

KNORR-BREMSE  
RAIL VEHICLE SYSTEMS

***For safe mobility  
worldwide.***



**KNORR-BREMSE**





EVERY DAY, MORE THAN **1,000,000,000** PEOPLE  
AROUND THE WORLD RELY ON SYSTEMS FROM KNORR-BREMSE.

DURING AN EMERGENCY STOP, THE BRAKES OF A  
HIGH-SPEED TRAIN REACH TEMPERATURES OF MORE THAN  
**800 DEGREES** CELSIUS.

LAST YEAR KNORR-BREMSE USED SOME  
**7,000,000** SINTERED METAL ELEMENTS FOR ITS FRICTION PRODUCTS.

KNORR-BREMSE HAS PRODUCED SOME **1,100,000** KE VALVES  
SINCE THEY WERE FIRST MARKETED.

THE KAB60 CONTROL VALVE CAN FUNCTION AT TEMPERATURES AS  
LOW AS **-60 DEGREES** CELSIUS.

EVERY DAY, ALL OVER THE WORLD, OUR IFE ENTRANCE SYSTEMS  
OPEN AND CLOSE MORE THAN **50,000,000** TIMES.

“Under the motto of ‘Local Thinking. Worldwide’  
Knorr-Bremse ventured into international markets early  
on. It has been a real success story.”

*Peter Karius, Director International Sales, Knorr-Bremse Rail Vehicle Systems*





## KNORR-BREMSE: FOR SAFE MOBILITY WORLDWIDE

The development of the Knorr-Bremse Group from the company's early days in 1905 to its current position as a world leader is a fascinating and gripping story. But from the very outset, the company was – and still is – driven by an absolute commitment to safety on road and rail. After initially focusing on manufacturing, selling and servicing braking systems, it eventually developed into a global group offering complete systems for rail and commercial vehicles. At Knorr-Bremse we see ourselves as the service partner of choice for customers all over the world – which is why we develop innovative solutions for road and rail vehicles' entire life cycle.

**System solutions for greater safety.** This is what has made us so successful and has driven our global growth. With 25,000 highly motivated employees at our headquarters and in a further 100 or more facilities in 30 different countries, we now enjoy the trust of customers all over the world.

**Products for partners.** Metros, high-speed trains, trucks or buses: in every segment we understand how customers' technological requirements vary according to the local environment in which they operate. Over the years, joint development of customized products has created close partnerships that have proved invaluable – to the benefit of customers and road and rail travelers all over the world.

**Actively facing the future.** Maximizing operational and functional safety is a priority for Knorr-Bremse's research and development engineers. Since 2016, the new Development Center in Munich has combined the rail and commercial vehicle divisions under one roof, enabling the company to benefit from the resulting synergies. Joining forces enables us to overcome tomorrow's challenges: globalization, urbanization, the need for energy efficiency – and greater safety. Knorr-Bremse is ideally positioned to react flexibly to the challenges: developing new braking systems to meet ever stricter regulations or creating more energy-efficient products in response to an increasing scarcity of resources.

**Assuming responsibility.** In improving our products we are also responding to calls for greater sustainability. Our Corporate Responsibility policy embraces environmental issues, HR development and our social commitment through our charitable organization Knorr-Bremse Global Care.



"Our customers expect absolute safety and reliability. We achieve this through our comprehensive systems competence, our technological lead and our local service."

*Masahiko Horiuchi, Managing Director, Knorr-Bremse Rail Systems Japan*



## ON TRACK TO SUCCESS: RAIL VEHICLE SYSTEMS

Every day, around a billion people use trains equipped with Knorr-Bremse products. Manufacturers and fleet operators choose to work with Knorr-Bremse because they value our systems expertise and want to offer their customers top levels of safety, reliability and comfort.

**Global presence.** With more than 14,000 employees and over 80 production, sales and service sites around the world, Knorr-Bremse Rail Vehicle Systems maintains a strong local presence, enabling it to provide on-the-spot aftersales service over the entire product life cycle. The result: rapid delivery combined with ongoing support.

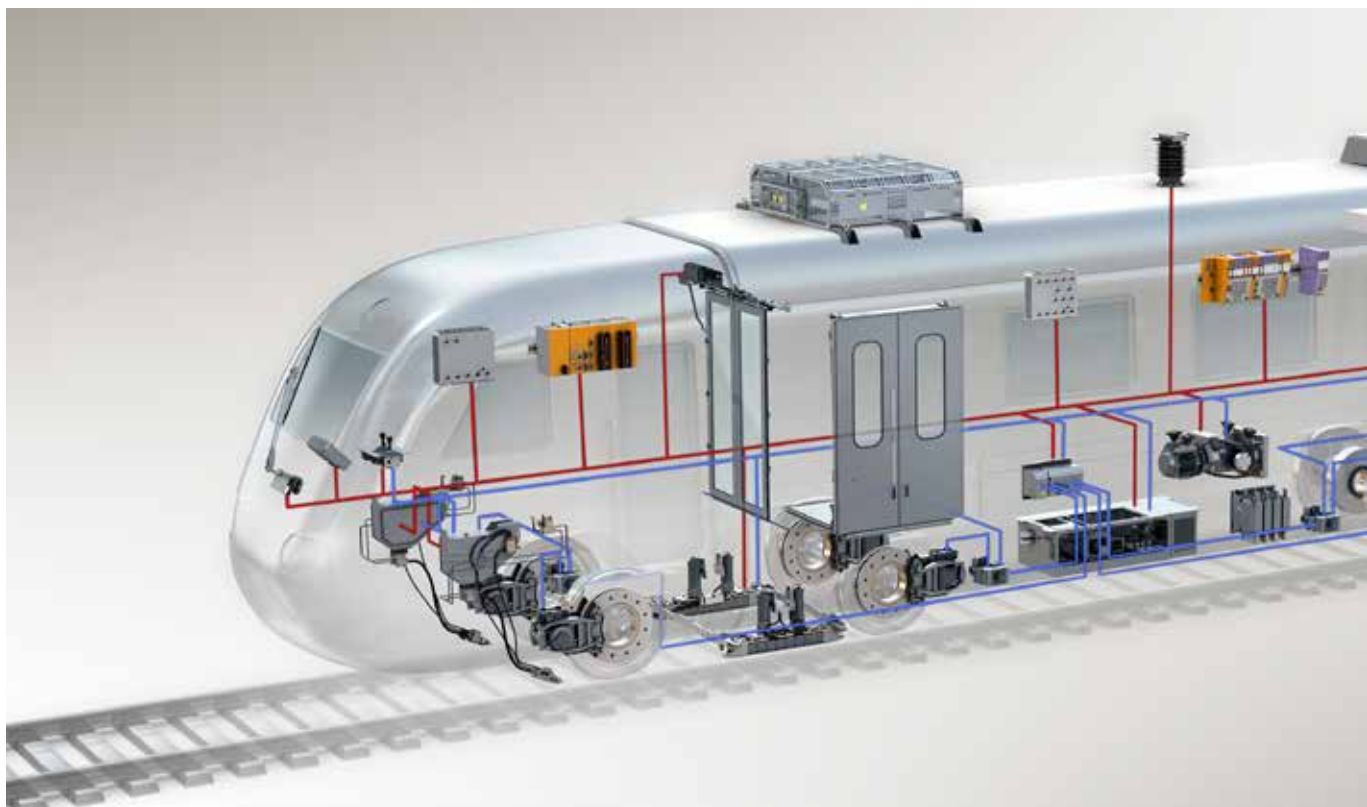
**State-of-the-art products.** Rail is an environmentally friendly mode of transport, and the brakes, entrance systems, air conditioning and power supply solutions supplied by Knorr-Bremse have a reputation for maximum operational and functional reliability. They are designed to form complete, networked systems that are unique in the market. Customers benefit from reliable, efficient rail vehicles, energy savings and reduced life cycle costs.

**Quality is the key.** As a developer and manufacturer of safety-critical products, Knorr-Bremse is uncompromising in its commitment to quality. The globally standardized Knorr-Bremse Production System (KPS) provides the basis for best-in-class production based on a proactive zero-defects culture.

**Solutions across the entire life cycle.** High-quality systems are crucial for the safe operation of a train. But that is not all – from the point of view of the operator, maximum availability is also essential. The necessary spare parts in OEM quality must always be available when required, combined with competent, reliable inspection and maintenance of rail vehicles throughout their entire life cycle. Customers can count on Knorr-Bremse RailServices to provide all this.

**Optimum networking.** The more closely the sub-systems in a rail vehicle are networked, the greater the benefits for vehicle builders and operators. Cross-system diagnostics avoid the need for individual service tools for each sub-system. And properly matched, pre-tested hard- and software interfaces simplify the task of constructing the system architecture. State-of-the-art control technology based on integrated system tools from Selectron Systems AG provides the perfect basis for this.

# STRONG PARTNERSHIPS: OUR TECHNOLOGY EVOLVES IN STEP WITH OUR CUSTOMERS



## Brakes

Braking and on-board systems for rail vehicles:  
Knorr-Bremse



## Door systems

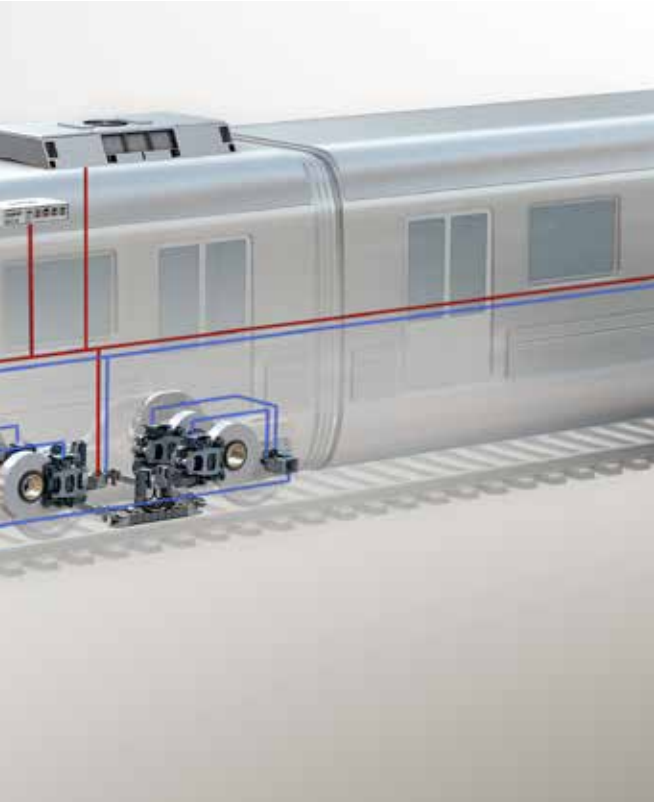
Entrance and platform screen doors for rail vehicles:  
IFE and Westinghouse



## HVAC

Heating, ventilation and air conditioning systems:  
Merak and Sigma





Mile-long freight trains in the Australian outback, modern metros on the Arabian Peninsula, or high-speed trains in Japan – every vehicle builder and operator has a specific profile. That is why Knorr-Bremse develops customized solutions for each application based on tried-and-tested, innovative technologies. Whether the trains will be operating in earthquake zones, in extreme cold or in dusty desert conditions – in all cases Knorr-Bremse is a single-source provider of perfectly matched braking and on-board systems that offer genuine added value, thanks to their intelligent networking with the overall train system. The result is uncompromising safety, top reliability and efficiency coupled with low life cycle costs.



**Power supply**

Electro-mechanical and electronic control elements and power supply systems for rail vehicles:  
Microelettrica Scientifica and PowerTech



**Further safety-critical systems**

Train control management systems (TCMs): Selectron; simulators; signal and traffic management systems: Zelisko



**Maintenance and service**

Maintenance, modernization and repair services for brakes and on-board systems:  
RailServices

“Brakes do not impose limits. On the contrary, with good brakes a train can travel faster and reach its destination sooner.”

*Eric Wright, Chief Engineer, New York Air Brake*





## KNORR-BREMSE: GREEN LIGHT FOR PROGRESS

The travelers waiting on the platform watch the train enter the station and glide to a precise halt in front of them. Countless times every day, precisely controlled braking systems stop trains with reassuring reliability. And it is Knorr-Bremse that bears responsibility for the entire system, with a perfect combination of electronic, pneumatic, mechanical and hydraulic components.

**Total systems competence.** Knorr-Bremse is a manufacturer of proven braking technologies for all types of rail vehicle. Over the years the company's highly integrated systems for the intelligent control and regulation of dynamic braking forces have been installed in thousands of trains. Hydraulic products are combined with air supply, brake control and brake mechanics to create efficient overall solutions. The company's systems meet global standards such as UIC, AAR, ARA, and GOST.

**Every component tried and tested.** This step in the manufacturing process is so important that we do not leave it up to third parties. Proven electronic brake control systems and pneumatic and hydraulic components for all types of rail vehicle from freight to high-speed trains are designed to cope with extreme operating conditions such as unusually high or low temperatures. And all products are carefully matched and designed for long maintenance intervals.

**Maximum operational and functional reliability.** Examples of products resulting from our ongoing development of braking technology are the oil-free compressor for heavy-duty locomotives, the air dryer with optimized regeneration requirements, the wheel slide protection system for improved braking distances, track brakes, the ESRA electronic platform, mechatronic brake control systems, ISOBAR high-performance brake pads and compact brake actuators. These are all high-quality products with extended operational lives thanks to their low-wear characteristics. Regular maintenance and modernization by RailServices ensures their reliable operation.

**Energy efficiency and sustainability.** In addition to innovative technologies, one of Knorr-Bremse's core competences is energy efficiency. This is demonstrated by our braking force management with modular brake control systems and special control valves, which is designed for operations in all kinds of ambient conditions. Passengers and the surrounding environment benefit from a reduction in noise emissions from moving trains by the use of sound-insulated compressors combined with special brake shoes and pads.

"We sell more than doors – we sell safe and reliable entry."

*Hans Gold, Director Business Unit LRV & Metro,  
Knorr-Bremse Division IFE Entrance Systems*





## SAFE STEP: ACCESS SOLUTIONS

Every train journey – be it in a regional train, metro or LRV – starts with safe access. Few passengers stop to think about the complexity of the train entrance system, but the driver knows how important it is for the technology to function smoothly. Reliable opening and closing are essential for a safe and efficient journey.

**Top quality, state-of-the-art technology.** Companies in the Knorr-Bremse Group are market leaders when it comes to door systems for rail travel. They realize how important it is for trains to be accessible at all times and for entrance systems to meet statutory safety requirements. IFE is responsible for all aspects of electric train door systems, and Westinghouse offers a full range of products and services related to platform screen doors.

**Safe, efficient entrance systems from IFE.** The latest generation of entrance systems has significantly improved train and station safety. The main elements are the drive system, the door leaves, the sliding step with its patented guidance system and the control unit. IFE's entrance and internal door systems for rail vehicles meet customers' needs for low installation costs, good heat and noise insulation and low life cycle costs. Reduced maintenance requirements help to keep costs down.

**Safe, efficient platform screen door systems from WPSD.** The global market for platform screen doors systems continues to grow. The doors separate the platform from track and train, delivering a cleaner and safer environment for system users. The use of full-height platform screen doors facilitates the economical air conditioning of platforms, again enhancing the platform environment. In addition, platform screen doors facilitate consistent boarding zones, effectively guiding passengers and speeding boarding and disembarkation.

**Tried-and-tested, convenient, economical.** Train operators and builders put great emphasis on safe entry systems – understandably, because the efficient boarding and disembarkation of large numbers of passengers strongly impacts on the punctuality, reliability and economy of mass transit systems. Prior to installation, IFE subjects every door to exhaustive testing in its own validation center.

“An optimum HVAC system achieves a good balance between passenger comfort and energy efficiency.”

*Michael Powell, Group Technical Director, Knorr-Bremse Division Merak HVAC Systems*





## FRESH AIR IN ALL CLIMATIC CONDITIONS WITH KNORR-BREMSE

Rail is currently one of the most environmentally friendly modes of transport, and Knorr-Bremse contributes to keeping it that way. The latest HVAC systems for rail vehicles use innovative heat pump technology to reduce their energy consumption and help combat climate change. And, of course, they ensure fresh air and an agreeable temperature for the passengers inside the train.

**Worldwide quality.** Merak and Sigma have capitalized on global synergies, making Knorr-Bremse a world leader in the development and manufacture of HVAC systems, and will further drive growth in the rail vehicles and special applications sector, respectively. Their customized systems integrate service-proven modules, meet the highest quality standards and operate equally well in desert conditions with temperatures up to +55 °C and winter conditions with temperatures as low as -45 °C. Global production and service facilities mean that we are always close to the customer.

**Reducing energy consumption.** Climate protection and passenger comfort go hand in hand. Knorr-Bremse's eco-friendly HVAC systems operate with maximum energy efficiency, recycling braking energy to produce heat, and varying the rate of air exchange according to the number of passengers.

**Innovation strengthens market position.** As part of the process of continuous improvement of our products we have developed a self-cleaning sand filter system for dusty desert conditions. The filters are cleaned by compressed air, with the result that the maintenance intervals of the HVAC system are similar to those for servicing the vehicle as a whole.

**Integration of sub-systems.** HVAC systems interact with the operation of other sub-systems on the train, e.g. with the power supply for efficient energy management, with entrance systems for balancing interior pressure, or with the brake system by using compressed air for self-cleaning filters – only if all the components and sub-systems are carefully matched for a specific vehicle, can one fully achieve safe and economical operation.

“Comfort and safety demands massively increase a train’s energy requirements. We supply the power efficiently and according to need.”

*Dr. Bertram Langhanki,  
Member of the Board,  
Knorr-Bremse PowerTech*







## OPTIMUM POWER SUPPLY MANAGEMENT

Knorr-Bremse is helping achieve the energy revolution in trains. As demand for greater comfort and safety drives up energy requirements, it becomes important for power supply systems to be well integrated into the train's on-board systems so that energy use can be regulated as efficiently as possible. Control elements also distribute the power in the right form exactly where it is needed. In this way, Knorr-Bremse combines environmental and economic aspects in its products.

**Consistent quality.** Power supply systems at Knorr-Bremse are the responsibility of two highly experienced companies – PowerTech and Microelettrica Scientifica – both of which offer extremely reliable products. PowerTech supplies various types of on-board power converters and electrical supply systems, including for local and mainline trains; and Microelettrica Scientifica is a leading supplier of electronic and electro-mechanical control components for rail vehicle applications.

**Value-added from PowerTech.** PowerTech supplies on-board power converters based on standardized, modular products that are suitable for all train types and performance categories. The brand's converter technology has the advantage of being compatible with other Knorr-Bremse products and services such as iCOM diagnostic software, air compressors and HVAC systems.

**Value-added from Microelettrica Scientifica.** The control components produced by Microelettrica Scientifica optimize the performance of rail vehicle applications and reduce their life cycle costs. The all-embracing ECO system measures energy consumption, evaluates the results and relays the information to the train control management system.

**Integration into other systems.** Knorr-Bremse can, if required, equip rail vehicle systems with their own power supply from PowerTech. Balanced on-board product solutions give rail vehicle builders greater flexibility and make it easier for operators to retrofit their fleets. Similar advantages are also offered by integrated functional units (FUI) from Microelettrica Scientifica. Contactors and circuit breakers are supplied as complete units, so that the customer merely has to tighten a few screws to install them in the vehicle.

“Train control management systems bring together all the sub-systems on a single platform. We aim to perfect this integration process.”

*Bernd Riedel, Strategy & Marketing Manager, Selectron Systems AG*





## LEADING THE FIELD: SAFETY SOLUTIONS FROM KNORR-BREMSE

Maximizing railroad safety involves a comprehensive, across-the-board approach for Knorr-Bremse. In addition to modern platform technology and networking solutions from Selectron, safety is also about having highly trained employees and a well-functioning external infrastructure. These are offered by Knorr-Bremse in the form of signal systems from Zelisko and sophisticated simulation equipment for training purposes – completing the picture and supporting reliable and energy-efficient train operations.

**Vehicle control and networking.** Selectron control systems and networking solutions form a rail vehicle's central nervous system, with information from the individual vehicle components flowing to the control management system. This includes data from the braking, door and HVAC systems, the power supply, the vehicle diagnostics and the passenger information system. An efficient exchange of data supports high safety standards and accelerates the approval process. Large volumes of data are processed using high bandwidth routers and switches from Selectron. Wireless data transmission by modem (WLAN, GSM, LTE, GPS) ensures passenger comfort (WiFi) and an exchange of diagnostic information for various kinds of evaluation.

**Strong signals.** Zelisko signaling systems ensure the safe operation of level crossings on many important railroad routes. The high visibility and top levels of safety offered by LED trackside signals ensure the smooth running of railroad networks in many countries. But Zelisko is equally important for local public transport systems with its state-of-the-art ticketing systems. And in a third area the company also ensures a reliable power supply with its high-grade current and voltage converters as well as sensors for internal and external installation.

**Market-leading simulation technology.** Engineers, electricians and graphic designers develop and produce software for customized driver training simulators. By ensuring high-quality training with simulation products ranging from the high-end 'full cab simulator' down to simple training documentation, the company contributes towards improving safety on the world's railroads.

**Software utility for safe applications.** Under the name of 'Symphony' Selectron offers a whole family of carefully matched software tools offering efficient features such as programming, engineering, commissioning support, configuration, train setup, network management, diagnostics etc. The tools for safety-relevant applications simplify the vehicle approval process.



"We are driven by a determination to be the service partner of choice for our railroad partners worldwide, offering innovative and competitive solutions across the entire product life cycle."

*Manuela Sergizzarea, Project Leader, Center of Excellence Service, Knorr-Bremse RailServices*




## KEEPING YOUR TRAINS ON THE RAILS

Any railroad company wishing to remain competitive has to offer two things: absolute safety and reliability. Passengers expect to feel safe on trains, and to ensure this, Knorr-Bremse looks after rail vehicles throughout the entire product life cycle. Reliability is important for two reasons: It keeps operating costs low and makes the train service more attractive for passengers.

**Global presence.** More than 30 service centers all over the world offer customers a comprehensive range of services based on top-quality technologies. Knorr-Bremse's global competence is demonstrated in the form of local service solutions: Knorr-Bremse RailServices makes it possible for repair and maintenance to be carried out rapidly in one location close to the customer. The high-quality working environment in some service centers has already achieved ECM certification – a standard that Knorr-Bremse aims to roll out at all its European sites.

**Product expertise.** Knorr-Bremse RailServices is familiar with individual types of rail vehicle and develops products and services irrespective of the manufacturer or operator. As a long-term systems partner the company puts together service packages that are tailored to customers' specific requirements. Such ongoing collaboration not only increases vehicle availability but also encourages innovative solutions and cuts life cycle costs. As part of its close cooperation with its customers, RailServices passes on a deeper understanding of its products and constantly works to improve their quality.

**Service throughout the entire life cycle.** You can choose the particular services you require from our flexible aftermarket program – whether this involves trouble-shooting, kitting or a complete overhaul. To ensure smooth running, regular maintenance, overhaul and repair are essential. RailServices helps you meet this challenge by offering active service management that includes a comprehensive needs analysis, spare parts supply, punctual delivery, proactive wear management and a dedicated contact person. Via its global 'Advanced & Project Engineering' network, RailServices offers integrated, customer-specific modernization programs to prepare rail vehicles for the approval process.

A blue high-speed train, identified as 'Skånetrafiken' with the number '065' and '1065', is positioned on tracks inside a large industrial maintenance facility. Two men are present: one in a black work jacket stands in a narrow aisle in the foreground, pointing towards the train; the other, in a high-visibility orange and blue safety jacket, stands to the right of the train. The facility features overhead power lines and structural steel beams.

"Your partner RailServices provides through-life support for your rolling stock needs."

*Dr. Johnny Leung, RailServices Director, Rail Asia Pacific*



## KNORR-BREMSE RAILSERVICES OFFERS YOU MORE THAN JUST ORIGINAL SPARE PARTS.

As competition between transport modes increases, and passengers demand ever greater levels of comfort, train manufacturers and operators are subjected to growing price pressure. This makes it all the more important to ensure operational reliability, short downtimes and minimal repair costs. RailServices offers through-life support to its customers, with tailored service packages and original spare parts, full maintenance, direct service, technology upgrades and highly trained technicians. This enables it to keep brakes and on-board systems functioning reliably and extend vehicles' lives through modernization programs.

**Original parts.** Purchase original spare parts from Knorr-Bremse and you receive quality products designed for a long and reliable life. All the components are carefully matched and approved for use in the railroad sector. Efficient parts management by RailServices minimizes customers' inventory requirements, offers first-class maintenance and reduces administrative costs.

**Vehicle maintenance.** Preventive maintenance and regular overhaul keeps your vehicles in operation and reduces life cycle costs. Consistency is ensured by the sheer quality of Knorr-Bremse remanufactured parts, which are tested to the same level as new products.

**Local service.** RailServices offers a rapid, flexible service at local level. In addition to over 30 service centers around the world, highly trained local field service technicians are available to support customers. An additional service is the transfer of knowledge through training measures.

**Modernization.** RailServices maintains a worldwide portfolio of new or improved components and systems for existing fleets with a view to extending their service life. A dedicated engineering team ensures that customer-specific, homologation-ready solutions are offered and cross-product synergies can be used. On offer are innovative new products, component upgrades and system modernization for existing fleets.

**Digitalization.** Use of Generation 4.0 products in a vehicle maximizes operational safety and minimizes operating costs. iCOM Monitor enables you to keep a precise eye on the condition of your fleet and use the data from vehicle sub-systems to optimize running and maintenance. The iCOM Assist application acts as a driver assistance system, reducing energy consumption and wear and tear of parts.

All these applications run on an open platform with the option of customer-specific analysis and evaluation in a state-of-the-art back office.



“Taking on responsibility is something Knorr-Bremse does wholeheartedly as part of its strategic mission.”





## TAKING ON RESPONSIBILITY – A PRIORITY FOR US.

For Knorr-Bremse, acting entrepreneurially with an eye to the future is all about taking on responsibility – for our products, our employees, the environment and the society in which we live. As a family-owned business with more than 110 years of history behind it, Knorr-Bremse has an active corporate culture that combines environmental, economic and social goals.

**Sustainable business.** What does corporate responsibility actually mean for us? On the one hand we work on developing products and technologies that are designed to make mobility safer, more future-proof and more environmentally compatible. With our energy-efficient and low-emission products for the rail sector we contribute towards developing forms of mobility that save fuel and reduce noise emissions. We are also careful to make sparing use of resources, use energy efficiently, utilize environmentally friendly materials and operate an optimized logistics chain. Our global energy efficiency initiative ECCO2 (Efficient Cut of CO<sub>2</sub>) has enabled us to increase our energy efficiency by 38% since 2010 and to reduce specific CO<sub>2</sub> emissions by 17%. In addition, Knorr-Bremse has joined with other companies to form the Railsponsible initiative, which aims to promote a common understanding of sustainable procurement processes, exchange information and experience and jointly utilize instruments, for example for assessing sustainability performance.

**Involvement in society.** As an international company, it goes without saying that our responsibility goes well beyond our products and production processes: We are determined to offer our employees an atmosphere of fairness and respect and a safe, attractive working environment. Outside the company we also support social projects at local and global level. The charitable organization Knorr-Bremse Global Care was founded in 2005 and funds aid projects all over the world in the fields of education and WASH (water, sanitation and hygiene) as well as providing emergency aid where required. As part of the Local Care initiative, employees also support selected social projects in the vicinity of local sites.

Thus responsibility at Knorr-Bremse starts with individuals – and continues at global level to form an impressive whole.

“With our interdisciplinary work at the Development Center in Munich we serve as a model for the entire industry.”

*Marc-Oliver Herden, Director Brake Systems Development,  
Knorr-Bremse Rail Vehicle Systems*





## OUR DEVELOPMENTS: CLOSE TO THE CUSTOMER

The better a train's brakes, the faster it can travel. Further development of braking technology calls for extensive systems competence. Knorr-Bremse networks all its components, including HVAC systems, power distribution units, driver assistance and maintenance systems as well as brakes. Whether we are talking about highly integrated control systems, materials testing or winter-proofing – in all cases our new and improved products keep customers ahead of their competitors in terms of safety, quality, environmental compatibility and resource efficiency.

**Every customer benefits.** Knorr-Bremse has focused its production plants and R&D facilities fully on meeting customer requirements and maximizing efficiency. Some €90 million was invested in the new Development Center in Munich that opened in 2016. At the same time the company is steadily expanding engineering capacity at its international sites, for example in China and India. For Knorr-Bremse, staying ahead in terms of expertise even at its local sites is a competitive advantage that positively impacts the entire company.

**Employees benefit.** The strength of Knorr-Bremse's research and development activities is reflected in the innovations it offers to customers. The company's philosophy is to bring together engineers from a wide range of disciplines in the rail and truck divisions and foster a creative exchange of ideas. Such a center of competence drives forward development work – as do the company's countless links with universities, sectoral and industry associations and government initiatives.

**The rail sector benefits.** Knorr-Bremse uses state-of-the-art measuring and testing equipment to validate new developments well before field testing takes place. This increases our understanding of the braking process – both within the system itself and where it interfaces with the infrastructure, enabling Knorr-Bremse to optimally configure every braking system to match the customer's needs. Train builders and operators themselves become technology leaders, with a profitable future providing safe mobility.

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