INFORMER

G R O U N D - B R E A K I N G Innovations for the Digital Freight Train from Knorr-Bremse

GREEN POWER Alternative drive systems for new and existing vehicles

PARTNERSHIP FOR THE FUTURE

Launch of Europe's Rail Joint Undertaking

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KNORR-BREMSE

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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.



Dear Reader,

As someone familiar with the rail sector, how long do you think setting aside administrative preparations and obligatory brake testing – that it takes to prepare a freight train with, for example, 25 cars? Roughly one hour.

That's the time it takes for the marshaller to hang the 30-kilo drawbars of the screw couplers onto the towing hooks, tension the connections and connect the brake pipes. He then walks along the entire length of the train on one side, tapping each brake to test it, and back along the other side. Which takes about another three quarters of an hour.

This may be a rather extreme example – in reality the amount of time needed depends on various factors. But it illustrates a basic problem: Whereas road freight transportation has long since developed just-intime operations, Europe is still preparing freight trains almost exactly as it used to 130 years ago. As a result, rail is often not competitive in this segment.

But if we care about the future of our planet, this is obviously a crucial issue: Measured in ton-kilometers, a truck emits around six and a half times more greenhouse gases than a train. And as you know, switching to green electricity could enable rail to reach 100-percent renewable energy consumption faster than any other transport mode.

That is why, in "Spotlight" (p. 16), we take a look at plans for the Digital Freight Train, or DFT. Digital Automatic Coupling (DAC) enables entirely new functionalities in freight trains: automated brake testing, parking brake control and remote control coupling, monitoring and train completeness check.

Elsewhere, this edition of the informer is also full of groundbreaking ideas. For example, on p. 8 we present the DB Regio train - a project in which Knorr-Bremse is involved. We also present the new Evac brand (p. 20), under which the global technology leaders for rail vehicle sanitary systems - Knorr-Bremse and the Evac Group - have joined forces. In addition we focus on alternative drive systems (p. 22) in the rail sector, which are beginning to play a crucial role in sustainable, low-emission, energy-efficient mobility. And then there is a global first which we and Siemens Mobility are particularly proud of: the world's first collaborative project between a leading systems supplier and a leading vehicle builder, in the field of digital condition monitoring of HVAC systems (p. 28). But why not read about all this for yourself?

Yours sincerely,

Harald Schneider



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

Information for **Knorr-Bremse's customers** and business partners

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In the shadow of major projects

RailServices' comprehensive, state-of-the-art modernization portfolio offers more than just braking, door and HVAC systems.

PORTFOLIO DIVERSITY in the High Speed

Clean and comfortable: new on-board sanitary systems

Installing modern systems based on vacuum technology in rail vehicles is a challenge that calls for creativity as well as expertise. For example, RailServices engineers hit on the idea of saving space by "hiding" the water supply and waste water tanks behind compartment walls or under seating.

Reliable and durable: new on-board power converters

As vehicles age, sourcing spare parts can become increasingly difficult. On the principle that installing new components can significantly extend a vehicle's life, RailServices collaborates with Kiepe Electric to offer replacement on-board power converters.

Efficient and safe: new sanding systems

Sanding systems are a tried-and-tested way of improving poor track adhesion and ensuring that trains can continue to operate at optimum intervals. Modern, speed-related sanding not only cuts the quantity of sand required but also reduces downtimes by extending the intervals between sandbox fillings.

Unobtrusive but invaluable: air guality monitoring

Drawing on the principles underlying its energy metering system, Knorr-Bremse company Microelettrica has developed a system for monitoring air quality in trains. The straightforward plug-and-play solution provides passengers and operators with real-time information on air quality.

The one-stop shop: improving customer satisfaction

With its new one-stop shop (OSS) concept, RailServices aims to deliver even greater customer satisfaction. Knorr-Bremse is now offering support for any screw compressor brand – including remakes of modules that are no longer available on the market. "If the customer wants something and it's technically feasible, then we'll do it for them," says RailServices employee Sylvie Muller. This approach has gone down well with the market – over the next four years, RailServices will be overhauling around 1,200 units for French rail operator SNCF, starting with the screw blocks.

RailServices has also won another order for the "like-for-like" replacement of screw blocks that have been discontinued by the manufacturer. This will allow SNCF to keep 110 trains in service. A combination of dedicated capacity, exceptional training processes and decades of experience with screw compressors allowed RailServices to start delivering the existing design this year. "By working directly with the operator, we are finding ways of optimizing the project that we would never have imagined when we started," adds project coordinator Reinhard Rauscher.



InnoTrans 2022

September 20–23, 2022 Berlin

Knorr-Bremse looks forward to welcoming you to Stand 250 in Hall 1.2

There will be more information on our special focus and general reports about the event in the next informer (August 2022)



The Knorr-Bremse Melksham site has once again been awarded a RoSPA Gold Medal for its excellent standards of health and safety. This year, the site also won an additional special award.



Gold Rush

This is what consistently high-quality working conditions look like: For the tenth year in succession, the Knorr-Bremse site in Melksham, southwest England, has been awarded a Gold Medal by the Royal Society for the Prevention of Accidents (RoSPA). With this prestigious annual award, the charity honors companies that have an exemplary record of protecting the health and safety of their employees. This year, the site also received a RoSPA President's Award in recognition of having won ten "normal" Gold Medals in a row.

"What an achievement!" said Paul Rooke, Director of Quality and EHS: "Receiving this award is a testament to our Health & Safety team's tireless work. A huge 'well done' to everyone who contributed to this latest success."

RoSPA is an internationally recognized organization that focuses, amongst other things, on corporate health and safety management. Its awards are recognized as some of the most prestigious of their kind, and applications for them are received from companies all over the globe.

DELIGHTED WITH THE LATEST ROSPA AWARD for Knorr-Bremse Rail Systems UK in Melksham are, from left to right, Paul Rooke, Director, Quality and Environmental Health and Safety (EHS), Joe Chamberlain, EHS Advisor, and Samantha Franklin, UK EHS Manage

Stay well informed about the latest developments in the world of rail vehicles!

On our (Rail) LinkedIn channel we report on the latest innovations and trends making waves in the rail world. Read more about our Knorr-Bremse facilities the world over.





Egypt on the right track

Africa's second-largest economy – Egypt – is investing massively in its rail infrastructure. And Knorr-Bremse is heavily involved.



Egypt has made the train its new transport mode of choice - and is planning to link its main ports by rail. In the country's major cities, streetcars and monorails are already competing with traditional minibuses. Siemens Mobility is supplying Egypt with high-speed and regional trains, locomotives and rail infrastructure, as well as accompanying services. For the Velaro high-speed trains and the Vectron locomotives, Knorr-Bremse is responsible for the braking systems and also, in the case of the Velaro, the door systems.

Progress Rail Locomotives supplying 50 locomotives

The Egyptian state railway company ENR has ordered fifty JT42 platform locomotives from Progress Rail Locomotives. New York Air Brake (NYAB) has developed a JT42-specific variant of its CCBII brake control system with dual BC control. The block brake units are also specially designed for the JT42 bogie. The air supply comes from SL22 compressors.

for Cairo

NEWS

Alstom to deliver 29 four-section monorail trains

Two monorail lines in Cairo are currently being built or expanded. Knorr-Bremse is equipping 29 Innovia "Monorail 300" four-section trains from Alstom with braking systems. The vehicles are even being fitted with two independent braking systems – one electro-dynamic and the other electro-hydraulic. Another special feature is the fact that the individual brake calipers can be opened mechanically to facilitate maintenance work.

10th of Ramadan City LRT

Egypt is creating a completely new administrative capital immediately to the east of Cairo - and the new urban areas will be connected by rail. "Light Rail Transit" (LRT) is the name of this project, which will also have a station on the new high-speed line from the Red Sea to the Mediterranean. Chinese manufacturer CRRC Sifang is supplying 22 six-section trains, for which Knorr-Bremse is providing the braking systems. Knorr-Bremse Group company IFE is involved in the project via its subsidiary in Qingdao, China - supplying 1,056 RL2-e2 entrance systems.



Ideas trains set new standards

the commuter train of the future.

the train."

What would happen if we were to completely rethink trains? If we designed them to meet individual needs? With flexible capacity? Knorr-Bremse has partnered with DB Regio to develop the "Ideas Train" project.



View the virtual tour



HVAC solutions from Knorr-Bremse brand Merak clean the air in three dimensions: "First, optimized distribution and mixing improves air quality by blowing in additional fresh air," explains Merak CEO Fernando Hazeu. In the next stage, market-proven Merak filters separate out particles smaller than 30 micrometers (µm) with an efficiency of more than 99 percent - "including aerosols that can transport SARS-CoV-2 viruses." The third element consists of air purifiers that not only separate out pathogens but also - as confirmed by independent laboratory tests - efficiently remove them. "The system installed in the IdeasTrainCity effectively showcases two of these dimensions and the flexibility of Merak's solution to adapt to any operator's needs."

Seating configurations that extend or retract at the push of a button.

Seats for rush hour commuters when required - but also space for

bicycles and baby strollers in the afternoon. New types of displays

and digital foils on windows and doors to improve passenger infor-

interior temperatures. A combination of these innovative ideas can

be found in DB Regio's new IdeasTrainCity - a full-scale mock-up of

"The innovations in the IdeenzugCity are the key to increasing rail

passenger numbers and protecting the climate at the same time,"

said Jörg Sandvoß, CEO of DB Regio, at the presentation of the new

mobility and attract more people to a greener mode of transport -

concept this summer. "This is how we can bring about a revolution in

mation. New HVAC systems to ensure air quality as well as controlling

By using innovative sensor technology and software, Merak also offers air quality monitoring and visualization (CO2, PM10, PM2.5 and VOC values) that can be made available to operators and passengers at any time. Combined measures such as these are essential for maintaining passenger confidence in trains as the most sustainable method of transportation.

Evac in the IdeasTrainRegio: Comfort and well-being in the sanitary facilities

The IdeasTrainCity is the second life-size mockup from DB Regio. The IdeasTrainRegio first presented to the public in 2018 is now equipped with newly designed sanitary facilities and a flexible system for carrying bicycles. Here, too, there is Knorr-Bremse technology on board - the new sanitary systems come from Evac, the latest company to join the Knorr-Bremse Group. Having installed over 100,000 sanitary facilities in regional and high-speed trains worldwide, Evac is a leading supplier in this segment.

In designing the toilet cubicle of the future, this specialist company has created a brand-new user experience, with warm colors, bright lighting and pleasant materials. The main focus is, of course, on hygiene. Door opening and locking, flushing and waste bins operate contactlessly - and the same goes for soap or disinfectant dispensers, faucets and driers.

But the cubicles are also configured for common everyday situations: For example they are equipped with a fold-down baby's changing table made of soft fabric material and cleverly located so that an adult can easily stand in front of it. The baby restraint enables an adult to use the toilet without having to hold the baby.

And thanks to Evac, if you merely wish to wash your hands, you no longer need to enter the cubicle - it comes with an external hand-washing facility. One thoughtful detail is a kick mechanism that causes a footstool to slide out, enabling a child to use the facility.



Train, not plane



ICE 3 NEO-VELARO

This is the well-known mantra of those advocating more environmentally friendly - and often also faster - travel on heavily used routes between major cities. Knorr-Bremse recently received further major orders from Siemens Mobility for two more high-speed projects. The next 43 Velaro ICE 3neo high-speed trains for Deutsche Bahn are to be equipped with braking systems – including eddy current brakes – by Knorr-Bremse. In Egypt, Siemens Mobility is supplying high-speed and regional trains, locomotives and rail infrastructure as well as related services. The Velaro high-speed trains ordered by Egyptian State Railways from Siemens Mobility are being equipped with braking systems by Knorr-Bremse that have been specially adapted for the difficult environmental conditions in North Africa.

Both projects – in Germany and in Egypt – will also be fitted with rapid-closing, pressure-sealed IFE entrance systems. These have an important role to play in ensuring intelligent passenger flow management, shorter station stops and improved passenger comfort.

Continuous improvement



Felix Iñiguez wins Merak's first ever Employee Quality Award. This new award recognizes outstanding quality improvement ideas. To qualify, they must have been successfully implemented in the company's processes.

"Quality is our watchword", says Merak Managing Director Fernando Hazeu. "It's an area where we want to keep improving – especially at a time when supply chains and transportation are under pressure." It was this commitment that gave rise to the idea of an Employee Quality Award last year. "We see this as another measure that will help us go the extra mile in our quality assurance."

QRQC adapted to HVAC system production

Award winner Felix Iñiguez came up with an innovative idea for faster and "more reliable" certification of the sealants and coatings that are used in one of HVAC technology's special processes. "Many of them were originally designed for the automotive industry. But in the HVAC systems business they need to meet higher requirements, for example with regard to fire safety and fatigue strength." explains Iñiguez. This means the materials have to undergo additional validation. But according to Iñiguez, it can be difficult to predict whether they will be able to satisfy the demands placed on them. This led him to create a database of materials with similar formulae that have already been certified. He also involved suppliers in the process. "It means not only that we are better able to predict a material's suitability for a specific application, but also that we can validate it significantly faster." And faster validation means shorter lead times. It goes without saying that this must not result in any deviation from the specified product quality or generate any NCRs (non-conformity reports).

Managing Director Hazeu stresses that the procedure for dealing with NCRs in general forms an integral part of the company's quality processes. "It's based on an approach called Quick Response Quality Control, or QRQC, that originated in the automotive industry. We have adapted the QRQC methodology – which encompasses logistics, production, production technology, quality, engineering, and maintenance – to the production of our HVAC systems. This allows us to respond rapidly to any deviations and ensure that they are permanently resolved."

He also highlights the importance of systematically involving local employees in order to continuously develop their awareness and problem-solving skills. Hazeu believes that the award, which will now be presented annually, was an obvious next step that sets a positive example.



France: Retrofitted sanding systems



ADJUSTMENT OF SANDING SYSTEMS on AGC equipment

Exclusive maintenance contract for up to 15 years

Spanish rail vehicle manufacturer CAF has set up a long-term partnership with Knorr-Bremse RailServices for the maintenance of various train types and several of their sub-systems. This fall, Knorr-Bremse and CAF signed a global framework agreement with a value in the mid double-digit million euro range for the maintenance of braking systems (including friction materials), HVAC systems, and entrance systems. The contract runs for a period of eight years, with an option to extend it for a further seven.

The lengthy contract period is part of CAF's global procurement strategy of signing long-term agreements with strategic suppliers, reflecting its comprehensive commitment to improving quality and competitiveness. It also avoids the need to spend significant time and effort negotiating new maintenance contracts, as individual contracts can be swiftly incorporated into the framework agreement and adapted to specific project requirements.



Sanding systems are essential for the reliable operation of rail vehicles – and Knorr-Bremse always has replacements available for legacy systems. Now another major operator in France has decided to install new systems in several of its trains, improving functionalities, accuracy, and quality compared to competitors' homologated products. Initially the customer had retrofitted new sanding systems to ten regional trains, but it has now placed a further order for 55 trains.

The decision came after close technical consultations between the rail operator and Knorr-Bremse France as well as extensive testing using the customer's own vehicle fleet. The system installed is an easy-to-implement solution that delivers a consistent, high-precision jet of sand between wheel and rail. Furthermore the settings can be adjusted remotely from the driver's cab as well as on the nozzle of the sand pipe itself.



Continuous improvement

Filling in the annual customer satisfaction survey is a quick, straightforward process, but the responses offer Knorr-Bremse invaluable feedback to help target its offerings even more precisely towards customers' requirements.

Knorr-Bremse has a long tradition of organizing and analyzing customer satisfaction surveys – after all, excellent products and services must above all be geared to the needs of the customer. The results of the latest survey paint an overall positive picture that serves both as a confirmation and an incentive.

In the OE sector, customers' evaluations of Knorr-Bremse braking systems, project management and logistics continued the upward trend recorded in recent years. Their perceptions of the Company in terms of strength and reliability as business partners also improved. And they praised the robust processes that helped avoid any service interruptions during the Corona epidemic. While the results reflect the Company's position as a leading developer of sustainable transportation technologies and confirm the positive environmental and safety credentials of its products and systems, the survey also reveals some room for further improvement. Above all, customers want to see faster responses to complaints and quotations – as well as shorter throughput times.

RailServices combines survey with fundraising campaign

One of the special features of the RailServices survey is that each return triggers a donation of ten euros to one of two Knorr-Bremse Global Care projects, with customers being asked at the end of the survey where the donation should go. With almost 300 returns, the latest survey raised nearly EUR 3,000 for a children's home in Ukraine and an education project in Cambodia.



"Silver ISO" for Knorr-Bremse France



EXTERNAL VIEW OF THE KBSF BUILDING the first French company to receive a Silver Level award

INFORMER RAIL VEHICLE SYSTEMS

XInvoices for Deutsche Bahn

In technical terms, the XInvoice is little more than a structured XML data model. But in practical terms it represents a significant step towards the paperless office. That is the background to the decision by Knorr-Bremse Systeme für Schienenfahrzeuge and Deutsche Bahn AG to introduce this next stage of electronic invoicing with effect from the start of Q3, 2021.

The crucial advantage of the XInvoice is the fact that all the relevant invoice data can be processed without further manual intervention. If required, further documentation can also be easily incorporated – and automatically processed. The necessary security is provided by a structured identification number, the so-called Routing ID, which enables the invoice recipient to be clearly identifiable at all times.

From the perspective of Deutsche Bahn, the aim is to streamline invoice approval processes and cut processing times. The advantage for Knorr-Bremse is improved cash flow thanks to punctual payment within the deadline. Since the system was first introduced, Knorr-Bremse has sent Deutsche Bahn some 1,500 XInvoices for RailServices spare parts directly from its SAP R/3 system – the equivalent of around 18,000 invoices per year.

NEWS

In 2020, following an auditor assessment, Knorr-Bremse Systèmes Ferroviaires France in Tinqueux became the first company in France to be awarded "Silver Level" certification according to IRIS standard ISO TS 22163. Now, in fall 2021, the site has achieved certification for the second time.

The international standard is based on the ISO 9001 quality management standard, but includes additional rail-specific requirements. Its aim is to strengthen competition and ensure higher quality standards by using uniform terminology, uniform evaluation guidelines, and standardized audits.



Simone Mantero

becomes new Confindustria president in Florence-North



The Confederazione Generale dell'Industria Italiana – Confindustria for short – is the largest Italian employers' organization, representing the majority of the Italian manufacturing and service industries. Simone Mantero – Managing Director of Knorr-Bremse Rail Systems Italia – has now been elected as the new President of one of its largest regional divisions, Florence-North.

"I am delighted with the trust placed in me and am proud be representing – for at least two years – almost 200 Confindustria companies in one of the strongest industrial regions in the country. I am at their service," said Mantero. "My tasks include further strengthening the region's attractiveness for investors and ensuring that research and innovation, infrastructure, mobility, public services, and digitalization have a strong, sustainable backbone."

Mantero does not intend to operate alone. "I see myself as a team player, working together with the vice presidents, the counsellors and other parties involved – for example when it comes to greater diversity in companies, an exchange of ecological best practices across the sectors, and improved links between educational institutions and industry.

Pneumatic gives way to electric

Operating as a general contractor, IFE is supplying a safety upgrade for more than 1,000 door systems and installing it in SBB EW IV passenger cars.



In August 2019 a serious accident in Switzerland involving an EW IV passenger car prompted Swiss Railways to launch an extensive modification program for its door systems. In a first phase, ten cars were fitted with a customized solution, after Knorr-Bremse Group company IFE had successfully modified four cars and achieved approval by the Federal Office of Transport (FOT). On this basis the SBB has now ordered a second series of more than 249 cars with a total of 988 door systems from IFE's factory in Kematen an der Ybbs, Austria.

The biggest modification is a systemic one - changing the original pneumatic drive unit to an electric system with modern electronic control. In addition to the new drive system and more reliable obstacle detection, TSI-compliant door controls and visual and acoustic warning systems have been retrofitted. The cars are currently undergoing modification at the main SBB workshop in Olten, Solothurn Canton, with SBB's Aebimatt workshop in Bern Canton also due to be involved. The program for the second series is scheduled for completion by mid-2024.

The upgrade will ensure that the vehicles, which date back to the 1980s, will be able to safely and reliably serve SBB passengers right into the 2030s.

SBB is also planning a further door system upgrade for its long-distance fleet with preparations underway to modernize similar Type IC/ICV Bt cars.



It was in Berlin in 1905 that Knorr-Bremse embarked on its journey towards becoming the global market leader for rail vehicle braking systems. Now the Company has significantly expanded its brake disc manufacturing capacity in the German capital.

The underlying reason for expanding disc production in Berlin was the pressure on disc manufacturing capacity in general. The importance of the decision became increasingly clear in 2021, when three of the four remaining machining centers went into operation: "We were able to cut delivery time for standard brake discs to between six and eight weeks," explains Frank Junghans, Vice President RailServices Deutschland. "As a result we can now offer customers an even greater degree of reliability, flexibility, and adaptability for equipping their fleets."

Customer reactions have been highly positive - for example from J. Felix Beck, Head of Supply Chain Management at DB Fahrezeuginstandhaltung GmbH: "Greater environmental awareness and a shift in mobility patterns thanks to Germany's 'Strong Rail' strategy meant we needed to bring forward delivery dates for axle-mounted brake discs for the 411 and 415 series," he reports. "Without the additional production capacity developed in Berlin, this would not have been possible at such short notice."

NEWS



BRAKE DISC PRODUCTION at our Berlin plant

Commitment to Germany and the Berlin home base

A total of 15 million euros has been invested in nine machining centers, including CNC machines for turning, drilling, and milling. They have been specially designed for disc production, for example for axle-mounted brakes on high-speed trains. Each center is capable of producing a double-digit number of steel discs per day.

But there are other equally important factors for Knorr-Bremse and its customers: The new centers enable production to rapidly switch between disc types - for example for high-speed or metro trains. And of course an investment in 27 new full-time jobs is also a statement of commitment to Germany and Knorr-Bremse's Berlin home base.

There is a shortage of manpower, as the working environment particularly when it comes to coupling/decoupling activities - is a dangerous one. Single freight car operations, in particular, no longer meet 21st-century needs. Routing individual cars from start to finish is a time-consuming and difficult process. As a result, loads have to be regularly transferred to other transportation modes. Part of the problem is the fact that many of the processes involved in train preparation are not automated, and the process of setting up a 25car freight train can easily take up to an hour. In other words: Rail freight transportation is too slow, too sluggish, too expensive, and too inflexible - and therefore often uncompetitive compared with road freight.

Elecurified

CARGO

Rail freight has a reputation of being too slow, too sluggish, too expensive, and too inflexible compared with road transportation. But now a new epoch is dawning with the birth of the digital freight train. Knorr-Bremse is at the forefront of the three main areas involved.

SPOTLIGHT 17

That is one of the challenges the sector faces. The other is related to the EU's climate goals. By the year 2030, the EU aims to increase the proportion of freight transported by rail from currently 18 percent to 30 percent. This plan is based on a simple calculation: A truck emits some 111 grams of greenhouse gases per ton-kilometer, whereas the equivalent figure for a freight train is a mere 17 grams. Furthermore, no other means of transport can so rapidly achieve 100-percent consumption of renewable energy in the form of green electricity. Yet - and this is where competitiveness and climate protection overlap - there is one precondition if the EU's goal is to be met: Rail freight has to become much more attractive.

This makes development of the digital freight train crucial: using automated processes and digital solutions to increase transportation capacity and boost efficiency and reliability, making rail freight faster, more predictable, and more flexible. But automated processes for trains and entire fleets are only possible with smart freight cars that are capable of automatization and do not reduce current vehicle interoperability.

OVERVIEW of the digital freight train and its main functionalities

From individual cars to complete trains and their configuration, engineers are focusing on three main areas that can combine to offer maximum added value:





FREIGHTLINK: the new **Digital Automatic** Coupling (DAK) FreightLink: Digital Automatic Coupling With FreightLink Digital Automatic Coupling (DAC), Knorr-Bremse is introducing a system that has long been the norm for passenger trains and can offer a crucial boost to the efficiency of freight trains. In addition to automatic mechanical/pneumatic coupling and uncoupling, the functionality of the DAC system also includes the train's electrical and data connections. In other words, FreightLink not only automates the coupling process itself - it also acts as a central enabler for digitalizing and automating the entire train. A combination of DAC, automatic brake testing and intelligent environment observation makes it possible to carry out highly automated marshalling operations.

Knorr-Bremse is one of four coupling system manufacturers participating in the European DAC Delivery Program (EDDP). The focus is on future standards for migration of approximately 500,000 European freight cars as well as coupling testing in collaboration with freight train operators.

In general, industry-wide cooperation is considered crucial for the Digital Freight Train to be successful. This is because there are enormous challenges, especially when it comes to interoperability: Mechanical elements, electrics and software equipment, DAC, pneumatic brake equipment - and soon also the electro-pneumatic freight car brake - all have to be able to be supplied by different manufacturers.

FreightControl: Freight train automation

FreightControl aims to equip today's mechanical/pneumatic freight cars with electronics for automation as well as further digital functions - for example in order to automate manual processes such as predeparture brake testing. It promises to make frequent checking of each individual brake on the train - as is currently often necessary – a thing of the past. And continuous collection of sensor data, exchanged via the cloud between the operator and the train manufacturer, paves the way for condition-based maintenance for freight cars as well.

One important aspect of FreightControl, particularly during the migration to DAC, is the fact that secure wireless communication in the trainset makes it possible to implement automation and safety functions even in freight trains without DAC.

Looking further into the future, secure train communications also provide a basis for further functions such as remote decoupling of DAC 5 units or introduction of an electro-pneumatic brake.

Future electro-pneumatic braking system (EP Brake)

Equally essential is the third main area for action – a future electro-pneumatic braking system. Because European freight trains do not have any on-board electronics, they are currently still only braked pneumatically. There is one important drawback to this: The braking signal only passes slowly down the entire length of the train. The electro-pneumatic braking system of the future, which Knorr-Bremse is working on, transfers the solution from passenger trains to the freight segment. In future, braking and control signals will also pass electronically along the length of the freight train and simultaneously trigger the pneumatic brakes on each bogie. This will allow long, heavy trains to travel faster but still retain the same braking distance - an important factor in enabling the rail system to transport greater volumes of freight.

The world's leading suppliers of integrated sanitary systems for rail vehicles, **Knorr-Bremse and** the Evac Group, have joined forces. How will vehicle operators and manufacturers benefit?

As the most recent brand in Knorr-Bremse's rail division, Evac has more to offer than just half a century of experience and a total installed base of over 100,000 sanitary systems: For example, the modules it produces are currently the most compact and fully integrated in the market. The company also operates a worldwide sales and service network, with highly qualified engineers, as well a large supplier base, a reliable supply chain, and local production facilities in many important markets.

Acquisition of the North German specialist in vacuum toilet systems puts Knorr-Bremse among the global market leaders for fully integrated sanitary units in regional and high-speed trains. But that is only part of the story: Above all, vehicle manufacturers and operators will reap benefits from the acquisition.

Innovation boost for sanitary systems It is no secret that reliable, integrated sanitary systems are among the most essential components to ensure maximum train availability. Furthermore, they are an important element in passenger comfort. Evac has put both these factors - as it were - on new tracks.

"We can now combine the strengths of both companies," says Harald Schneider, Member of the Management Board of Knorr-Bremse Systeme für Schienenfahrzeuge GmbH, and responsible for the Sanitary Systems business unit. "Completely closed, vacuumbased water-saving systems with hygienic and clean wastewater disposal are particularly complex." The water and wastewater systems, tanks, and door mechanism, together with the control system linked to the Train Control & Management System (TCMS) first need to be integrated with each other and then with the rail vehicle itself.



"In our rail environment, the innovative activities of the entire Group in terms of digital solutions such as condition monitoring and condition-based maintenance will also help drive innovation in our sanitary portfolio," explains Schneider. He adds that further aspects include cyber security and state-of-the-art links to the TCMS, for example via Ethernet.

Customized systems including on-site commissioning

Another element of value-added for the sanitary systems is the way their design is integrated with other Knorr-Bremse sub-systems. "As part of a 'one-stop-shop' approach to door, HVAC, and entrance systems, and tailored to the particular TCMS of the vehicle concerned, we can put together 'total care' packages with shorter production times," says Schneider. "Last but not least, these customized packages are offered in conjunction with on-site commissioning of all the KB systems installed, plus lifecycle management, if requested."

INFORMER RAIL VEHICLE SYSTEMS



The EU has vowed to become climate-neutral, aiming to achieve net zero greenhouse gas emissions by 2050. By 2030, greenhouse gas emissions from transportation will need to have fallen by 42% compared to 1990 levels if Germany is to meet its climate targets. Consequently, the use of innovative technologies to reduce energy consumption and prevent harmful emissions is as important as ever and this is just as true for rail as for other forms of transportation.

Having been quick to respond to this trend, Knorr-Bremse is now in a strong position. As well as developing its own alternative drive technology solutions, the Company is a trusted systems partner for new battery- or hydrogen-powered vehicles and for diesel train conversions. Here, we provide an overview of some of the latest developments.





Power

Alternative drive technologies are playing an increasingly important role in enabling sustainable, low-emission, energy-efficient passenger and freight transportation.

INFORMER RAIL VEHICLE SYSTEMS



INFORMER RAIL VEHICLE SYSTEMS



RIMINI: Articulated electric bus with IMC® technology



VIENNA: Modernization of low-floor cars for operator Wiener Linien – includina new vehicle control technology and converters

Converting diesel hydraulic vehicles to fuel cell or battery traction

Having made its name producing electric drives for new trains and LRVs, Kiepe Electric is now the specialist for complex but practicable alternative drive solutions within the Knorr-Bremse Group. "We already have a tried-and-tested, ready-to-go technique for converting heavy-duty special-purpose vehicles from diesel hydraulic to fuel cell or battery traction – and it isn't limited to rail vehicles," explains Kiepe Electric Managing Director, Alexander Ketterl.

Bridging the gap to the climate-neutral train

Kiepe Electric can convert diesel trains to full hybrids, providing a compelling solution for anyone wishing to transition their existing fleet towards climate-neutral operation. On electrified sections of the route, the train runs on electricity from the overhead lines. On non-electrified sections, which still make up 40% of Germany's rail network, the train switches over to its traction battery. This means that on routes where trains used to run entirely on diesel, some operators have been able to cut diesel use to just 20%, while others are now running their vehicles fully on electricity.

An electric drive solution complete with traction batteries

A similar solution is available for electric buses. An ingenious combination of Kiepe technologies allows the buses to charge their batteries in just a few minutes, with a charging power of up to 750 kilowatts. Until now, the fact that battery-electric buses took all night to charge their batteries was a major drawback. The concept and technology are modular, scalable, and suitable for any make of bus.







IMC technology: charge-as-you-go

IMC (In Motion Charging) is the technology behind the e-hybrid electric bus. The vehicle is powered by electricity from the overhead lines on parts of the route where these are present. At the same time, it also charges its batteries so that they can be used on sections of the route without overhead lines. In theory, this enables uninterrupted, round-the-clock operation, with no breaks for charging. With the IMC500, currently the most powerful system on the market, a 12-meter bus only needs to be in contact with the overhead lines for around 15% of the time.

Sub-systems for the trains of tomorrow Vehicle manufacturers are choosing Knorr-Bremse



METRO: Upgrade for large-profile double multiple units

VANCOUVER: **Kiepe traction** equipment for electric



to supply a wide variety of vehicle subsystems for the trains of tomorrow. They know that Knorr-Bremse can deliver the precisionengineered systems that are equally indispensable for new hydrogen- or battery-powered vehicles and for converting diesel trains to semi- or fully-electric traction systems. The flagship new vehicle projects where Knorr-Bremse is a key partner include Alstom iLint and Alstom Coradia Stream Hydrogen, and Stadler Rail's Flirt Akku and Flirt Hydrogen.



Launch of **Europe's Rail Joint** Undertaking

For more than a decade, the European technology initiative Europe's Rail has been regularly supplying the rail sector with innovative ideas. Now Europe's Rail Joint Undertaking (ERJU) has embarked on the next step. Knorr-Bremse is one of the founding members of the new initiative.



Rail has always been regarded as the greenest means of transport – the most sustainable way of moving people and freight per capita and per ton. But that is no reason for the sector to rest on its laurels in either industrial or political terms. Which is why the Europe's Rail technological initiative has been running for more than ten years. It most recently featured as part of the "Horizon2020" research program, and now – under the title of "ERJU" – it is also one of the main pillars of the successor program, "Horizon Europe" (2021 to 2027). Knorr-Bremse, which is currently involved in five ongoing Europe's Rail projects, is one of 25 founding members of ERJU.

Its purpose is clearly defined: Rail passenger and freight transportation is to be given even greater emphasis in tomorrow's environmentally friendly mobility systems – and their climate footprint is due to be further improved through innovation. The costs will be shared between the European rail industry and the European Union. Major players at the level of operators, vehicle manufacturers, system suppliers such as Knorr-Bremse, and also research institutes and companies from the transport infrastructure, are pooling their specialist expertise for this purpose.

"Taking things to the next level"

According to Martin Ertl, Vice President Innovation and Portfolio Management at Knorr-Bremse Rail Vehicle Systems, "Even the huge efforts that have been made

"There's no guestion that such an across-the-board focus on the rail system is a huge challenge," says Ertl. "But who could be better placed to take it on than the brightest minds in the industry?"

in recent years are not enough to meet our ambitious climate goals and enable the market to respond to rising passenger numbers and increased demand for freight transportation. To be able to assume this responsibility towards society and the environment, we have to take things to the next level."

In the form of the ERJU, this is now officially a done deal. "The primary focus is on redefining rail transportation's role in tomorrow's mobility landscape," says Ertl. Whereas Europe's Rail focused primarily on developments related to rail vehicles and their sub-systems as well as the rail infrastructure, "ERJU" is clearly approaching things from an automation and digitalization perspective.

This is not surprising, since both symbolize the enormous potential of rail within a close-meshed, efficient passenger and freight transport network: automated processes, for example, in train composition and brake testing, intermodal end-to-end transportation thanks to digitalized supply chains, and, in general, automated train operation (ATO) as the next big step in the industry, and reproducible braking distance (RBD), which is so central to it. With the latter, Knorr-Bremse aims to significantly reduce the variation and divergence of braking distances, offering scope for reducing headways and scheduling trains more frequently. This enables transport capacity to be expanded using existing infrastructure but without compromising safety.

Digital alliance

Knorr-Bremse and Siemens Mobility are launching the world's first collaborative project between a leading system supplier and a leading vehicle builder – for remote condition monitoring of HVAC systems.

> South Western Railway in the UK operates a fleet of 45 five-car "Class 444" and 127 fourcar "Class 450" trains, adding up to a total of 172 regional trains with no fewer than 733 HVAC systems. The latter are the subject of a new development in the rapidly digitalizing rail sector: For the first time ever, a leading system supplier and a leading vehicle builder are joining forces to equip an entire fleet with remote condition monitoring of its HVAC systems.

Smart data evaluation to optimize operation and cut energy consumption

The 733 HVAC systems are to be retrofitted with Knorr-Bremse's digital solution for remote condition monitoring. First a hardware add-on collects large quantities of data, and this is then evaluated in the cloud. Such big data insights enable comprehensive monitoring of the systems concerned, with the results also being shared with Siemens Mobility's Railigent® application suite. As a result, Siemens service teams are able to identify possible repair requirements and respond proactively, long before unexpected problems interrupt vehicle operations.

AT ITS SOUTH-AMPTON DEPOT Siemens Mobility services the two fleets.





BY THE END OF SUMMER 2022, all 733 HVAC units will have been connected to the condition-monitoring system.

The HVAC systems will also be equipped with CO₂ sensors, so that if air quality falls below a certain pre-set level, the control system boosts the fresh air input. As the incoming air in many cases has to be cooled or heated, such a demand-driven air supply reduces energy consumption and improves the train's overall carbon footprint.

"Important upgrade to the digital era"

"As a systems supplier we have in the past expanded our digital maintenance-as-a-service activities - in particular in the field of remote condition monitoring," says Dr. Nicolas Lange, Chairman of the Board of Management of Knorr-Bremse Systeme für Schienenfahrzeuge GmbH. "Now we are able to give the South Western Railway fleet an important upgrade to the digital era."

Installation of the HVAC systems began in the third quarter of 2021 and is scheduled for completion by the end of the third quarter of 2022, so the new solution can go into service early this year.

This latest cooperation is the second digital service project for Knorr-Bremse within a short period of time: In February 2021 it launched a multi-year project with Deutsche Bahn for the smart use of vehicle data - for example generated by entrance systems.



CONDITION DATA AND CO, values are provided by the upgraded HVAC systems from Merak.

Learning from the best

Changes in the urban environment, combined with a growing need for low-impact transportation, call for rail services that are both efficient and reliable. To keep pace with this global development, companies must be able to rely on highly trained technical personnel. The Knorr-Bremse Rail Services Training Academy Germany is the partner of choice for vocational training and professional development – delivered on site or virtually.



DIRECTOR AND PROJECT MANAGER of the Training Academy

High-quality systems are an essential requirement to ensure the operational availability of rolling stock, and operators always have to rely on their employees' in-depth knowledge of a vehicle's sub-systems. After all, even the failure of a single component can bring an entire train to a halt and cause delays and inconvenience for passengers.

Virtual classroom meets hands-on training using original equipment A practical, everyday example: The Knorr-Bremse Rail Services Training Academy Germany is located in Berlin, some 650 kilometers from Zurich as the crow flies. The journey takes half a day, but staff from fleet operators or vehicle builders can avoid this traveling time without missing out on any of the many available training courses on Knorr-Bremse subsystems.

As Jens Blaufuß, Director of the Knorr-Bremse RailServices Training Academy Germany, explains, "Using a 'virtual classroom' we can offer almost all our theoretical training courses – for example, Brake Basics for Multiple Units and Basic Maintenance TreadAct Freight (formerly CFCB), or Regular Advanced Training for Multiple Units – to participants wherever they may be and save them miles of travel."

The 'virtual classroom' is only one pillar of the Knorr-Bremse Training Academy. Another is the consistently practical focus of all the courses, whether they are delivered face-to-face or virtually. The Academy's catalogue covers training on every braking system available from Knorr-Bremse – under as realistic conditions as possible. 70 to 80 percent of all practical training can take place at the customers' site in the form of personal training or coaching on their own vehicles.

And anyhow: Who is in a better position to provide the required knowledge than the system manufacturer himself?

Visualizing complex functional relationships: the CT² demonstrator

Partners with staff undergoing training are given access to a unique resource used by Knorr-Bremse to train its own employees: the CT² rail air-brake system demonstrator at the Berlin training center. CT² stands for Computerized Train Console for Training, and takes theoretical training in braking systems to a new level by simulating all brake functions and technologies. Without requiring an actual vehicle, the console is used to provide hands-on teaching and demonstration of the complex functional relationships of braking systems.

"The instructors delivering the theoretical and practical courses have international experience and are not only trained in teaching, but also certified in accordance with Deutsche Bahn's brake training guideline 046.9015," says Jens Blaufuß, Director of the Training Academy. "Many of them have decades of active training experience under their belts, and know the products and systems like the back of their hand."

In terms of methodology, the Training Academy employs a balanced mix of traditional and digital training formats including new approaches using virtual reality elements and explanatory videos. After all, the rapidly advancing digitalization of the rail sector does not stop at the virtual training classroom.

It is not surprising that demand is steadily growing and the training catalogue has expanded, particularly in recent years. "Our wide range of training modules enables us to tailor training to customers' specific needs," says Jens Blaufuß. One example is a training package drawn up for a local mass transit operator consisting of troubleshooting, instruction in brake function, and regular in-service training on 'Flirt' type vehicles. Another is a training package for a major fleet operator lasting several years in which 70 employees are learning how to overhaul vehicles' braking systems. There are also regular braking system updates where the topics, duration and training media are directly determined by the customer's requirements. "Our standardized training modules, on the other hand, mean the Academy can easily organize a training package, even at short notice."



THE CT² takes center stage in the process of virtual knowledge transfer.



BLOCK BRAKE UNIT and wheel slide protection at the CT²



families that cover all the bases

Knorr-Bremse's product strategy in the multiple-unit brake control system segment is based on the twin pillars of the CubeControl and FlexControl families, enabling the **Company to deliver customized control** systems for virtually any application.





CubeControl in operation on a vehicle of the Alstom Aventra platform for Greater Anglia

"We have seen a lot more standardization in the industry, particularly over the past few years," explains Knorr-Bremse braking system specialist Martin Strobel. "Our customers are increasingly focusing on vehicle platforms, and we are responding to this trend by standardizing our brake control systems."

But standardization has its limits, and there are times when off-the-peg braking systems just won't do. That is why Knorr-Bremse's portfolio actually contains two strong product families for multiple-unit applications, ensuring that the Company is always able to deliver the optimal brake control solution.

Setting the standard - the CubeControl family

The CubeControl brake control system family follows a systematic standardization approach. The decentralized control unit combines all the control hardware, including electronics and pneumatics, into a single mechatronic unit mounted close to the bogie. The family comprises just a handful of hardware variants, with adaptation to different vehicles carried out entirely via project-specific software.

This approach delivers a highly affordable, compact system that can be fully installed under the vehicle floor. The space savings in the car body ultimately benefit travelers in the passenger compartment, for example in the form of extra space for bicycles.

"Of course, a one-size-fits-all approach like this does mean compromising on flexibility to some extent," says Strobel. But that's the whole idea. "On the other hand the project planning costs are lower. This approach helps our customers to further optimize their lifecycle costs and enjoy the full cost benefits of lower maintenance requirements."

The next stage in CubeControl's development has recently been completed, with support for the TRDP Ethernet protocol and a twostage emergency brake further extending its range of applications. The service brake's wheel speed-based deceleration control system improves braking distance precision. Brake disc temperature monitoring simulates the temperature of individual brake discs in real time, helping to avoid unnecessary speed restrictions. Meanwhile, enhanced condition-based maintenance reduces maintenance costs.

The next stage in CubeControl's development will also shortly be available, offering a four-stage, deceleration-controlled emergency brake, integration of indirect braking, roll monitoring and the latest MGS3 wheel slide protection for extremely low adhesion values. The Cube-Control product family thus claims the highest possible integration standard, with fully comprehensive brake control functionality in the market for metros, regional and high-speed trains.

The FlexControl family: The clue is in the name

There are of course some highly specific requirements that this standardized product family is not designed to meet. This is where the second pillar of Knorr-Bremse's brake control system product strategy comes in: the FlexControl family.

With its ready-to-go electronic, pneumatic, mechanical, and software sub-components, this flexible, modular system can be configured for specific projects in terms of functionality, integration, installation envelope, and special features. These include regional requirements such as a fully redundant electronic control unit, and specific operator requests that go beyond the usual standards - for example redundant wheel slide protection valves and/or wheel speed sensors. The FlexControl family is also suitable for meeting high domestic content requirements or for allowing maintenance to be carried out by small customer-owned workshops without the need for any special equipment. Systems can also be configured for specific operating conditions, including extremely low temperatures down to -55° C.

Knorr-Bremse's systems engineers combine, configure, program, and mechanically integrate the different component parts for each specific project, providing additional ones as required and incorporating them into the modular platform.

As well as individual components, the platform also includes several preconfigured variants, ranging from small pneumatics panels to complete, fully integrated and pre-tested systems. This helps to keep project-specific configuration work down to a minimum.

project-specific variants

FlexControl Extensive modular system with

Smart paradigm shift

AirSupply Smart represents a paradigm shift in compressed air supply for rail vehicles: The focus has moved from individual components to demand-driven supply combined with continuous monitoring of components and operating data as well as ambient conditions.





Improved **Energy Management**



Noise Emission Management



Flexible & Lightweight Design



Optimized **Operation & Control**



Digital Communication **Optimized control and operation** The key is a new frequency converter that has been specially developed for the rail industry. Connected between the auxiliary converter and the air treatment elements, it also serves as the central intelligence of the air supply system. Operating as a multifunctional platform, AirSupply Smart provides the basis for a new climate- and environment-friendly energy and noise emission management system for rail vehicles.

Noise management

Public acceptance of railway operations is partly dependent on the concerns of trackside residents. This is where the AirSupply Smart 'Silent Mode' comes in. The control system reduces the compressor's rotation speed, making it run much more guietly when vehicles are parked at night near residential areas or in train stations.

The impact of 'Silent Mode' is huge – for example the noise emissions from an oil-free VV120T compressor can be reduced by up to 75 percent.

Improved energy management

Adaptive compressor management also works in the reverse direction: AirSupply Smart can switch to 'Boost' mode when there is a particularly high requirement for compressed air. For example if a large number of passengers disembark at a central transfer station and the air suspension has to adjust accordingly, higher air delivery counteracts the risk of traction blockage caused by the reservoir running low. In other words, 'Boost' mode can increase train availability and punctuality. Another advantage is the fact that it also reduces the time required to set up a parked train for service.

The extra performance provided by 'Boost' mode also means that a smaller compressor may be sufficient, with an associated reduction in weight and lifecycle costs. Vehicle builders also benefit from the smaller installation envelope required for the air supply system.

A positive side-effect of a more constant compressor running time is a reduction in component wear and tear and a further cut in lifecycle costs.

Lightweight, flexible design

The intelligent converter even dispenses with the need for a separate auxiliary compressor - which reduces vehicle weight and simplifies train configuration. This is achieved because the reduction in power requirements thanks to the control system means that the main compressor can now be powered temporarily from the vehicle battery and the pantograph can be raised. This function is called 'Pantograph Mode'.

Fit for digitalization

AirSupply Smart is designed to be future-proof. Not only can further functions be easily added via software updates – the AirSupply Smart sensors also enable extensive health status monitoring to take place. The system monitors itself, using algorithms to transfer operating data and ambient conditions into status signals. As ongoing condition monitoring enormously reduces the risk of unexpected failure for the operator, the result is increased vehicle availability and lower lifecycle costs.

The advantages of Smart Air Supply can also be utilized in existing vehicles. In an initial project, a gateway was developed in collaboration with RailServices that links the interfaces with the existing train interfaces.

Securing security

Knorr-Bremse Railway Product Cybersecurity Architecture. The name may be a bit of a mouthful, but it says it all: The new cybersecurity architecture includes every component installed in a Knorr-Bremse sub-system.

The latest generation of rail vehicles represents a radical evolution compared with the way they used to operate just ten years ago. Vehicles and their sub-systems are now closely networked with each other and integrated into digital business models. Communications run via the Ethernet, and the data is stored in the cloud.

"It is therefore time to have a cybersecurity architecture that incorporates every single system component," says Paolo Fanuli, head of the Knorr-Bremse Cybersecurity Center of Competence based at Selectron AG in Switzerland. Fanuli wouldn't come out with a statement like this without providing the solution in the next breath: "We call it Knorr-Bremse Railway Product Cybersecurity Architecture."

Behind this lies a lifecycle concept that extends from the system component level to the vehicle communication interfaces, and runs through the entire product world of the Knorr-Bremse Rail Vehicle division. The approach involves eight complementary layers of protection applied to each sub-system, with cost-effective cyber protection for new and legacy fleets. Here is a short overview:

Strong basis:

The IEC 62443 series of standards and the future TS 50701 technical specification provide the reference points for Knorr-Bremse to align all its product cybersecurity activities.

Safe product development:

Risk assessment, security testing and management, and immediate "patching" when relevant new security risks appear: A rigorous Secure Development Lifecycle (SDL) process reduces to a minimum the likelihood of cyber protection vulnerabilities.

Threat Detection Solution (TDS):

The Threat Detection Solution (TDS) transfers intrusion detection systems (IDS) from the IT world and the automotive industry to the world of rail vehicles. Like an early warning system, it detects anomalies in data traffic long before any damage can be caused.

Secure Device Management:

For its products Knorr-Bremse uses protocols with depending on the application - local or remote secure device management. Secure Device Management defines the necessary architectures.

Future rail operations will require multiple Ethernet networks in the same vehicle, for example for TCMS



Secure data flow:





Railway Protection Architecture

and comfort functions. The new SGW 901-TW Secure Gateway separates these networks not only logically, but also physically, allowing specific security zones with associated security levels to be set up for each network.

Hardware with a brain:

When it comes to "Secure Boot" functionalities or key management that requires special protection, security chips based on the Trusted Platform Modules standard (TPM 2.0) are used. Even the new "Windows 11" requires this hardware security. TPM 2.0 chips are permanently installed in the hardware of the local computer to provide maximum protection against software manipulation by unauthorized third parties.

Knorr-Bremse PKI:

With its thousands of security certificates, the Knorr-Bremse Public Key Infrastructure (PKI) enables highly secure integration of a wide range of functionalities (e.g. device identity, access control, software integrity check, secure boot check) into the digital system landscape and not just for Knorr-Bremse systems and products.

The specialists:

True cybersecurity doesn't tolerate downtime. Using the very best specialists, Knorr-Bremse and Selectron are jointly able to support their customers in the safe operation of their fleets. Worldwide. And around the clock.



FRICTION TECHNOLOGIES



Quick to recognize the importance of friction pairing in delivering braking system excellence, Knorr-Bremse steadily built up its expertise in this area. The Company is now able to supply application-specific friction pairings for virtually any type of train and almost every global rail standard.



PRODISC ULTRADISC LIGHTDISC

will deliver exactly the same quality and performance. This means that the Company can now supply customized, application-specific friction pairings of brake pads, blocks and discs for virtually any type of train and almost every global rail standard. "We can rightly claim to be a full-line friction material supplier with in-house production," says Peters. "Our engineers optimize the friction pairing's performance, durability and cost for each specific project, for both OEM and aftermarket customers."

It all seems pretty straightforward at first glance. Powerful forces press the brake pads against the brake discs or the brake blocks against the wheels. This generates friction, converting kinetic energy into heat. But there is far more than meets the eye to creating the optimal friction pairing for a braking system. "Understanding how the friction pairings behave in the field is a science in its own right," explains Dr. Carsten Peters, Director Business Development Friction Technologies. "Even small differences in the material's composition or manufacturing process can significantly affect friction coefficient behavior."

In fact, the integrated development of braking systems and brake pads is crucial to enabling optimal braking performance and reducing lifecycle costs. Ensuring that the friction material, pad/block geometry and braking system are perfectly matched is also key to keeping noise levels as low as possible. "We optimize the friction pairing for every specific application to ensure that it is suitable for the relevant braking system and operational requirements," explains Peters. "That's what sets us apart from most of our competitors."

A full-line friction material supplier with in-house production

The Company can make this claim because it has strategically developed and expanded its engineering and manufacturing expertise in this area over a number of years. It has also made several strategic acquisitions. Back in 2008, Knorr-Bremse acquired Anchor Brake Shoes, the leading North American manufacturer of brake shoes for locomotives and freight cars. Two years later, the Company launched the ICER Rail joint venture, which has now become Knorr-Bremse Pamplona. In 2016, Knorr-Bremse acquired the rail vehicle operations of brake pad specialist TMD Friction, as well as all the outstanding ICER Rail shares. Two years on from this, the Company acquired the entire know-how and intellectual property rights for the production of friction materials for rail vehicle and industrial applications from DRiV (formerly Federal-Mogul).

The acquired products and IP rights have now been integrated into the main plant in Pamplona. UIC homologation has also been achieved, certifying that the products are fully interchangeable and



INSTALLATION of an UltraPad Extreme sintered pad for highperformance brake applications The Company's engineers draw on an extensive portfolio of brake discs, pads and blocks made from different materials and with different geometries in order to create the optimal friction pairing. Axlemounted and wheel-mounted brake discs are available in steel, gray cast iron, nodular graphite cast iron or aluminum. "UltraDisc" designates steel brake discs, "ProDisc" gray cast iron or nodular graphite cast iron brake discs, and "LightDisc" aluminum brake discs.



Systematic renaming of individual material designations

To make it easier for customers to understand its extensive friction portfolio, the Company has systematically renamed all the individual material designations. Knorr-Bremse now groups its product technologies – sintered and organic, pads and blocks – into three Friction Technologies product segments: ProPad, ProBlock and UltraPad. The suffix '-Pad' stands for brake pads, while '-Block' designates brake blocks. The prefix 'Ultra-' signifies a sintered base material, while 'Pro-' refers to organic friction material. The new system also makes use of the number suffixes widely used in the industry. ICER P16, for example, now goes by the name of ProPad P16. Other products that have achieved UIC homologation after being integrated into Knorr-Bremse's production system following the acquisition of the DRiV know-how bear names such as ProBlock J816M, ProBlock J822 and ProPad 878.





KNORR-BREMSE