremse expands service network

SETTING NEW HEADINGS:
Refining Knorr-Bremse Rail's strategic vision

BLUE-WHITE TRAIN OF THE FUTURE:
Munich's new S-Bahn

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the customer magazine of
Knorr-Bremse Rail Vehicle Systems

KNORR-BREMSE

Contents

Dear Reader,

Rail travel was still in its infancy 120 years ago, but when Georg Knorr set out to speed it up, he didn't focus on engines or drive systems. Instead, the gifted engineer zeroed in on the other end of the drivetrain: the braking system. For him, it was perfectly clear that a train with good brakes can travel faster for longer. Shortly afterward, the Knorr single-chamber rapid-action brake and K1 distributor valve became the launchpad for Knorr-Bremse's subsequent success. In this anniversary issue, we look back over the various milestones in the company's evolution (pages 8–11).

Last autumn, I was given the opportunity to help write the next chapter in this success story when I was appointed to the Management Board of Knorr-Bremse Rail Vehicle Systems (RVS). What a responsibility! But also, what a joy! Beyond taking care of day-to-day business, I've deliberately spent my first few months getting to know the company inside and out. Internally, I've connected with our employees – and externally, I've engaged with you, our valued customers. It's truly inspiring to witness the remarkable passion driving forward the development of tomorrow's mobility across so many desks, workbenches and collaboration platforms.

My new area of responsibility also encompasses Knorr-Bremse's aftermarket specialist RailServices, including an extensive modernization portfolio. In this issue's Spotlight section (pages 14–17), we provide a concise overview of some of our latest modernization projects. As you'll see, even minor adjustments can dramatically improve a vehicle's safety and comfort levels.

I hope you enjoy reading our latest issue!

Warm regards,

Cora Hentrich-Henne

CORA HENTRICH-HENNE,
Member of the Management Board, Knorr-Bremse Systeme für Schienenfahrzeuge GmbH

Information for Knorr-Bremse's customers and business partners

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New Mireo platform:

A first for Knorr-Bremse braking equipment

Starting at the end of 2027, Siemens Mobility will deliver the first of 70 new-generation Mireo trains to Austrian Federal Railways (ÖBB). For the first time, Knorr-Bremse is supplying essential braking system components for the platform, including the FlexControl pneumatic brake control system and air-supply systems with oil-free compressors. As in previous Mireo trains, the new vehicles will also use Knorr-Bremse's windscreen wiper and wash systems.

This first call-off from a platform agreement covers eleven 73-meter commuter trains and 28 106-meter trains for use in various Austrian federal states. Another 31 trainsets, also 106 meters long, are destined for long-distance transit services in the country's Alpine regions. Siemens Mobility is manufacturing the trains – a lightweight, single-car design which can reach speeds of up to 160 km/h and features space-saving, internally mounted bogies for the first time. The manufacturer is using the resulting space to relocate other vehicle components under the cars. At ÖBB's request, Siemens Mobility has also designed the vehicles to be wider than previous Mireo trains, giving passengers more room and a greater feeling of space.

ProBlock IB116* is awarded stringent UIC recertification

As a full-range supplier of friction materials, Knorr-Bremse is able to provide friction "pairings" that meet highly specific customer requirements for practically every kind of rail vehicle application, based on almost all global railroad standards. Organic LL brake pads such as the ProBlock IB116* are key elements in Knorr-Bremse's brake block portfolio. Unlike traditional gray cast iron blocks, the organic pads do not abrade wheel surfaces when braking, resulting in less vibration from the wheel-rail interface and making the train noticeably quieter: On "average" track, with appropriately polished wheels, a train fitted with composite brake pads emits about 10 decibels (dB(A)) less noise. The brake pads must undergo a stringent recertification process at regular intervals, and in February, Knorr-Bremse successfully completed this process for the ProBlock IB116* series. The pads were also issued with a declaration of TSI conformity for interoperability.

From left: Markus Seidl, Director Quality, Processes and Homologation @ Bogie X-Systems with Matthäus Jaskulski, EU Homologation Officer @ Bogie X-Systems

A quarter of a century in the United Kingdom

Twenty-five years ago, Knorr-Bremse acquired Westinghouse Brakes, a British company with a long and proud tradition. Based in four different locations, Knorr-Bremse Rail Systems UK has since become one of the major players in the country's rail transportation market.

"This year, we're not just celebrating 25 exciting, successful years for Knorr-Bremse Rail Systems UK, we're also celebrating 20 years since we started operations at our head office in Melksham," says Paul Goodhand, the company's Managing Director. The British subsidiary provides UK train manufacturers and operators – as well as their local service workshops – with access to the Knorr-Bremse Group's entire product portfolio.

Within the Knorr-Bremse organization, the UK site is part of the Brake Control Systems Center of Competence and is also responsible for Knorr-Bremse's Platform Screen Doors business unit. Knorr-Bremse's service specialist RailServices also operates out of Melksham. In the 25 years since it was founded, Knorr-Bremse Rail Systems UK has equipped some 12,000 rail vehicles for all major train manufacturers with its products and systems, and supplied 947 platform screen door systems to 448 stations around the world. In 2009, the company won the prestigious Queen's Award for Enterprise for the CubeControl brake control system. Queen Camilla (formerly the Duchess of Cornwall) visited the Melksham site to present the award.

2025 is also a special year for the British rail industry
In 2025, the British rail industry as a whole will be celebrating a special anniversary. The Stockton & Darlington Railway (S&DR), widely regarded as the world's first public railroad, officially opened 200 years ago on September 27, 1825. The line in northeast England was primarily intended to transport coal, but also carried passengers.

At the official opening, the famous "Locomotive No. 1" developed by George Stephenson and his son Robert, and capable of a maximum speed of 15 mph (24 km/h), marked the beginning of steam-powered rail transportation. As Paul Goodland says: "We're very proud to be part of this 200-year history."

New, on-demand video library for Customer Training Portal

More than just a provider of training courses, the RailServices Training Academy also acts as a sophisticated service provider, putting together tailored, all-in-one packages to meet customers' specific requirements. On request, almost all the Academy's theory-based training courses can be delivered in a "virtual classroom".

Now the RailServices Training Academy is adding multiple IT solutions to its portfolio, which can also be accessed via the Customer Training Portal. "We've launched our new video library for on-demand learning," confirms project manager Mansi Pabari. "Customers with access to our Training Portal can access the library as a matter of course; customers who don't yet have access are very welcome to request it." The Academy is also planning to include digital twin technologies in the future.

"To build a modern, practical training experience, we're currently integrating digital twins and interactive simulations into our learning modules." As well as German and English, the Customer Training Portal is now available in seven other languages.

High-tech hub in Grottaglie: Knorr-Bremse expands service network

Knorr-Bremse Rail Systems Italia recently inaugurated a new center for repairing electronic components in southern Italy's Puglia region. The fully refurbished plant's core competencies include extensive maintenance and repair services.

A year ago, Knorr-Bremse Rail Systems Italia acquired engineering firm Alisea S.r.l., with the aim of expanding its global service network. Recently inaugurated, the new Electronic Repair Center (ERC) in Grottaglie close to Taranto in the Puglia region has been designed to deliver higher production capacity, based on optimized logistical workflows and advanced workstations.

With over 35 years of experience, Alisea S.r.l. has built up a reputation as a highly experienced specialist in obsolescence management, as well as in the repair, maintenance and reverse engineering of electronic modules and circuit boards used in rail vehicles. The ERC has a broad portfolio that also includes complete solutions for testbench electronics, diagnostic and test procedures, measuring systems and simulators for programmable logic controllers (PLCs) as well as various types of communication buses, such as multi-function vehicle buses (MVBs).

Deep maintenance of electronic components extends the useful lives of vehicles

One of the new center's core specialties is providing deep maintenance solutions for electronic components. "By implementing these solutions – as an alternative to replacing obsolete components with new ones – we put our customers in the attractive position of being able to significantly extend the service life of their rail vehicles at relatively low cost," explains Simone Mantero, Managing Director of Knorr-Bremse Rail Systems Italia.

"Technical Exchange" for tomorrow's HVAC

Together with several European rail operators, Merak has launched a technical forum for discussing the latest trends and challenges associated with developing and operating climate control systems.

Climate control systems can account for up to 30 percent of a rail vehicle's total energy consumption. The opposite side of the coin is the corresponding scope for improving the vehicle's ecological footprint. But that's not all: "Efficient climate control systems can also improve the range of battery-powered trains," explained Fernando Hazeu, Managing Director of Merak, the Knorr-Bremse brand that specializes in these systems, when this event was first launched in cooperation with Deutsche Bahn (DB). Close collaboration between HVAC manufacturers and rail vehicle operators also delivers benefits when addressing the various challenges associated with refrigerants, PFAS and in particular, end-to-end system digitization.

This was the idea behind the first "Technical Exchange". It didn't take long for other European operators to join the "Technical Exchange", including Swiss (SBB) and Austrian (ÖBB) Federal Railways, Nederlandse Spoorwegen (NS), Schweizerische Südostbahn (SOB) and Rhätische Bahn (RHB). So far, in-depth conversations have been held on the deployment of future-safe natural refrigerants, the energy efficiency of R290 HVAC systems, how to avoid the use of PFAS (Per- and poly-FluroAlkyl Substances) in the cooling circuit as well as data concepts for HVACs and digital twins.

Taking the first step

The most important finding of these first meetings was that "especially where efficiency is concerned – both of the systems and the way they operate – digitization acts as a major catalyst". To reap the full benefits, it also became clear that new systems must be fitted with many more sensors, so that data on the performance of key constituents can be transferred to the "right" places for further processing. Operators can use this data to optimize maintenance processes, keep passengers comfortable by analyzing onboard atmospheric conditions or more precisely calculate their maintenance plans, while HVAC manufacturers can use it to perfect future designs, evolutions or spare parts.

"We've only taken our first steps, but we definitely intend to continue sharing technical ideas and perspectives," says Hazeu – to refine, for example, how best to transfer data between the main players in the rail ecosystem. "And of course other operators would be very welcome to join the forum," adds Hazeu.

What our customers say

Peter Danzer, Expert Vehicle Components – Air Conditioning & Refrigerants at Deutsche Bahn: "Deutsche Bahn AG welcomes such an exchange between manufacturers and railway undertakings, especially regarding the challenging aspects of tomorrow's HVAC technology. Deutsche Bahn AG is encouraging the industry to improve efficiency. A standardized data exchange format will support these efforts, and Deutsche Bahn developed a strategy for enhancing energy efficiency and transitioning from F-gases to natural refrigerants as far back as 2014.. Such an exchange facilitates efficient collaboration on the right topics for all parties involved."

Sebastiaan Rodermond, Senior Engineer – Product Group Climate & Sanitary at NS Treinmodernisering: "At NS Train Modernisation (NSTM), we're currently modernizing the largest fleet of Dutch Intercity double-decker trainsets. In addition to a completely new interior and livery, we're also upgrading the climate control system. The challenge is to integrate a brand-new HVAC system into a train that was originally developed in the early 1990s. To ensure long-term sustainability, the new climate control system includes energy-saving features such as a heat pump, CO_2-controlled ventilation, and a frequency-controlled compressor."

120 Years of Knorr-Bremse

Georg Knorr steered his young company through the challenging early years with the determination, imagination and technological foresight of a true inventor. These qualities form part and parcel of our corporate heritage – and have transformed Knorr-Bremse into one of Germany's most successful industrial companies.

With all formalities prepared, it was time to act. On January 19, 1905, Georg Knorr and the Executive Board of Berlin-based Ludwig Loewe & Co. AG added their signatures to the partnership agreement underpinning the newly founded Knorr-Bremse GmbH. The machine tool manufacturing company wanted to expand into a new market segment, whereas Georg Knorr, then in his mid-40s, needed new partners and fresh capital.

Shortly before this, Prussian State Railways had decided to equip its passenger trains with a new brake – specifically, a package consisting of Knorr's single-chamber rapid-action brake and K1 distributor valve. Not only was this solution capable of braking passenger trains faster and more safely, but – in a world first – it did so without juddering or jolting. Over the next few years, the young company would deliver around 50,000 braking systems.

Serial revolutions in rail technology

The company's next innovation, a graduated-release air brake for freight trains (the KK brake), was revolutionary. Powered by a single line running from the locomotive to the other end of the train, it eliminated the need for the old, hand-cranked brakes previously distributed throughout the train. In 1953, Knorr-Bremse moved its headquarters to Munich and introduced the Knorr standard brake, together with the KEa – the first distributor valve to reliably fill and vent brake cylinders in the specified time, regardless of their size or stroke. Following UIC certification, almost 1.5 million KE units have been installed in more than 40 countries. The latest KEf generation was launched in 2018.

In the early 1980s, Knorr-Bremse supplied the brakes for a record run by France's new high-speed train (TGV). Later, Germany's ICE-V set a new world rail speed record of 406 km/h – with a newly developed braking system consisting of a microprocessor-driven brake control system, high-performance disc brakes and an electromagnetic eddy current brake.

Global expansion during the Thiele era

Heinz Hermann Thiele started working at Knorr-Bremse in 1969. In 1985, having risen from legal clerk to Commercial Business Director, he became sole owner of Knorr-Bremse AG. As Chairman of the Executive Board and CEO, he revitalized the qualities that had characterized the company in previous decades. With imagination, determination and technological foresight, he transformed a company in dire

Milestones

1905

Georg Knorr at his desk in 1905, having just founded Knorr-Bremse GmbH in Berlin.

1931

During the 1930s, the Hildebrand-Knorr brake (HiK) becomes an industry standard in 17 countries.

1945

After World War II, the Berlin headquarters is dismantled and expropriated. In 1953, the company sets up a new headquarters in Munich.

1985

With imagination, determination and technological foresight, the company's new owner Heinz Hermann Thiele transforms a company in dire need of restructuring into a global market leader.

1985

Customers start to use the company's first low-vibration, screw-type compressors, which are also exceptionally quiet.

1991

Germany sees the start of the ICE era – with high-speed braking systems supplied by Knorr-Bremse.

1997

The onboard systems business sees its first major expansion in the form of a stake in IFE AG, a leading Austrian manufacturer of automatic door systems.

2005

Non-profit association Knorr-Bremse Global Care e. V. is founded to support people who find themselves in need through no fault of their own due to environmental disasters, war, poverty or illness.

need of restructuring into a global market leader. Thiele recognized the importance of the Chinese market at an early stage, concluding Knorr-Bremse's first major contract in the country in 1989 (supplying brakes for Shanghai Metro). Two years later, the company took its first big step across the Atlantic with the acquisition of New York Air Brake (NYAB).

At the end of the 1990s, the Rail Vehicle Systems division began to systematically expand its onboard systems business. As part of this drive, the division took a stake in IFE AG, a leading Austrian manufacturer of automatic door systems, before finally acquiring the company. In 2005, this acquisition was followed by two others: Merak (HVAC systems) and Microelettrica Scientifica, a specialist in switching and control components for train energy management. In 2010, Knorr-Bremse acquired Anchor Brake Shoes in the USA and Icer Rail in Spain, both specialists in friction materials. With the acquisition of Selectron, the brake specialist entered the train control and communication systems business, focusing on the automation, networking and management of rail vehicles.

On the product side, Knorr-Bremse launched innovations like the CubeControl brake control family and AirSupply Smart. CubeControl combines control hardware with electronics and pneumatics in a single mechatronic unit that can be customized for specific vehicles using project-specific software exclusively. AirSupply Smart eliminates the rigid on/off logic of previous air supply systems, adapting the delivery of air according to the vehicle's load, speed and track topography. It represents the starting point for a new approach to the climate-friendly, eco-friendly management of energy and noise emissions in the rail sector.

New signaling technology business unit
Knorr-Bremse entered the coupling systems market in 2021. And last September, the company announced that it had acquired Alstom Signaling North America's entire signaling technology business – including some 800 employees working in six locations. With the new Signaling business unit, the company aims to evolve into a Tier 1 platform partner in the signaling technology segment, supplying signaling products, systems and services. The new business unit will also take over the company's existing signaling business in the European marketplace.

Knorr-Bremse at a glance

120 years
In 1905, Georg Knorr founded Knorr-Bremse GmbH in Berlin

> 32,000
employees worldwide at over 100 locations in 30 countries

~ 12,000
patents reflect the company's capacity for innovation

KNORR-BREMSE
120 YEARS
1905 - 2025

Milestones

2005
Two more acquisitions: Merak, specializing in heating, ventilation and climate control equipment, and Microelettrica Scientifica, a specialist in electromechanical and electronic switching and control components.

2015
Modern rail vehicles need advanced control systems: Selectron AG, a reputable specialist in train control and communication systems, joins the Group.

2018
On October 12, 2018, Knorr-Bremse AG goes public.

2021
As a founder member of Europe's Rail Joint Undertaking (ERJU), Knorr-Bremse plays a leading role in developing new generations of rail technology.

Knorr-Bremse acquires EVAC, becoming the world's leading provider of integrated sanitary systems for passenger trains.

2024
With the acquisition of Alstom Signaling's North American signaling technology business, Knorr-Bremse expands its portfolio to include electronics for rail infrastructure and digitalization.

2006

As the new millennium begins, the Group expands its position in the rapidly growing Chinese market by entering into joint ventures and building its own plants.

2016

Knorr-Bremse opens its new Development Center in Munich, where several hundred engineers work on future technologies across multiple disciplines.

2022

Knorr-Bremse enters the coupling systems business and, just two years later, produces the first prototype of the Digital Automatic Coupler (DAC).

2024

Knorr-Bremse and eleven other partners launch the European Rail Data Space (ERDS), a shared virtual environment for seamless, secure data exchange.

next stop
FUTURE

Setting new headings

Knorr-Bremse Rail is refining its strategic vision. The most significant change: extending the company's focus beyond vehicles to become a Tier 1 supplier for the entire rail ecosystem.

Customer needs are Knorr-Bremse's top priority worldwide. Consequently, while revising Knorr-Bremse's strategic vision, the company engaged in in-depth dialogue with vehicle manufacturers and operators throughout Europe, Asia and North America. Knorr-Bremse also reached out to contacts in institutions and associations across the rail industry, including unbiased analysts and forward-thinking visionaries. Even international competitors and customers provided valuable (albeit from Knorr-Bremse's perspective, anonymized) insights.

What technological developments and market trends are emerging in the long-distance, suburban and local public transit and freight transportation segments? Which technologies will manufacturers and operators want and need in the future? And where precisely can Knorr-Bremse, as a "Rail Mobility Visioneer" and systems partner, make the most impactful contributions?

"This wasn't just about updating our strategic vision, but about defining the long-term direction of our division as a whole," says Dr. Nicolas Lange, Member of the Executive Board of Knorr-Bremse AG with global responsibility for the Rail division. "We essentially challenged almost every fundamental assumption we've ever made about the future."

"This wasn't just about updating our strategic vision, but about defining the long-term direction of our division as a whole."

Dr. Nicolas Lange, Member of the Executive Board of Knorr-Bremse AG

What customers need – today and tomorrow
Out of all this feedback emerged some fundamentally positive news: Many industry projections anticipate a rising global demand for rail transportation. There is little doubt that all major markets will see growth. The urbanization, digitalization, mobility and sustainability megatrends are turning out to be just as stable as the industry trends they have triggered: lifecycle management, transportation capacity, availability and environmental compatibility.

From a customer perspective, future priorities include improving the availability of vehicles and infrastructure, as well as increasing track capacity. Safety, cybersecurity and energy savings are considered essential. The same applies to noise reduction, as well as optimized cost and operational efficiency.

From Tier 1 supplier for vehicles to Tier 1 supplier for the entire rail ecosystem
Based on these insights into future rail system developments and the resulting customer needs, Knorr-Bremse defined a Value Pool portfolio – business areas covering key customer requirements where the company can leverage its expertise. This includes both proven "value pools" such as braking and entrance systems, and emerging value pools that are showing every sign of becoming very important in the future, such as energy management and communication between networked vehicle systems.

The company is also exploring new value pools that extend beyond the vehicle itself to encompass vehicle-infrastructure interactions. This includes train, track and operational automation, for example, as well as mission-critical Control, Command & Signaling (CCS) functions. The focus on CCS reflects one of the most significant shifts in the company's strategic vision: Knorr-Bremse now sees itself not just as a supplier and partner to rail vehicle manufacturers and operators, but also as a highly innovative Tier 1 provider of solutions for the entire rail ecosystem.

Knorr-Bremse's entry into the signaling technology business is an important step in this new direction. Braking and signaling systems play a key role in managing safety and capacity in the rail sector – and by adopting an integrated approach to both, the company sees a huge opportunity to develop a truly future-proof rail system.

An interview with Kathrin Moder

"RailServices puts the customer first"

Ms. Moder, when we spoke about the beginnings of RailServices two years or so ago, you said: "In the past, we were mainly involved in supplying the spare parts operators needed to keep their operations up and running over the long term." What's changed?

Safe, long-lasting fleets are still vital for operators today. But in recent years, a number of important new factors have emerged. Increased environmental awareness for one, but also higher energy prices and a sharper focus on rail transportation's economic viability. The latter two points in particular have caused operators to pay much greater attention to their fleets' operational efficiency. This includes taking a much more integrated view of total lifecycle costs.

Can you give us an example?

Surprisingly often, seemingly minor details can have a dramatic impact on a vehicle's operational readiness. If a 20-year-old control board is discontinued, operators need to find a replacement. But if you're already sending a vehicle back to the depot to make this one replacement, it's worth exploring whether any other upgrades would also make sense. Installing Wi-Fi and adding USB ports to passenger seats, for example, or upgrading to state-of-the-art sanitary systems.

Following the liberalization of the rail market, Europe in particular saw an explosion of new vehicle orders. These vehicles are now 20 to 35 years old, depending on when they were commissioned. What does this mean for RailServices?

It means that, whether driven by obsolescence or passengers' rising expectations of comfortable rail travel, operators now face a critical decision: Do we buy new vehicles, or do we modernize our existing fleets to potentially squeeze out another 15 to 20 years of cost-efficient operation?

As Vice President RailServices, you'll undoubtedly have a clear answer to this dilemma.

Clear, yes, but perhaps not in quite the way implied by your question: We're focused on finding the best solution for each operator's unique needs. I see the "new vehicle vs. modernization" conundrum as an exciting challenge that ultimately benefits everyone involved. We approach our service business as enthusiastic innovators, in the firm belief that modernized vehicles can still be incredibly attractive for both operators and passengers.

But doesn't modernization primarily benefit operators with big fleets? If you've only got a few vehicles, doesn't the cost of developing the relevant upgrades become prohibitive?

As Vice President RailServices, Kathrin Moder is responsible for Knorr-Bremse Rail Vehicle Systems' global service business. Kathrin Moder first gained international experience of the company's service side – at that time still very much focused on spare parts – while working for Knorr-Bremse as a student trainee. She began her professional career with the company in 2005 and joined RailServices in 2013.

You're describing a challenge we repeatedly hear about in our conversations with our customers. It's one of the reasons we've refined our strategy so we can offer more turnkey modernization solutions and platform-based midlife upgrades. Increasingly, we're developing concepts for mission-critical subsystems on platforms that either already need or will soon need modernization.

What's the strategic thinking behind this?

By spreading the development costs of modernization across multiple potential customers, we can make it more attractive. It's equally beneficial for leasing providers looking to offer their customers life-extending solutions for their vehicles. Sellers of used vehicles will also benefit. Two other key aspects of our strategic refinement: We're expanding our portfolio of modernization kits and digital upgrades for locomotives and building up our core expertise in hydraulic braking systems and digital solutions. In the rail freight market, we're driving forward digital transformation by making freight cars "smart", with the aim of reducing unscheduled maintenance, improving vehicle availability, cutting costs and saving time. Or to put it in industry terms: We're staying ahead of the curve.

Leveraging a portfolio to create the best solutions

Extending vehicles' service lives, solving challenges associated with obsolescence, enhancing vehicles with new functions and digital upgrades. Let's take a tour of RailServices' ongoing or recently completed modernization projects.

Modernization solutions for platforms

Desiro Classic: replacing critical MRP components with future-proof ESRA technology

In 1999, the first Desiro Classic diesel multiple units manufactured by Siemens Mobility entered regional service with Deutsche Bahn. Without modernization, these ageing vehicles would now be experiencing the first spare parts shortages or non-availability. As well as onboard electronics, these shortages would also be affecting some of the pneumatic components in the original MRP braking systems.

By the end of 2025, RailServices will have completed a modernization program that is replacing critical MRP brake components with advanced brake control products from the ESRA family. This will ensure that Deutsche Bahn can look forward to a reliable supply of spare parts, as well as state-of-the-art repairs and modifications, for the remaining service life of the 155 vehicles concerned.

Knorr-Bremse offers an obsolescence solution for brake electronics in the Desiro Classic, here shown on the Almtal-Grünau line. I © ÖBB-Kriechbaum

The modernization program, which has been approved by the German Federal Railway Authority (EBA), is based on an interface-compatible replacement strategy that does not require any other modifications to the vehicles. Braking forces, bogie setups and vehicle weights remain unchanged, as does the vehicle bus protocol. The new brake unit for controlling the electro-pneumatic (EP) brakes replaces the MRP equipment panel, including the parking brake. The retarder control unit – which uses an advanced digital transducer – is also new, as is the ESRA wheel slide protection system.

In 2024, after a Europe-wide tender, Austrian Federal Railways (ÖBB) placed an order for almost identical systems. The modernization kits are scheduled for delivery starting in 2025, after which ÖBB will begin the vehicle modernization work. Similar Desiro Classic vehicle configurations are used by operators in, for example, Hungary, Bulgaria and Romania – the modernization kit could also help them to overcome similar challenges related to spare parts shortages and the non-availability of trains.

Upgrading the braking systems on LRV platforms

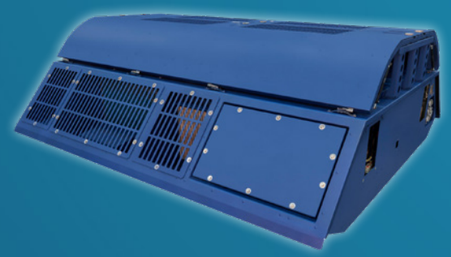
Knorr-Bremse braking systems are currently hard at work in thousands of LRVs in various parts of the world. Many operators have now reached the point of deciding whether to buy new vehicles or modernize their existing LRV fleets. To ensure that these LRVs continue to operate efficiently for many years to come, RailServices designed a package of modernization solutions for replacing key system components that will reach the end of their service life over the next few years.

More specifically, the package includes various solutions for replacing the hydraulic braking system, as well as replacements for the first-generation ESRA brake control systems that were originally installed. Wherever possible, the modernization process leaves existing vehicle interfaces untouched. The aim is to develop solutions that can be implemented across several fleets owned by multiple rail operators, thereby mutualizing the engineering work required and optimizing the costs of modernization for customers.

From product to "full-scope" modernization, including vehicle integration and homologation

Modernizing HVAC electronics in Sweden's Regina fleet

As the years go by, impending obsolescence is also an increasingly urgent issue for climate control systems. These include, for example, the M35 HVAC control boards installed in the Regina multiple units operated by Swedish rail company AB Transitio. Thanks to the board's plug-and-play successor, the M36, this will cease to be an issue for the foreseeable future. RailServices is supplying 225 of the new, state-of-the-art control boards to AB Transitio in the course of 2025 – as a single solution for the Regina VTA1-3, RFT and RSJ series.



A complete HVAC unit customized by Merak for the VIRMm fleet operated by Nederlandse Spoorwegen (NS) in the Netherlands

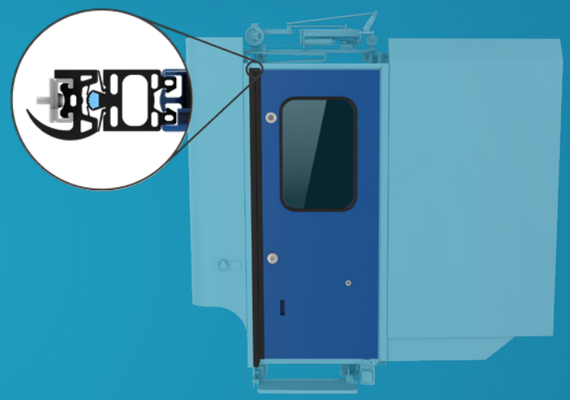
Improved HVAC systems for VIRMm2/3 and VIRMm4 vehicles

Dutch operator Nederlandse Spoorwegen (NS) decided that instead of overhauling the air conditioning systems originally installed in its VIRMm2/3 trains, it would purchase new, much more efficient and reliable systems. Although Merak did not supply the original equipment, NS decided to award the contract to Merak following a pan-European public tender. The project consisted of installing 484 state-of-the-art Merak climate control systems of various types. The modernization work was carried out between 2020 and 2023 – and NS was clearly very happy with the results: Earlier this year, the company placed a largely identical order for another 408 Merak climate control systems for the VIRMm4 series. The retrofitting is being carried out in multiple steps and should be finished in the course of 2028.

A train from the VIRMm fleet operated by Nederlandse Spoorwegen (NS) in the Netherlands

SBB's EW IV intercity coaches: new door system plus approval

Swiss Federal Railways (SBB) currently operates 279 EW IV intercity coaches, representing a total of 1,116 train doors – and plans to continue doing so in the future. These were the quantitative parameters defining a comprehensive modernization project which RailServices completed for SBB at the end of last year. The project focused on a new, more sensitive obstacle detection system, new electric door drives, new door leaves and new door locking mechanisms, combined with visual and acoustic TSI-compliant warning elements that make it easier for passengers with impaired hearing or vision to use the trains. The turnkey solution provided did not just include the engineering and manpower required to install the new door systems – the team also managed the vehicle approval process by liaising with the relevant authorities.



Multi-system modernization

Modernizing multiple systems on Kassel's RegioTrams

Since 2007, an innovative dual-system light rail solution known as RegioTram has been operating in the city of Kassel and surrounding areas in northern Hesse. The light rail solution connects the inner-city streetcar network with the regional rail network, ensuring that travelers can move directly from one system to another. The solution uses 28 Alstom RegioCitadis vehicles, based on two different versions: 18 dual-system vehicles for electrified lines, and 10 hybrid vehicles (DC/diesel) for non-electrified lines. Last year, Kassel's transit authority issued a call for tenders for a comprehensive vehicle modernization program, with the aim of ensuring that the RegioTrams remain in service until 2040 and beyond.

The RailServices department of Knorr-Bremse company IFE was awarded the contract to work on the entrance systems: The vehicles are being given new sliding steps, the ESCO door drive system is being overhauled, and the door control system is being upgraded from PMC to FLEX. Scheduled to run from 2025 to 2030, the project faces a major challenge: to ensure that the many different contractors involved are tightly coordinated so that vehicles to be modernized are only taken out of service for the shortest possible periods of time.

Modernizing luxury rail travel

By following unique itineraries, "La Dolce Vita" Orient Express trains unveil Italy's hidden treasures and help travelers to experience the Bel Paese's most iconic destinations. Operated by Arsenale S.p.A., "La Dolce Vita Orient Express" has been back in operation since April 2025, after undergoing extensive modernization by RailServices.

The new climate control systems optimally distribute cooling power to all passenger compartments. They also support manual or automatic regulation of temperature and ventilation in each passenger car. The compact sanitary systems are equipped with a closed water circuit and early fault detection system. In the magnificent lounge cars, the customized entrance systems help to maximize space and make the whole process of embarking and alighting comfortable and convenient. Included in the package: new emergency brake override (EBO), wheel slide protection and remote diagnostic systems.

RailServices was also involved in modernizing the Venice-Simplon Orient Express (Belmond) between 2023 and 2025. The work included converting previously "open" sanitary systems into "closed-circuit" systems.

View of a passenger coach on the "La Dolce Vita" Orient Express luxury tourist train

Faster, better testing

A huge amount of work goes into rail vehicle design – especially when designing safety-critical braking systems. Knorr-Bremse's virtual testing expertise makes things easier for customers.

"Today, customers can run our braking systems' TrainSim modules on their own systems as virtualized, fully integrated components."

Ralf R. Schmid, Director Global Tools & Test Equipment, Knorr-Bremse Rail Vehicle Systems

The train has just accelerated to full operating speed. Suddenly and unexpectedly, a track signal switches to red. The driver initiates the braking command. The braking system builds up braking force but, within the first few meters, the wheel slide protection system detects critically low levels of adhesion. At the same moment, a passenger manually activates the emergency brake. Simultaneously, a sensor system on the second bogie reports a critical loss of pressure – possibly caused by a ruptured hose.

As unlikely as such a combination of incidents may seem, vehicle manufacturers still like to be sure that the braking behavior of their new trains has been tested and validated in even the most improbably extreme situations. "But it's obvious that it's very difficult to test such extreme scenarios on a real train," explains Ralf R. Schmid, Head of Global Tools & Test Equipment at Knorr-Bremse Rail.

In the virtual world, however, such testing is entirely feasible. "Fault injection" is the technical term for the deliberate introduction of defects or malfunctions into the testing process so that their individual and reciprocal impacts can be validated. "Nowadays, these steps form an integral part of our braking system design process," adds Schmid.

Virtual integration of braking systems into customers' train testing systems

Knorr-Bremse invested in building up virtual testing expertise at an early stage, and has steadily continued to do so. "Today, customers can run our braking systems' TrainSim modules on their own systems as virtualized, fully integrated components," explains Schmid. Vehicle manufacturers can incorporate Knorr-Bremse's function modules into the simulation models running in their own virtual train testing environments. Alstom Transportation, for example, uses this option in the company's TrainLab end-to-end train testing system.

In addition to improving safety levels, this approach also results in significant time and cost savings in the vehicle dimensioning and design process. First, because manufacturers no longer need to build so much expensive hardware, as virtualization can (significantly) reduce the complexity of the "iron bird". And second, because Knorr-Bremse can cost-effectively make certain adjustments to the braking system at a very early stage in the design process.

Three approaches for resolving specific issues

When devising test setups or implementation platforms for new braking systems, Knorr-Bremse's development teams take three different approaches, choosing the most appropriate combination of these methods depending on the technical problem structure.

The **hardware-in-the-loop** approach involves embedding original braking hardware in the virtual test setup. "The hardware runs in exactly the same states as if it were installed in the original vehicle," explains Schmid. "So it doesn't actually 'notice' that it's only running in a test system, and reacts to commands and other influences in exactly the same way as it would if it were running on rails." This means that test runs on physical tracks can be performed at an already validated and more mature stage of development.

The **model-in-the-loop** approach adds similar value. In this case, the test system models – for example – the mechanical properties and friction effects of system components. This makes it possible to implement test scenarios featuring a wide variety of system states and environmental conditions, which can be directly selected as required. So the results of component-related tests can be used for and applied to tests of the entire vehicle.

Developers using the **software-in-the-loop** approach embed the original brake control software in the simulation setup. In this case, the brake control system's suitably prepared but logically identical source code runs on a simulation server instead of the real-world train control system, so that programmers can carry out validation, optimization and other steps or adjustments at an early stage.

The advanced TrainLab (aTL) navigating autumnal rail conditions on the test track between Krakow am See and Karow.

Future technologies: Knorr-Bremse puts brake innovations to the test

Working with Deutsche Bahn and DB Systemtechnik, Knorr-Bremse is testing brake-level functionality in the "advanced TrainLab" (aTL). While paving the way for automated train operation (ATO), the tests also represent the next step toward Reproducible Braking Distance (RBD).

Picture this – first-class ICE train seats filled with passengers wearing bright orange safety vests, their alert faces focused on open laptops. Because this is no ordinary business trip. These technical specialists, employed by Knorr-Bremse, Deutsche Bahn and DB Systemtechnik, are all sitting in the advanced TrainLab (aTL) as it repeatedly brakes to a standstill on a secluded branch line in Mecklenburg-Western Pomerania. And this is precisely the purpose of their journey.

The engineers are conducting their braking mission on behalf of Europe's Rail Joint Undertaking (ERJU)*, the European partnership for rail research and innovation. R2DATO (Rail to Digital Automated up to Autonomous Train Operation) is the acronym of an ERJU project focusing on automated train operation (ATO). Using technologies from Knorr-Bremse's Reproducible Braking Distance (RBD) program, the company is aiming to support the project by providing brake and adhesion management systems. Last autumn's test runs, involving over 350 braking maneuvers, put these systems through their paces.

Members of the Knorr-Bremse test team at one of the aTL measuring stations during a test run.

Tackling even the most challenging rail conditions

Before conducting the tests, the team installed project-specific measuring technology in the aTL, with over 1,000 channels for recording – in particular – the performance of the wheel slide protection and sanding systems also fitted to the aTL. Now they are focused on the in-depth evaluation of the results of 200 or so of these signals.

To efficiently improve wheel-rail adhesion – the whole point of Knorr-Bremse's Adhesion Management (ADM) system – the sanding process must be precisely controlled. Unlike the conventional method, which involves applying a predefined quantity of sand to a single wheelset per vehicle in a given direction of travel, the new function will distribute the sand in an intelligently controlled manner at multiple points along the entire train, dynamically adapting to the actual level of adhesion between wheel and rail in real time.

While this does mean installing additional sanding systems on the train, the higher – and above all, more reliable – level of adhesion achieved makes a vital contribution to bringing the train to a consistently reproducible halt within defined braking distances, especially in poor track conditions. The test crew simulated adverse test scenarios by creating various challenging wheel-rail adhesion conditions using mixtures of water and soap, paper, oil and leaves.

Validating the new adaptive wheel slide protection algorithm

Previously, the advanced TrainLab had already used the new WheelGrip Adapt wheel slide protection algorithm to successfully brake to a standstill on slippery surfaces from speeds of up to 160 km/h. The algorithm was installed in the test brake control system so that its impact on the utilization of available wheel-rail adhesion could be quantified in "autumnal conditions".

The measurements were performed on a main line near Minden in North Rhine-Westphalia in accordance with the current EN 15595 standard, meaning that the algorithm can be considered ready for regulatory approval. The wheel slide protection system also collected data for adhesion mapping – a technique that could eventually link wheel-rail adhesion data to precise positioning references such as GPS coordinates or predefined sections of track.

A continuous innovation cycle

In the case of Deceleration Management (DMM), the team focused on calculating a train-wide deceleration value from the data supplied by networked local CubeControl units, and on forwarding this data to the other RBD functions.

The test program finished by analyzing the performance of the magnetic track brake on a leaf-covered track. The data obtained from these measurements makes it possible to quantify the adhesion-enhancing impact of wheel slide protection systems, sand and magnetic track brakes – both on the train itself and on following trains. Reproducing these effects in simulation models is a basic prerequisite for transferring aspects of real-world test runs to simulation test rigs. Given the (very) limited availability of suitable tracks, this approach could be used to further develop DB Systemtechnik's well-established procedure of combining the results of simulated bench tests with real-world tests for the certification of wheel slide protection systems.

Analysis of the various metrics is ongoing, and Knorr-Bremse and DB Systemtechnik plan to publish their findings toward the end of 2025. In parallel, they are also planning a possible follow-up project with new testing criteria. In the world of technical innovation, one truth remains constant: Today's breakthrough is tomorrow's starting point.

New braking system technologies are paving the way to automated train operation (ATO).

*This project received funding from the Europe's Rail Joint Undertaking (ERJU) under Grant Agreement 101102001. In turn, the ERJU receives financial support from the European Union's Horizon Europe research and innovation program, and from ERJU members other than the European Union.

WTB gateway family awarded three top certificates

The Rail Computing & Communication business unit’s three Wire Train Bus (WTB) gateways have been awarded certificates of compliance with UIC Leaflet 556. No big deal? For customers managing new vehicle or modernization projects, it’s a major plus.

WTB gateways integrate proven train bus technology with state-of-the-art vehicle architecture – enabling seamless interoperability in today’s digital rail operations. As a key element in train bus communication, their intelligent processes ensure that every trainset is explicitly recognized and correctly configured, and that trains, locomotives and cars can all communicate with each other over train bus systems. The gateways also enable seamless communication between the WTB train bus and the various vehicle buses used for

Ethernet, MVB or CAN (illustrated) versions of the Wire Train Bus (WTB) gateway are available.

functions such as braking systems, door controls or safety-critical data transmission, depending on the application. And now the WTB family developed by the Rail Computing & Communication business unit – part of Selectron Systems AG in Switzerland – has achieved a key milestone: three successful certifications of compliance with UIC Leaflet 556.

All three versions are easy to configure

Versions of the Wire Train Bus (WTB) gateway are available for Ethernet, MVB (Multifunction Vehicle Bus) and CAN (Controller Area Network) TCNs, suitable for a variety of vehicle architectures. Thanks to an intuitive user interface, all three versions are easy to configure. The devices also meet IEC 62443 cybersecurity requirements for Security Level SL2.

“Vehicle manufacturers now have access to a flexible WTB gateway that matches the technology they’re using,” explains Luca Della Ricca, CTO of Knorr-Bremse subsidiary Selectron Systems Italia, based in Udine, Italy. This is equally true of modernization projects: “Vehicles equipped with WTB can continue to operate over MVB or CAN-based consist buses, or else be converted to the latest Ethernet technology.”

Challenging approval process

The certification was preceded by almost five years of intensive preparation. “Our teams began working on the approvals just as the COVID-19 pandemic was gathering pace,” says Della Ricca. “It wasn’t the easiest start!” Even so, from a market perspective there was no alternative: “The certification takes a complex, cost-intensive task off our customers’ shoulders – it’s a process that’s almost impossible to manage without in-depth specialist knowledge.”

Three certificates confirming reliable interoperability

Reliable rail mobility throughout the Eternal City

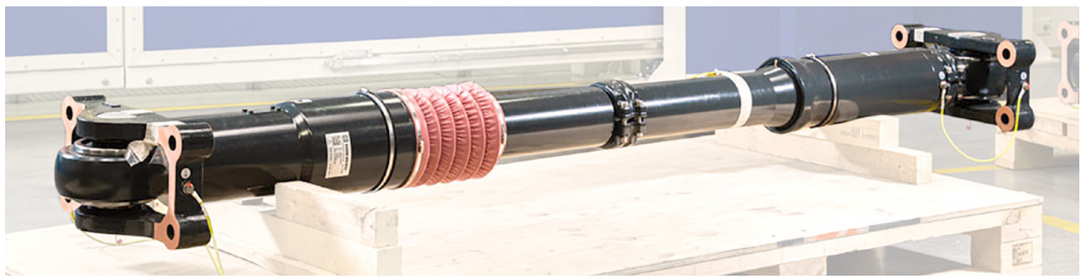
Following a successful project to equip 46 new trains for Milan Metro, which started in 2023, Hitachi Rail has now placed an equipment order for up to 30 trains destined for Rome Metro. The manufacturer aims to install three different types of couplers from the Knorr-Bremse portfolio – along with other systems.

For those who can see beyond the preconceptions conjured up by the puttering Vespa, tooting Panda and growling Ferrari, Italy's mobility landscape tells a far richer story.

After all, this unrepresentative list – however iconic – scarcely does justice to the country's local public transit network. In Milan and Rome alone, well over one million passengers travel "in treno" (by train) every day. In 2023, Milan's public transit operator, Azienda Trasporti Milanesi (ATM), added 46 new Hitachi Rail trains to the city's fleet. But the order also marked Knorr-Bremse's entry into the technologically sophisticated coupler segment.

Coupling at speeds of up to 15 km/h – no problem for 'AutoLink'

From Knorr-Bremse's perspective, a new order from Italy – this time from the Azienda per i Trasporti Autoferrotranviari del Comune di Roma (ATAC) – is very similar. Hitachi Rail is installing electropneumatic braking systems complete with 'FlexControl Modular' brake control systems and 'SysControl' brake electronics – including a wheel slide protection system – in up to 30 six-car metro trains. Included in the scope of delivery are weight-optimized, maintenance-friendly



Among other systems, Knorr-Bremse will supply couplers for the trains that have been developed in Munich and the company's large R&D center in Budapest. | © Knorr-Bremse

entrance systems from IFE that will keep passengers safe while boarding and alighting and also help to keep rail operations reliable. The framework agreement includes a base order for 14 trains and an option for an additional 16 units. Hitachi Rail is installing three types of couplers from Knorr-Bremse's coupling system portfolio: an 'AutoLink' automatic front ("center buffer") coupler, capable of efficiently coupling trains at speeds of up to 15 km/h, and two variants of the 'Short Link' semi-permanent coupler for connecting together the railcars in each trainset.

Customized coupler heads for full operational compatibility

The design of the front couplers in particular is customer-specific. For historical reasons, Rome Metro uses a special coupler layout (as does Milan), so Knorr-Bremse has redesigned the coupler heads to ensure that the new vehicles are fully compatible with existing stock.

The first Knorr-Bremse coupling systems were delivered in November 2024. ATAC plans to put the first of the new trains into passenger service by the end of this year.

Blue-white train of the future

For the first time, Siemens Mobility is installing Knorr-Bremse coupling systems – starting with the prestigious Munich S-Bahn project. The braking equipment also includes a quieter compressor.

THE NEW TRAINS CAN REACH A TOP SPEED OF 160 KM/H
©SIEMENS MOBILITY GMBH

Around 202 meters long, each of the new trainsets destined for Munich's S-Bahn (suburban rail) network is capable of carrying up to 1,841 passengers. Passenger cars feature family and group zones at each end. There are 480 seats in total, each equipped with storage areas and USB-C ports. Comprehensive passenger information – such as details of the next station, the train's progress, and connecting services – appears in real time on 104 displays. A display above each door provides information on platform facilities at the next station – do you turn right or left to find the elevator?

The multipurpose areas are evenly distributed throughout the 13-car trains. They each feature an additional entrance, so that even passengers with bicycles can easily reach a door. There are also specially designated wheelchair areas with dedicated displays. Hearing-impaired passengers with Bluetooth-enabled hearing aids can connect to the train's PA system so they no longer miss any announcements.

Even less noise thanks to new, electrically controlled compressor fans

The arrival of the first of at least 90 new lightweight trains on Munich's rail tracks in 2028 will also be a special moment for Knorr-Bremse: For the first time, Siemens Mobility is installing Knorr-Bremse coupling systems, in the form of automatic center buffer couplers.

The braking systems include magnetic track brakes (MTB), pneumatic brake control systems, bogie equipment and the latest generation of ScrewSupply Eco screw-type compressors. The new compressors will optimize maintenance and overhaul cycles, and further reduce sound emissions by using smart components such as electrically controlled fans.

Also part of the order: wiper/wash systems, adding to years of successful collaboration between Siemens Mobility and Knorr-Bremse in this particular product segment. Knorr-Bremse wiper/wash systems are already used on the Mireo train platform.

New look for the new S-Bahn trains

With the new trains, the operator is also introducing a new color scheme. Instead of the previous red livery, the new trains will be painted white and blue. Although the blue is inspired by the diamond pattern on the Bavarian flag, it will be based on the slightly darker shades of blue used by the Bavarian rail operator.

KNORR-BREMSE