DB Systemtechnik Activity Report 2019/2020

Contents

Photo Cover: Martin Loibl
Photos: DB AG / Volker Emersleben,
Dr. Kai-Uwe Nielsen

A Strong Rail needs a strong DB Systemtechnik

For the first time in decades, substantial funds are being invested in renewing and expanding the rail infrastructure. Deutsche Bahn has launched its Strong Rail strategy based on the expectations of the rail sector in conjunction with this investment. We, DB Systemtechnik, will play a key role by supporting this strategy with our own action programme.

One crucial component of this programme is to increase the quality and availability of our means of production. In the future, we will equip these means with intelligence for better management. Often, for projects like these to be implemented effectively, we must have the necessary technical knowledge and digital expertise down to the smallest detail. We must succeed in combining new approaches such as digital twinning, robotics and sensor technology with the knowledge of our 900 experts to develop solutions for technology, maintenance and operations.

Despite the new, unpredictable challenges we faced this year, we reached fundamental milestones as we work toward our goals, such as the establishment of our new digital products and services business line. We also established an ETCS competence centre, which will allow us to bundle the knowledge that already exists in several places at DB Systemtechnik in the future.

You will find this and much more – as in previous years – in our performance report: a brief overview of the more than 5.000 projects that we carry out every day for the DB Group in Germany and around the world.

Yours sincerely,
Hans Peter Lang
Managing director
CTO Deutsche Bahn AG

DB Systemtechnik: The highlights 2019/2020

Christoph Kirschinger
General Manager Sales

We take pride in our 91% customer satisfaction rate

Our list of highlights wouldn't be complete without the results of this year's customer satisfaction survey. The entire team at DB Systemtechnik is delighted at the tremendous response rate, and we would like to thank our customers for all of their feedback.

An overall satisfaction rate of 91% is not only clear proof that we know how to make our customers happy; it is also a 6% increase on the survey results from two years ago. In particular, respondents singled out our employees' professional expertise and the quality of the support and advice they provide.

Christoph Kirschinger shared these words of gratitude for DB Systemtechnik's employees and customers:

"We would like to express our heartfelt thanks for our excellent partnership and trusting relationship over the past few years. Every day, we learn something new and we enjoy every challenge that we tackle with our customers. The positive feedback from the survey is due in no small part to each individual employee at DB Systemtechnik. I would like to take this opportunity to thank everyone who works at the company. It is your commitment, your motivation and your innovative ideas that have made these excellent results possible. Our customers' approval of our performance should inspire us to continue to provide excellent services, ensuring that we can maintain the same high satisfaction ratings in the future."

Photo: Martin Loibl

Photos: DB AG / Claus Weber, Frank Nonhoff

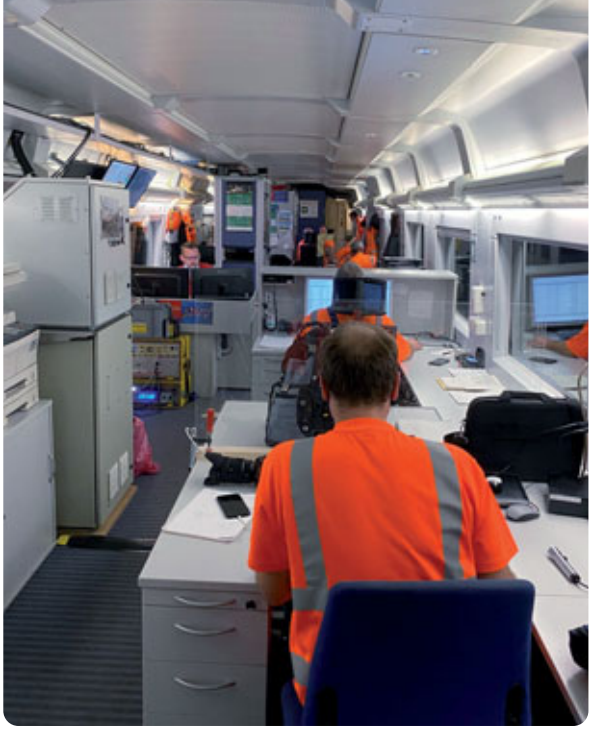
RAISING TRAIN SPEEDS

Germany

Speed increased to 265 km/h for ICE 4

In November 2019, a new requirement to raise train speeds to 265 km/h was added to the Siemens contract for the ICE 4. The aim is to increase the multiple units' permitted velocity by up to 15 km/h above the current top speed of 250 km/h.

The approval tests required for this higher threshold were carried out using ICE 4 units, which can be 12-13 carriages in length. The tests entailed assessing the performance of the brakes, engines, pantographs, running equipment and aerodynamics. To pass, the train had to meet performance requirements set for 292 km/h, or 10% faster than its actual intended maximum speed. DB Systemtechnik had planned and performed the tests across all disciplines and on schedule by the beginning of April 2020. Other test runs took place in Austria through June 2020.



Photos: 2 x AlpTransit Gotthard AG, Julius von Diepen

Tests in the Ceneri Base Tunnel

RUNNING TESTS

Switzerland

A new direct link will soon open between Lugano and Locarno thanks to the 15.4 km tunnel connecting Camorino and Vezia. On-line running tests in the Cenari Base Tunnel began in March 2020. They included a range of trials using DB Systemtechnik's ICE S vehicle.

Specialists used this high-speed train to inspect the overhead line equipment and tracks in the tunnel. The ICE S is DB Systemtechnik's contribution to ensuring that all of the components in the tunnel function and interact properly. Tests started at the beginning of March, but they had to be suspended temporarily due to the coronavirus pandemic. Work resumed on 20 April, which meant that the scheduled ICE S trials could begin on time on 29 April. Despite all of the additional challenges, tests were completed successfully on 30 May 2020.

Lab test rig for HVAC

DB Systemtechnik's LUDEK test rig went into operation in March 2020. Based in Munich, LUDEK is a new mobile testing facility for inspection, diagnostics and development support work on heating, ventilation and air-conditioning (HVAC) systems. Thanks to this new mobile lab, DB Systemtechnik is now able to perform functional tests on new, refurbished and repaired HVAC components, assess new and alternative coolants, and carry out stress checks on HVAC systems operating in extreme conditions.

LUDEK

Germany

Photos: Bairi / pixabay, Martin Loibl

ITRI

Taiwan

Ultra-modern testing for Taiwanese train transport

Taiwan's Industrial Technology Research Institute (ITRI) has turned to DB Systemtechnik for support. Combining their experience in rail operations with knowledge of Europe's tried-and-tested rail technology and the latest research, our engineering and inspection specialists are currently advising ITRI on a concept for a new testing centre in Taiwan.

The centre will use the latest testing procedures and measurement technology, and its work will meet the highest international standards. In its consulting capacity, DB Systemtechnik is advising ITRI on matters relating to vehicles, infrastructure and interfaces.

Some of the specific topics include traction technology (pantographs), chassis (bogies), wheel/rail contact and infrastructure (signals, point machines).

DIRK delivers greater comfort for train passengers

The German Aerospace Centre (DLR) and DB Systemtechnik signed a cooperation agreement for a demonstration vehicle for innovation in passenger comfort and climate control in 2019. Known as DIRK, the German acronym for the project name, the project put an ICE carriage into service for use as a test vehicle at DB Systemtechnik's facilities at Minden in spring 2020. The retrofitted carriage now functions as a lab for testing trains' HVAC systems. The two partners will research technology to improve passenger comfort and reduce the energy consumed by HVAC systems.

DEMONSTRATION VEHICLE

Germany

AsBo for rail vehicles, energy and CCS

On 24 June 2020, Germany's Federal Railway Authority (EBA) certified DB Systemtechnik as a notified body (AsBo) for various subsystems: rail vehicles, energy and CCS (train control, command and signalling). We have added this accreditation to our existing AsBo portfolio for rail operations and rail vehicle maintenance, and the new competencies cover key fields of expertise.

We are particularly pleased that DB Systel is now authorised to assess secure integration, which is an important aspect of the Fourth Railway Package. DB Systel is one of just two bodies in Germany with this authorisation.

AsBo CERTIFICATION
Germany

APPROVAL TESTS

Netherlands

DB Systemtechnik tests Alstom's fast ICNG generation vehicles

Dutch national rail operator Nederlandse Spoorwegen (NS) is buying 79 Coradia Stream multiple units from the train manufacturer Alstom. As of 2021, NS plans to deploy this new fleet under the name of Inter City Next Generation (ICNG). Trains will travel at speeds of up to 200 km/h on the Amsterdam-Rotterdam-Breda and The Hague-Eindhoven corridors.

Alstom commissioned DB Systemtechnik to perform approval tests for its Netherlands-bound multiple units, which are being produced at the manufacturer's Polish plant in Katowice. The testing and engineering specialist's experts have already reported the completion of the first part of their checks for the Coradia Stream vehicles, covering static and dynamic inspections of the brake system.

The series of inspections for approving the pantographs of the five and eight-part multiple unit started at almost the same time in the Netherlands. DB Systemtechnik is assessing how the ICNG's pantographs interact with the overhead line, which entails performing single and double traction test runs. Trials are also taking place at the Velim testing centre and using the network of Dutch rail operator ProRail.

IN-HOUSE PRODUCTION

Germany

Disinfectant production

The cost of disinfectant has seen a massive increase since the start of the pandemic, and delivery of supplies has at times taken much longer than usual. During the past few months, it has sometimes been more economical to produce disinfectant in house than to buy it on the open market. DB has decided to start making its own disinfectant at two locations. DB Systemtechnik's lab in Munich is one of them.

We have registered two formulas for manufacturing ethanol-based hand sanitiser with Germany's Federal Institute for Occupational Safety and Health. Our Munich site usually tests the suitability of fuels and lubricants for use in the rail sector, but it is now producing and packaging almost 500 litres of disinfectant a day. This new product is primarily intended for people working at other DB companies who are unable to wash their hands on a regular basis, such as train drivers and crew members.

Photos: Stadler / Karol Leszczynski, E-MAS / T. Baake

DB Systemtechnik is testing for Stadler Poland trains for Slovenia

The Slovenian National Railway Slovenske Železnice (SŽ) has further expanded its Stadler multiple unit fleet. In addition to an initial order of 26 KISS vehicles, SŽ has procured another 26 single-deck FLIRT multiple units (16 diesel-electric and ten electric multiple units (EMU)) from the vehicle manufacturer Stadler Polska, modernising its range of trains in Slovenia and in cross-border service.

DB Systemtechnik has been commissioned to conduct testing for the approval of the new FLIRT multiple units in Slovenia, Croatia and Austria on behalf of Stadler Polska.

DB Systemtechnik, Germany's leading testing and engineering service provider, will test brakes and interaction between the pantograph and overhead contact line for the Stadler EMU four-car FLIRT, with a speed of up to 160 km/h.

APPROVAL MANAGEMENT

Polen

Testing features:

- Brakes will be tested on four-car trains at Žmigrod Test Centre in Poland.
- The FLIRT EMUs are equipped as three-system trains, compatible with three different power systems for use in Slovenia, Croatia and Austria. (3 kV direct current, 15 kV and 25 kV alternating current).
- Pantograph tests will be conducted for approval in all three countries using a single and triple unit configuration.

Centre of expertise for repairing rail vehicles damaged in accidents

DB Systemtechnik has joined forces with DB Fahrzeuginstandhaltung to set up accident repair centres that can provide faster and more effective repairs and refurbishment for damaged rail vehicles. Design engineers from DB Systemtechnik and rail vehicle experts from DB Fahrzeuginstandhaltung jointly manage the repairs process for long-distance trains at these centres.

We use a proven four-phase accident refurbishment model that has been successfully used on several projects. We opened our first centre in Krefeld, and others are now in planning, which will allow us to work on the entire range of vehicles and models.

REPAIRING

Germany

The future of technology at DB

Hans Peter Lang: The future of technology at DB

For decades, transport policy treated rail as the poor relation of other modes. Dusty, outdated, unloved and used mainly by the poor, elderly and carless. Yet things could not have been more different in the beginning.

The railway was the technological revolution of the 19th century, a symbol of progress and a promise of mobility. It symbolised the dawning of a new era. And it is precisely this opportunity that has presented itself again today. Rail transport is emerging from the public debate on sustainable mobility as a climate saviour. And that's not just empty rhetoric. For the first time in decades, substantial funding is being made available for renewing and developing infrastructure, including funding for regional and local transport service.

Huge financial resources are at play, and the railway sector is also being expected to achieve great things in return:

Doubling passengers numbers

25% modal split in freight transport

The use of 100% renewable energy

Deutsche Bahn has developed its own targets based on these requirements, backed by its Strong Rail strategy. Four of these targets are:

260 m long distance passengers	**+1 bn** regional and local passengers
+70% more tonne kilometres in rail freight transport	**30%** increase in infrastructure capacity

All while increasing quality and customer satisfaction. The strategy is about making DB

more robust

more pioneering

more powerful

Each of these three strategic directions addresses five different components, all of which are underpinned by specific fields of action. There is a growing sense that since Deutsche Bahn is a technology company as well as an operating company, it needs to have its own technical expertise. It also needs to understand the rail system in all its complexity and work together with partners in the sector to advance it. This insight led to the development of a digital and technology strategy, which in turn gave rise to DB Systemtechnik's corporate strategy.

Photos: DB AG / Wolfgang Klee und Bernd Lammel

Both DB's Technology Division and DB Systemtechnik have now backed their strategies with an implementation programme that includes not only projects with a long-term impact, but also short and medium-term measures. After all, our customers want to actually see results. Below are a few examples of how we are doing more than just talking about the future; we are actively shaping it.

To achieve the transport policy objectives that have been set, we need more infrastructure capacity and more rolling stock. This additional demand needs to be addressed now, not down the line. We need solutions that will be effective in the short and medium term that can run alongside the long-term expansion plans we already have in place. One way we can do this is to increase the quality and availability of our production assets since delays affect capacity.

And that's exactly what we are focusing on: working together with industry partners to incorporate intelligence into our assets.

Trackside checkpoints record the condition of the wheel profile, wheelset and axlebox, before sending the data to the entities in charge of maintenance.

DB Regio is equipping its rolling stock with data transmission boxes to record vehicle conditions and facilitate the analysis of this information.

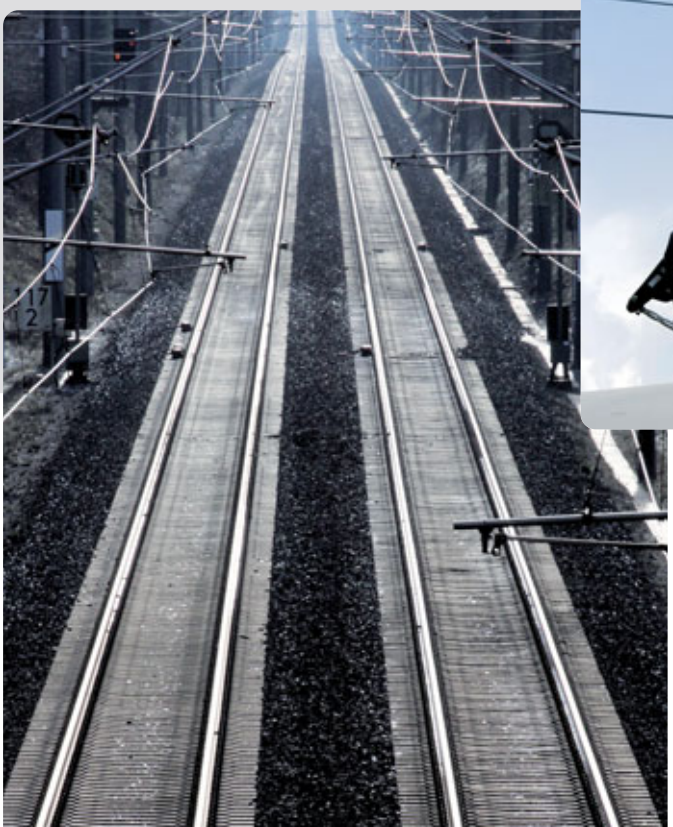
Not only do we want to be able to determine condition at any point in time; we also want to be able to forecast how condition will change overtime, identify upcoming failures before they occur and be able to intervene promptly.

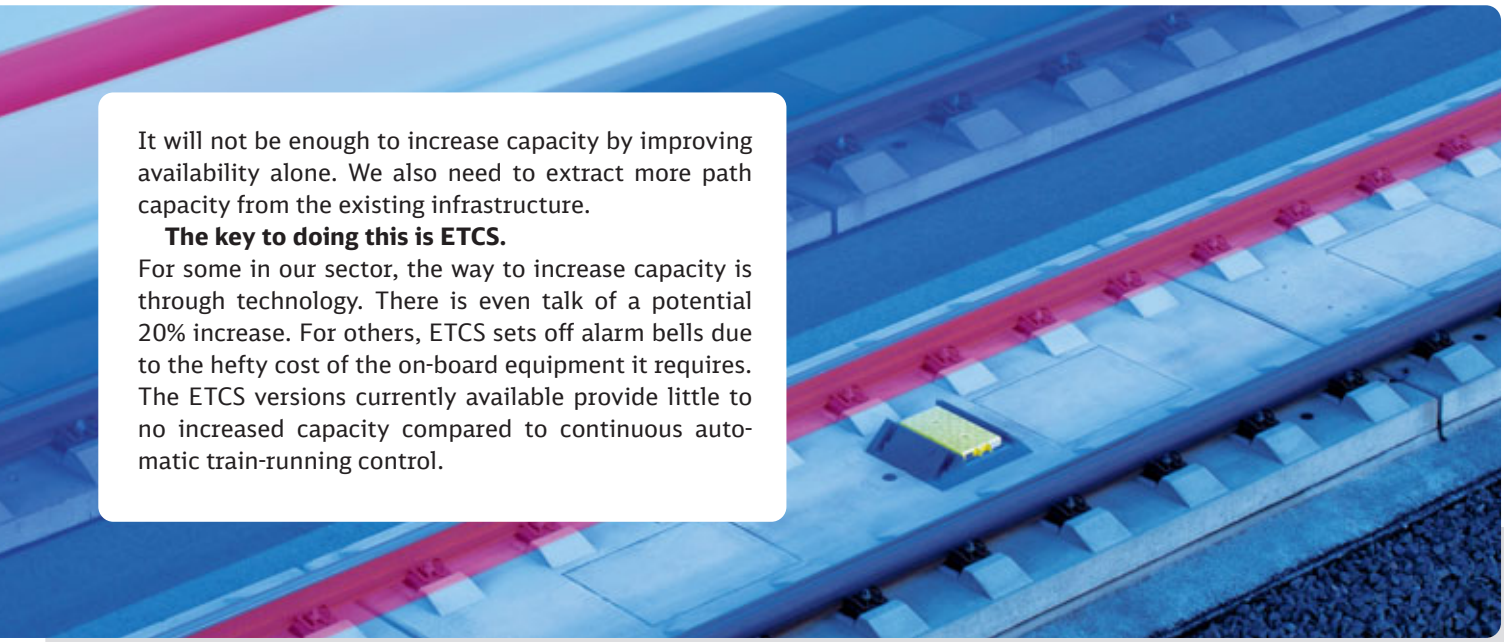
The industry already offers appropriate equipment for new rolling stock, but we also want to equip existing stock that will remain in service for many years to come. Our vision is to develop a condition dashboard that will show the current condition of all of the functions that affect availability at any time and in any place. Rolling stock and infrastructure data will be supplied to the condition dashboard, which will then process and analyse the data.

For the sector as a whole, the vision is to process data not only from Deutsche Bahn's production assets, but from all rail companies in order to increase the availability of the entire rail system.

To achieve this aim it will not be enough simply to continuously record condition; it will also be important to know how the condition of the rolling stock changes over time.

At present, special track geometry cars inspect the track geometry and the overhead line every three, six or twelve months, depending on the route category. This means the condition is only recorded at these exact times. We have now equipped several regular-service trains with measuring instruments that continuously record the condition of the track over several thousand line kilometres. This allows defects to be identified promptly and prevents speed-restricted sections caused by track geometry faults.





It will not be enough to increase capacity by improving availability alone. We also need to extract more path capacity from the existing infrastructure.

The key to doing this is ETCS.

For some in our sector, the way to increase capacity is through technology. There is even talk of a potential 20% increase. For others, ETCS sets off alarm bells due to the hefty cost of the on-board equipment it requires. The ETCS versions currently available provide little to no increased capacity compared to continuous automatic train-running control.

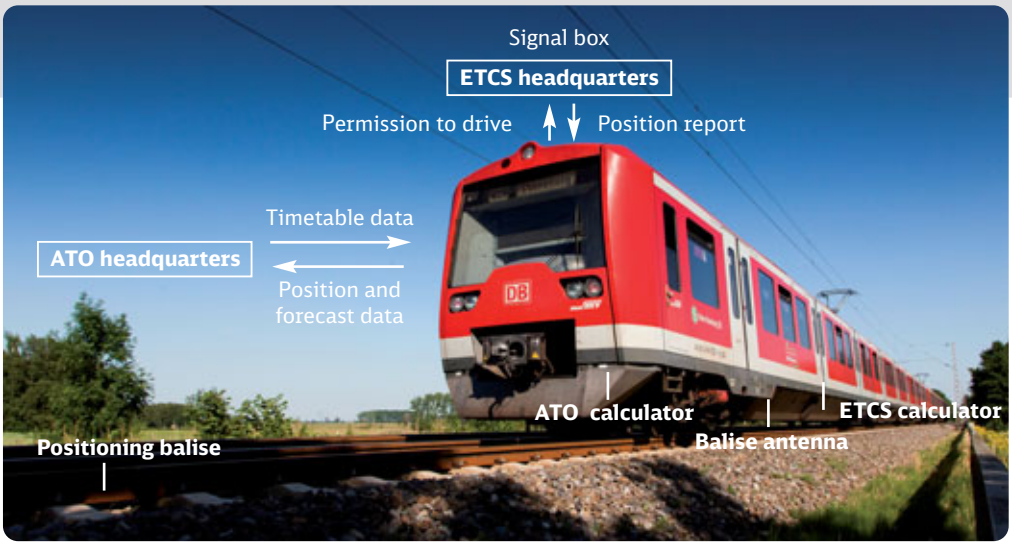
Despite this, the upcoming ETCS Level 3 equipment has considerable potential. However, for the fixed block headway to be eliminated and rolling stock to run in moving blocks instead, all vehicles will need to be upgraded to the latest ETCS version, including stock that is often more than 20 years old. Around 10,400 vehicles of approximately 415 different types will need to be upgraded, each of which will require specific engineering and separate approval. This is what DB Systemtechnik is gearing up to tackle right now.

The switch to ETCS is not a new issue for the integrated rail system. It affects everyone involved in the sector. DB is addressing it as part of Digital Rail for Germany, an organisation that has set out to involve the entire sector – from infrastructure managers, rail companies and manufacturers to the federal government and licensing and regulatory authorities.

Solutions for automatic rail operations are also being developed as part of Digital Rail for Germany. They will be yet another way to increase capacity in high-density networks.

www.digitale-schiene-deutschland.de

The best-known project is without a doubt the one that will see class 474 multiple units operating with Grade of Automation 2 on the Hamburg S-Bahn. This ambitious project is being carried out together with Siemens and Bombardier and will be handed over to the public transport network in 2021. It will set a benchmark for high-density traffic and for increasing capacity in the existing network using digitalisation. Additional projects, such as one in Stuttgart, are in the planning stages.

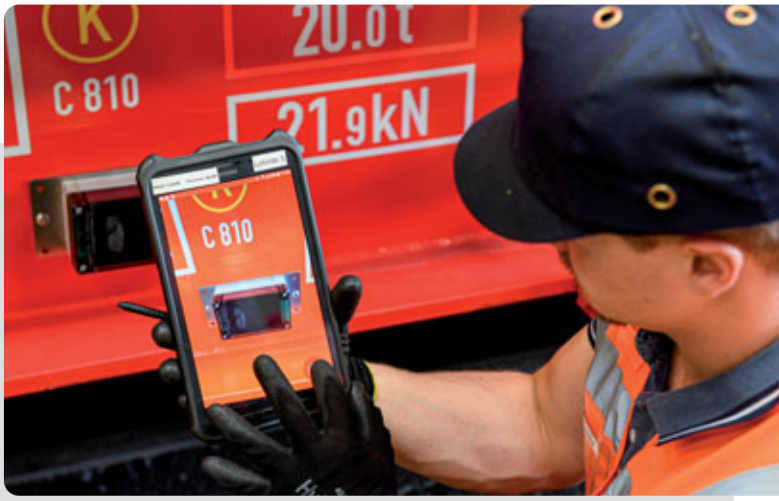


ETCS and ATO solutions require extensive pre-testing. Getting hold of test vehicles has always proved a problem, especially when vehicles are in high demand for scheduled operations. Here at Deutsche Bahn's Technology Division, we have taken three class 605 ICE multiple units previously used for long distance transport and are making them available to the entire sector for tests. The advanced TrainLab is a multi-purpose vehicle approved as a diesel ICE for speeds of 200 km/h and is in demand for a variety of tests. DB Systemtechnik is assuming the role of rail company for these test runs.

But rail operations are about more than just ICEs, regional and local transport. The aim is for freight transport to increase its modal share from 19% to 25%. Automation is the key to success here, but first the proper groundwork must be laid. We currently operate freight trains in just the same way as we did 100 years ago. Freight trains are not electric. Moreover, the lack of an appropriate power supply makes it difficult to install sensors for diagnosing conditions or automating brake testing, which is still conducted manually, for example. Coupling is done by hand and the integrity of the train is monitored using an end-of-train device, which is manually attached to the last wagon.

This is an example of what is currently involved in manual engineering:

When trains run in combined transport, locomotives are coupled and uncoupled eight times, wagons are coupled and uncoupled 30 times, wagons undergo four technical inspections, and nine brake tests are conducted.



Introducing digital automatic coupling throughout Europe is a crucial step toward ensuring that freight trains will be able to compete with the latest high-tech heavy goods vehicles. It will allow freight wagons to be coupled mechanically, pneumatically, electrically, and automatically and will connect them via a data line. This will lay the foundation for future applications.

Smart freight trains then become a possibility: the condition of both vehicle and cargo can be diagnosed, brake tests will be automated, and reliable end-of-train detection is possible – steps that must be in place for running in moving blocks.

Operators and wagon keepers from all over Europe have come together to pursue these goals in the Technical Innovation Circle for Rail Freight Transport (TIS). This group represents owners and keepers of some 300,000 freight wagons. The TIS has specified a range of practical requirements for coupling, power supply and data transfer. Limiting the specification to the essentials is a great way to ensure that cost-effective solutions will be developed instead of an expensive, super high-tech marvel.

Public funding bodies have also realised that freight transport must be automated if the transport policy objective of shifting more traffic to rail is to be achieved. A migration scenario has been developed on behalf of the Ministry of Transport, which assesses the costs and benefits of automatic coupling and automation functions, determines the total costs of a Europe-wide migration programme and proposes a reasonable and feasible timeframe for converting approximately 450,000 freight wagons. Four coupling variants will undergo fully funded testing, and one will then be selected as the most appropriate coupling type. DB Systemtechnik has been commissioned to carry out the tests and manage operations. Coupling interfaces will then be standardised across Europe based on these findings.

HELMS (Hybrid Electromechanical Shunter) innovation project with a new hybrid drive for proven, diesel-hydraulic locomotives that will be modernised. This reduces the diesel consumption - and CO_2 emissions of the locomotives by up to 20%.

Deutsche Bahn and the sector as a whole are also focusing on developing and introducing technical solutions for implementing operations on non-electrified sections of line that are environmentally friendly and as carbon-neutral as possible.

Synthetic fuels are one way of significantly reducing the CO_2 emitted by the diesel fleet without any fundamental vehicle conversion work. However, for this to succeed, the traction motors (not all of which are equipped with modern electronic engine control units) must be able to tolerate the new fuel without any loss of performance and must not fail after just a short period of operation. This is why extensive tests are being carried out in collaboration with DB Fahrzeuginstandhaltung, DB's heavy maintenance company, on DB's own engine test benches and with the advanced TrainLab diesel ICE. The disadvantage of these fuels is that they are currently only available in small quantities and are relatively expensive.

Battery vehicles even fuel cell vehicles are already available from many manufacturers or are in the development and approval process. But what manufacturers and operators still lack is operating experience. They are still unfamiliar with the service life that key components such as batteries and fuel cells can offer when running under railway conditions. We will give the industry the chance to conduct joint testing of components and rolling stock under real operating conditions. There are other challenges as well. Deutsche Bahn alone currently operates 2,178 diesel multiple units for passenger service, which are still a long way off from the end of their technical service life.

This raises the urgent question of how to continue using existing vehicles even as environmental conditions change.

In addition to qualifying synthetic fuels, we are working on concepts and solutions for converting and hybridising existing rolling stock. The first challenge is to reconcile what is environmentally desirable with what is technically and financially feasible.

It certainly makes sense to recharge battery vehicles below the contact wire when those vehicles are diesel hybrids, but retrofitting existing rolling stock involves a huge amount of conversion work. The question of whether or not the increased weight is technically acceptable then becomes the key factor in deciding whether to go ahead with conversion. A sensible and feasible alternative is to install batteries in diesel multiple units without the option to recharge them below the contact wire and instead use recovered braking energy to recharge them. Running electrically and thus emission-free and with reduced noise in the station area is a perfectly acceptable alternative.

Combined with synthetic fuels, these ideas make it entirely possible to come up with environmentally sound and eco- nomically feasible conversion solutions. These are the kinds of concepts that DB Systemtechnik is working hard to develop.

While the Technology Division is providing a strategic response, DB Systemtechnik is providing a technical and operational response to the enormous challenges we all face. Expectations for our work are high, and rightfully so. We will be able to meet those expectations only if every single partner in the sector pulls together – our rallying cry and invitation all rolled into one.

Photos: DB AG / FZI und Oliver Lang

DB Systemtechnik reference projects 2019/2020

Brake disc hub for double-decker coaches

The introduction of the new Dosto 2010 double-decker passenger carriages at DB Regio and the Dosto IC 2 at DB Fernverkehr ran up against a new monopoly situation: There was only one supplier for the axle-mounted brake discs used for the passenger carriages. In order to establish competition, reduce the cost of spare parts and increase supply security in the future, DB aims to qualify additional suppliers and enable brake disc hubs and friction rings from different manufacturers to be combined.

DB Systemtechnik's brake technology department was commissioned to define a standard hub interface that can be used in contract award procedures for spare parts.

The following steps were used to define the standard interface:

- Measuring OE hubs when pressed on and pressed off
- Preparing drawings with all necessary dimensions and specifications to describe the new standardised interface
- Drafting specifications for material selection for hubs

The project was completed in 2019. DB Regio, DB Fernverkehr and the spare parts purchasing department of DB AG now have all the documents they need for contract award procedures. In the future, additional trial installations and in-service tests will be carried out with each newly certified product from each manufacturer in order to check compatibility and properties under operating conditions. DB Systemtechnik will also coordinate these measures, provide technical support and perform the final evaluation.

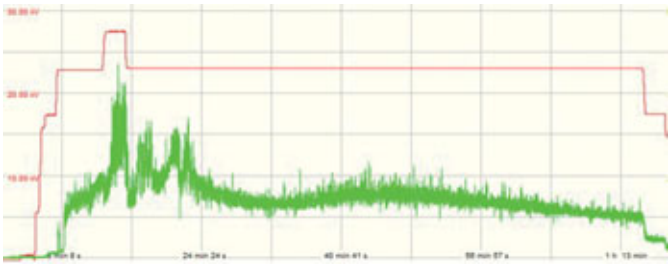
Photo: DB AG / Georg Wagner

Partial-discharge measurement on rail vehicle transformers

Traction transformers in electrically powered vehicles convert the energy from the catenary system into a voltage range that can be processed by the downstream power electronics. They are filled with an insulating liquid to cool and insulate the windings in the transformer. Analysing the insulating fluid is an established technique for assessing the condition of transformers.

DB Systemtechnik's experts were commissioned to develop an additional technique for diagnosing the condition of traction transformers.

An additional test was also required to assess whether newly produced transformer insulation systems were in good condition.



Voltage pattern with recorded partial-discharge profile

Partial-discharge (PD) measurement was identified as a measurement method that could potentially be used, as this procedure allows the performance of the insulation system to be evaluated over its entire service life.

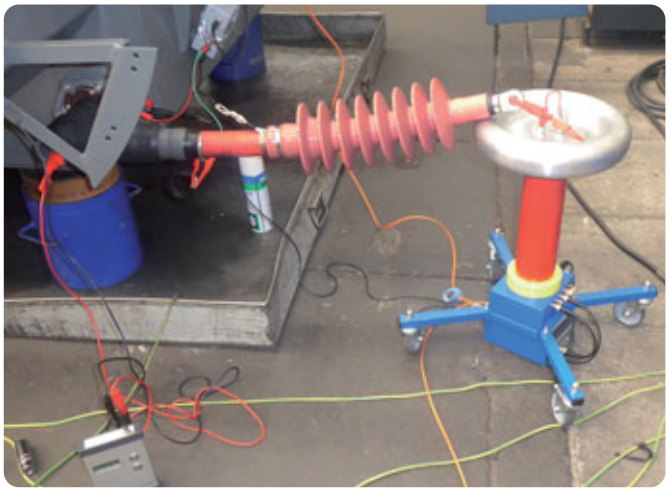
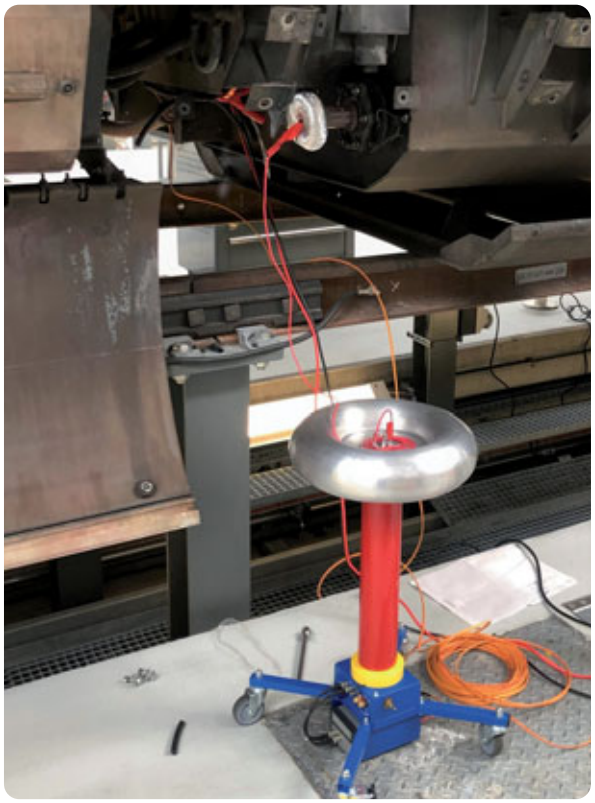


Figure: Example PD measurement set-up; source

As the rail vehicle sector did not yet have any experience with carrying out PD measurement on liquid-filled rail vehicle transformers, initial pilot measurements were conducted with two suppliers of PD measuring equipment. These measurements showed that it was possible to use this procedure with the transformers and the depot environment.

The pilot measurements were then used to establish a measurement procedure, including acceptance values, that ensures that measurements and evaluations can still be compared even if they are carried out at different locations using different measuring equipment. EN 60076-3 was used as the basis for creating a measurement procedure in line with requirements. Additional measurements went on to prove that they could also be conducted on traction transformers installed in the vehicle and provide comparable results.

PD measurements can now be carried out as a routine test after new vehicle transformers have been produced. The PD fingerprints obtained in the process are stored. During repeat measurements, deviations in the insulation system due to aging, for example, can be detected at an early stage by comparing data about the current conditions with the fingerprint, enabling preventive transformer maintenance.



Photos: Christian Schultz 2x, DB Fernverkehr / Christian Metke

Photos: DB Systemtechnik 2 x

Testing sound attenuation screens for reducing bridge noise

As part of the I-LENA project, DB Netz was tasked with testing various measures to reduce rail traffic noise by the end of 2020 on behalf of the German Federal Ministry of Transport and Digital Infrastructure (BMVI). One of the tests investigates the effect of sound attenuation screens on noise radiation from ballastless steel bridges.* These screens are intended to significantly reduce bridge noise, an additional component of the noise radiation that occurs when trains travel over a bridge.

To verify this claim, DB Systemtechnik assisted the project in selecting a suitable test bridge, designing and carrying out acoustic measurements, and evaluating the measurement results.

Tests have since been carried out on a ballastless steel plate-girder bridge near the Helenesee railway station west of Frankfurt (Oder).

For the tests, innovative sound attenuation screens like those used for acoustic deadening in shipbuilding were attached to the main, longitudinal and cross girders of the bridge structure. Acoustic measurements were performed with and without sound attenuation screens to assess the bridge noise produced when regular trains drove over the bridge.

The test results now available show that the sound attenuation screens failed to reduce bridge noise sufficiently and needed to be optimised. To make it much easier and more cost-effective to test and optimise products for reducing bridge noise using dampers in the future, a test rig for bridge dampers was also designed and put into operation in the first half of 2020 as part of the Shift2Rail project at DB Systemtechnik in Munich.

* Ballastless steel bridges are bridges on which the rails are connected directly to the bridge without a ballast bed.

Figure: Test stand for bridge dampers of DB Systemtechnik in Munich

Industrial upcycling of concrete sleepers. This is green.

Rail companies traditionally reuse the elements used in rail construction to conserve resources. In particular, reusable material is recovered during conversion and demolition projects and then reprocessed and recycled. Concrete sleepers that have been removed from the track are currently reprocessed at the six depots operated by DB Bahnbau Gruppe using standard track-laying tools.

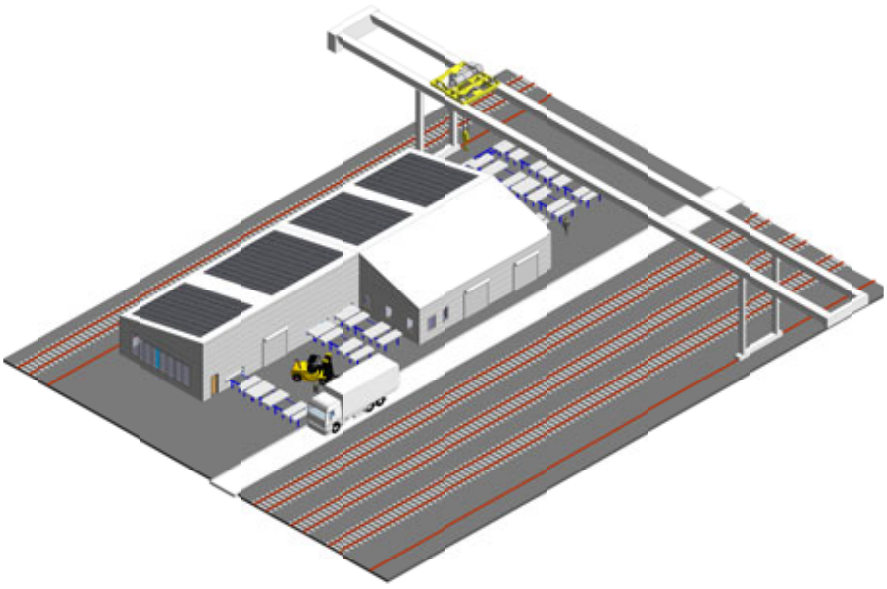
In 2019 DB Bahnbau Gruppe approached our workshop planning and process design specialists with an ambitious goal: to develop a semi-automated production line to overhaul 210,000 sleepers per year.

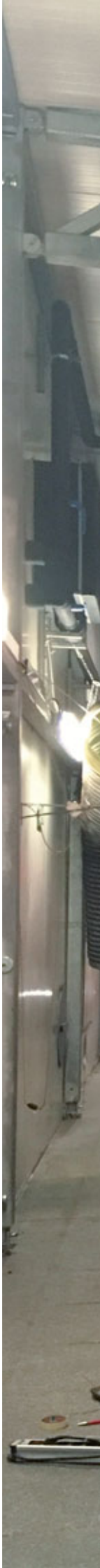
This would be enough sleepers to renew approximately 120 km of permanent way (e.g. from Leipzig to Dresden) and reduce the same number of new sleepers that would need to be procured. Using a reconditioned sleeper instead of a new one can also cut CO_2 emissions by approximately 40 kg. This means that DB AG's carbon footprint could be reduced by approximately 8,400 tonnes a year for each infrastructure asset.

DB Systemtechnik is helping its customer DB Bahnbau Gruppe to reach the ambitious climate targets of the Strong Rail programme by designing a concrete sleeper reconditioning plant at the Hanover-Leinhausen site.

Since comparable maintenance technology exists only for some subareas, the specialists at DB Systemtechnik in Kirchmoser first worked on recording the target processes so that they could then develop different variants for designing a production line. Discrete event-based simulation was used to test various hypotheses and identify bottlenecks for the total output. Aspects such as the size and arrangement of material buffers and the location of the plant for optimum crane utilisation were adapted.

In addition to designing the production line, DB Systemtechnik is also responsible for overall design management for the concrete sleeper reconditioning plant (project and specialist planning services in HOAI in service phases 1 to 7). Once procurement and commissioning are complete, the plan is to implement the concept at other DB Bahnbau Gruppe locations. Faster and better reconditioning of concrete sleepers will create secure, high-quality jobs in concrete sleeper reconditioning while helping make the rail sector even more eco-friendly.





Illustraton: Uwe Lauterbach
Photo: DB Systemtechnik / Kiepe

Testing and evaluating new refrigerants for HVAC systems in rail vehicles using simulations

DB Systemtechnik's HVAC experts are working with manufacturers of air conditioning systems to test alternative refrigerants for future use in HVAC systems in rail vehicles to comply with the EU Regulation on fluorinated greenhouse gases.

DB Systemtechnik worked with the HVAC manufacturer Kiepe Electric to test natural CO_2 refrigerant (R744) as part of the HLK Natur project for DB AG. Tests were conducted on two HVAC systems that work as heat pumps in one of DB Regio's double-decker carriages.

Since the thermodynamic process and pressure ratios of R744 differ significantly from those of conventional systems, DB AG uses simulations of the overall thermodynamic process in addition to bench tests and operational trials to gain experience with and information about R744 in conjunction with heat pump air-conditioning systems.

The test project involved creating models of the R744 process with a heat pump function using the simulation software Dymola, which enabled the thermal limits and extremes to be identified. The simulation also allowed a wide range of scenarios to be modelled and simulated, including the influence of ice formation on the ambient heat exchanger in heat pump mode, design parameter settings and different control strategies for the HVAC system. These calculations made it possible to gather knowledge about performance and controllability when operating near boundary conditions before the physical test system was created.

The overall model of the HVAC system and the thermal model of the vehicle body were validated in tests performed at the test bench and in the environmental chamber. The bench tests were performed at the Austrian Institute of Technology in Vienna, a partner of Kiepe Electric. The tests on the carriage were performed in DB Systemtechnik's environmental chamber in Minden.

Using the virtual twin allowed potential sources of error to be identified early on so that the causes could be traced and eliminated. In the future, HVAC system operators will benefit from optimised and new types of HVAC systems with a higher degree of maturity and reduced maintenance requirements, resulting in lower costs. Last but not least, in the course of this project, the HVAC experts at DB Systemtechnik were able to use their extensive HVAC simulation and evaluation skills in the early evaluation and optimisation of industrial system concepts, which benefits the industry and business units alike.

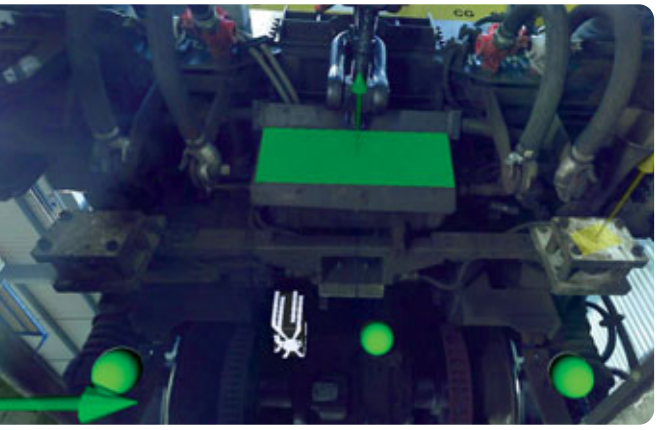


Figure: The images show different views of the model in which the measurements can be performed. The green spheres are reference points that allow the software to merge scans from different positions into a single model.

3D scan of a track geometry car for Eurailscout in Saint Varent

Eurailscout planned to replace the measuring equipment for one of its track geometry cars at different areas in the underfloor area. Since it lacked some of the technical data it needed, it commissioned DB Systemtechnik to carry out a 3D scan of this vehicle and process the data from bogies 3 and 4 in the underfloor area.

The first step was to determine the customer's requirements and feasibility in a video conference. As the time window from depot visit to data processing was very narrow, DB Systemtechnik was asked to act quickly and flexibly. DB Systemtechnik's experts travelled to France with 3D scanners and the necessary peripheral equipment. Because the areas of the vehicle were difficult to access with hand-held devices, the Faro installation space scanner was used. The scanner can be set up on the floor or a tripod and can capture the environment autonomously by rotating 360 degrees. The team only had one and a half days to complete the scan at the depot. The data was then post-processed at DB Systemtechnik's Cottbus site.

The results were presented to the customer and the data that was collected was handed over. Eurailscout was able to use the data to plan the conversion of the measurement vehicle remotely without additional vehicle downtime.

Expansion of the wheelset workshop in Rybnik, Poland

As part of plans to standardize maintenance Europe-wide, DB Cargo is gradually upgrading the maintenance depots of its subsidiary DB Cargo Polska to serve as production facilities for the core European market. This upgrade will also affect freight wagon wheelsets since the growing demand for this product can no longer be met by overhauling wheelsets at DB Fahrzeuginstandhaltung alone. DB Cargo Polska is therefore expanding the existing wheelset workshop at its maintenance depot in Rybnik, near Katowice close to the Czech border. It aims to increase capacity to 10,000 wheelsets per year and offer up to reconditioning level IS2 in house. A new production flow was designed, and the systems needed for internal transport, dismantling, washing, machining, non-destructive testing and measuring have been added to the existing machinery.

DB Systemtechnik provided a second opinion on the planning approach, drew up the specifications for the equipment and machinery, assisted with the selection of bidders together with the purchasing department, and provided technical support for the provisional and final acceptance of these systems.

DB Cargo Polska intends to put the expanded production line into operation by December 2020.

Photos: DB Systemtechnik 3 x

Photos: Jonny Franke 2 x

Development of a measuring method for Los Angeles abrasion machines

Los Angeles abrasion machines (the LA test method) are used to determine the abrasion resistance of track ballast in accordance with DB AG's DB 918061. The method involves placing a weighed quantity of a rock sample in the drum of a ballast testing machine together with a number of steel balls and rotating the drum up to 1,000 times. A shelf inside the drum lifts the load. The load then falls to the base of the drum, causing the rock load to be gradually crushed (see Figure 1). The different pieces of broken rock are sifted and weighed to determine the Los Angeles abrasion value according to a standardised procedure.

Figure 1:
Track ballast before (left) and after (right) an LA test

Comparative studies by DB Netz, SBB and OBB showed that the Los Angeles abrasion values of ballast fluctuated significantly in some cases. The test process was analysed by a group of track experts in order to identify possible variables that influence the test process. These variables included the geometric properties of the testing machines, the direction of rotation, the number of rotations, and variation in the speed and synchronisation of drums.

The project set out to determine the attributive characteristics and the characteristics to be measured on different types of LA testing machines and to compile the results. The hope was that the results would help the group of experts to reassess the informative value of the LA test method and, if possible, to better control the measurement process.

As part of a joint project involving the participating railways, the Technical University of Munich, the Association of Accredited Construction Laboratories (VAB) and others, DB Systemtechnik's Calibration and Testing Centre was commissioned to develop the necessary measuring equipment and measuring procedures and to test a total of 21 LA abrasion machines at 20 locations in Germany, Austria and Switzerland.

Each Los Angeles abrasion machine was tested using different aggregates provided by the Technical University of Munich. Various characteristics were recorded, the Los Angeles abrasion values determined in the different test series were compared, and the angular velocities or synchronisation variations of the drums were measured (see Figure 2).

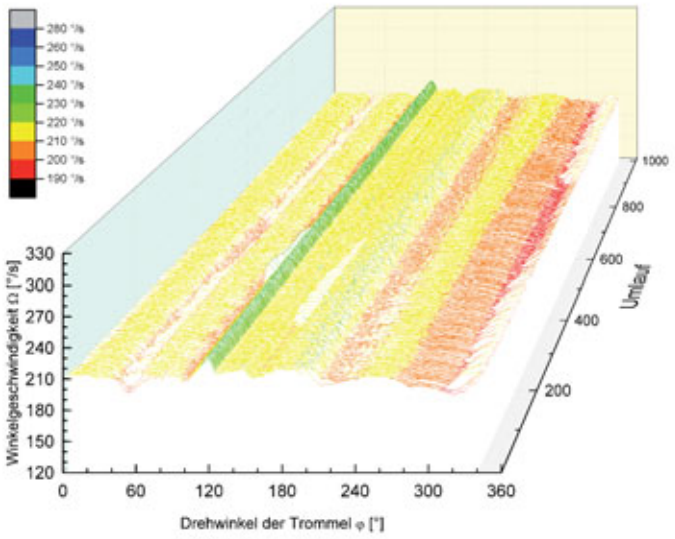


Figure 2:
Angular velocity of the drum over 1000 revolutions with the drum loaded with 10 kg of 32/50 aggregate

The test determined that there are a total of seven different types of abrasion machines, which differ greatly from each other in certain respects. This variation was mainly due to insufficient specifications in the relevant DIN standard.
The findings from the tests were taken into account in a revised DIN standard in mid-2020 and were able to contribute to better control of the measurement processes.

Running tests for Stadler Rail

The rail vehicle manufacturer Stadler Rail required technical tests to be carried out by DB Systemtechnik as part of the approval process for its FLIRT Limburg and GTW Refit.

The FLIRT Limburg, with a maximum speed of 160 km/h, will be used internationally in the Netherlands, Germany and Belgium. The GTW Refit, an existing vehicle of the Dutch operator Arriva, which was equipped with batteries to store recuperation energy*, needed to be approved for the Netherlands at a maximum speed of 140 km/h, i.e. without train protection systems for Germany.

One of the project's major challenges was the narrow time window for approving both trains. In addition, the lack of train protection systems meant that the GTW was not allowed to drive using its own traction. In order to comply with these conditions, the decision was made to test the two trains in a single train formation, i.e. to carry out the test runs of both trains simultaneously for the most part.

The test runs and on-line running tests had to be carried out under the following conditions:

- Maximum speed of the FLIRT Limburg: 160 km/h / + 10%
  Maximum speed of the GTW Refit: 140 km/h / + 10%
- Compliance with the specified equivalent conicities**
- Test runs carried out on empty and loaded vehicles
- The GTW Refit was not allowed to drive using own traction, but had to be towed by the FLIRT Limburg due to the lack of train protection systems for use in Germany.
- In Austria, the test runs were carried out using a third vehicle to tow, as the FLIRT was not allowed to run in Austria in its current condition.

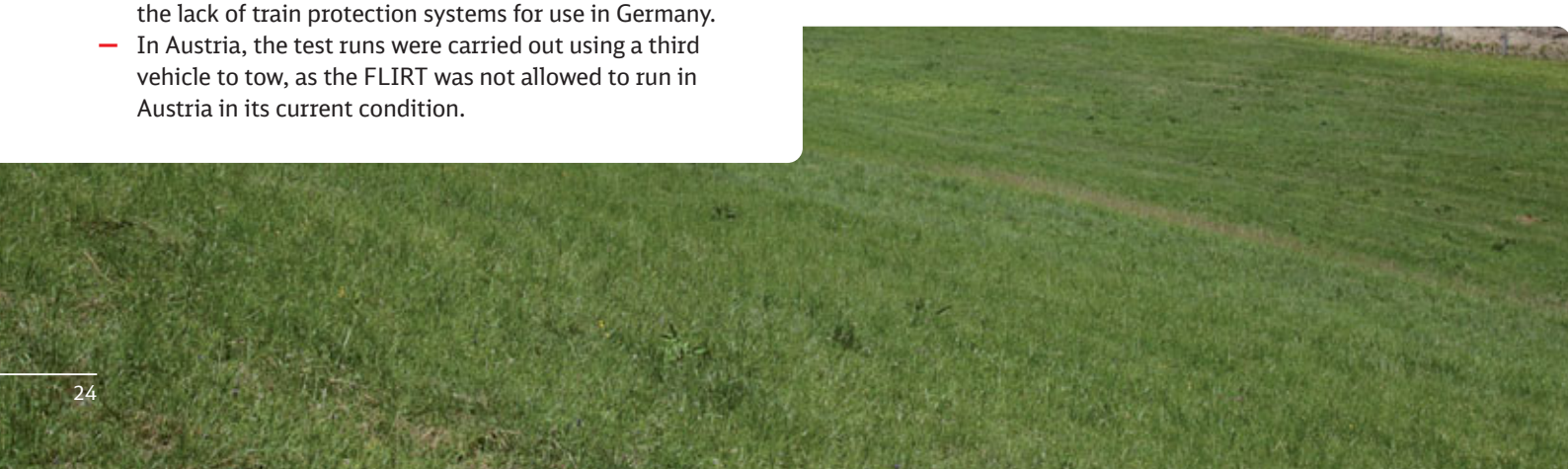
These conditions greatly complicated the execution of on-track testing. In order to test the maximum speeds achieved, the running test for the FLIRT Limburg had to be carried out at a speed of 176 km/h, but the GTW Refit had to be tested at a speed of 154 km/h. The prescribed equivalent conicities could only be achieved by reprofiling some of the vehicle wheels. In addition, the test route that was selected needed to have a specific rail head geometry. The test runs were therefore carried out between Amstetten and St. Valentin in Austria in addition to in Germany.

DB Systemtechnik completed the running tests in about three months, on the client's tight schedule. The test reports were handed over to Stadler Rail at the end of autumn 2019, which meant that both trains could be approved at the desired time.

* Recovery of energy that would otherwise be lost. The energy generated during the braking process is converted into electricity and stored in batteries.

** Parameters of the wheel-rail contact geometry that influence running behaviour. These are specified by the relevant standard.

Photo: DB Systemtechnik



Noise TSI measurements for CRRC Zhuzhou

Acoustic approval measurements needed to be performed for the shunting locomotive produced for the Hamburg S-Bahn network by the Chinese electric locomotive manufacturer CRRC Zhuzhou. The locomotive had not yet been approved.

Obtaining authorisation for placing the locomotive in service required verification tests to be conducted in accordance with the Noise TSI 2014 during battery and diesel operation, among other tests. DB Systemtechnik was commissioned to carry out these measurements and verification tests.

First, the customer was given in-depth advice regarding operational settings and a list of components that are relevant to sound so that an appropriate measurement concept could be created that would comply with the operating framework of the Noise TSI when measurements were being taken.

Once the scope of the acoustic verification measurements was decided on and the necessary documentation was drafted (list of components relevant to sound, operational settings of the assemblies during measurements, the test specification and measurement concept), the necessary verification measurements were taken on the Langenbach section, which has the right conditions to ensure compliance with the requirements of the Noise TSI (e.g. track decay rate, rail roughness and sound propagation). The DB Systemtechnik team also applied for the necessary timetables and provided the operational test manager for the measurement and transfer runs. The evaluation results were documented in an accredited test report.

As the advice and measurement runs provided were tailored to the customer's needs, CRRC was able to obtain acoustics authorisation as part of the approval for placing the light rail motor tractor in service.

Photos: Lukas Kirschinger, Mario Streng

HVAC consulting for Norway's Sporveien during tram procurement

The Norwegian local transport operator Sporveien AS planned to buy new HVAC trams for local public transport.

As early as the procurement phase, DB Systemtechnik's HVAC experts helped the Norwegian operator evaluate the bids it received from vehicle manufacturers and check whether they met HVAC requirements.

As the procurement process progressed, Sporveien asked for assistance with design reviews for the climate-control subsystem. Their aim was to evaluate the technical and functional descriptions for the HVAC units in the driver's cab and passenger area.

As part of the contract, DB Systemtechnik used the technical and functional descriptions provided by the HVAC system manufacturer to determine and evaluate the necessary details for the HVAC systems and discussed outstanding issues and ambiguities with the vehicle manufacturer during design reviews. Following the design reviews, the quality of the equipment was tested together with the client in a final first article inspection at the HVAC system manufacturer's site.

Thanks to its experience from various past procurement projects, DB Systemtechnik was able to provide Sporveien with reliable advice and clarify which documents and evidence the contractor would have to provide or rework as part of the design reviews. This enabled the customer to avoid project risk and to achieve consistently high quality when procuring the air conditioned trams.

Enhancement of the digital tachograph recording function

DB Fernverkehr uses Class 406 ICE 3 trains for its cross-border services to Belgium and the Netherlands. The trains were retrofitted to improve safety, and that process included upgrading the tachograph (a "RedBox") to record data about door and macrophone operation using new software and an integrated macrophone switch.

DB Systemtechnik was commissioned to evaluate the retrofitting project based on the Interoperability Directive 2008/57/EC, the LOC & PAS TSI, and the OPE TSI. As an associate partner of EISENBAHN-CERT (EBC), the inspection body of DB Systemtechnik was able to include the aspects in the European approval procedure.

While the type examination (module SB) – as an example in the fields of fire protection, system integration of the tachograph and recording of monitoring data – could largely be carried out based on records submitted, the three conversion sites (Cologne, Frankfurt and Krefeld) had to be inspected on site as part of a random audit of the production quality management system (module SD). The inspection reports of the evaluations were then incorporated into the technical dossier, which EBC, as the notified body, then used to issue the intermediate statement of verification.

Thanks to the fast and flexible audit and the provision of inspectors for the various vehicle disciplines, DB Fernverkehr is now able to convert the 16 vehicles in its Class 406 fleet and continue to use them in cross-border operations.

Analysis of heat accumulation in control cabinets on the ICE 3 and ICE T

DB Fernverkehr has installed additional computer units, known as train IT platforms (ZIPs), in its vehicles in order to provide an expanded range of information and entertainment on ICE trains. Dissipation of the additional waste heat generated by the new components was impaired by further modifications, causing failure of the ZIP and the passenger information system (PIS), which was installed in the same control cabinet. One of the tasks of the PIS is to display seat reservations. Although elevated temperatures do occasionally occur in every ICE class, the ICE 3 (403, 406) and ICE T (411, 415) were most frequently affected by failures.

DB Systemtechnik was commissioned to analyse the current problem areas and develop measures to ensure that the lost heat is removed, increasing system availability.

First, data loggers were used to measure air speed and temperatures for each control cabinet. The results were analysed and then suggestions for improving heat dissipation from the control cabinets were developed based on the extent of the problem. A total of 27 measures were identified, ranging from optimising maintenance and redesigning door vents with air deflectors to installing additional diagonal fans. The effectiveness of the measures was then tested in service trials and confirmed by measurement data. The effective measures that were developed can also be adapted to other classes, so that the availability of entertainment services, seat reservations and thus passenger satisfaction with long distance service can be increased in the future.

Photos: DB Fernverkehr, DB Systemtechnik, DB AG / Daniel Saarbourg

Technical optimisation of HVAC systems on the ICE 3

DB Fernverkehr uses Class 403 (1st and 2nd series), 406 and 407 vehicles for ICE 3 service. The trains are equipped with HVAC systems to ensure a comfortable temperature and pressure for passengers and train crew. Classes 403 and 406 use air as a refrigerant in their HVAC systems and are equipped with systems from two different manufacturers. Class 407 vehicles are equipped with conventional vapour compression refrigeration systems that use the refrigerant R134a.

To ensure smooth operation and to further increase the availability and reliability of the HVAC systems of class 403 and class 406 vehicles, DB Systemtechnik's HVAC experts were commissioned to collaborate with experts from DB Fernverkehr on HVAC issues within the scope of product line support and to look into options for implementing condition-based maintenance (CBM) for HVAC systems, and predictive maintenance (PM) based on CBM. They developed the following range of services in close collaboration:

Feasibility studies for condition-based maintenance of HVAC systems and predictive maintenance approaches based on CBM:

- Concept design with possible use cases for condition-based maintenance of HVAC systems
- The use cases were determined based on conspicuous or availability-relevant components and the data available on the vehicle for the HVAC system.

Verification of sufficient availability and quality of data, including allocation to use cases:

- Establishment of data interfaces for remote access to HVAC data during train operation
- Evaluation of the data to prove the usability for implementing the CBM use cases
- Development of predictive models (PM) based on this data using machine learning and artificial intelligence (AI) by analysing historical and live data

When working on product line support, DB Systemtechnik was able to draw on the knowledge gained in the course of the ICE 3 procurement projects. Other DB Systemtechnik experts in fields such as electrical engineering, EMC and fire protection could also be consulted at short notice.

Initial evaluations of the sensor data from condition-based maintenance showed that the quality of the data is sufficient to enable the damage patterns from the use cases to be analysed. The pilot project will now test whether this will also enable potential damage to be predicted far enough in advance to prevent failures.

The HVAC aspect of product line support offered by DB Systemtechnik therefore helps stabilise the HVAC systems of the ICE 3. If the CBM project is successfully implemented, it will also help to increase the availability and reliability of the HVAC systems in class 403 and class 406 vehicles.

Certification of fixed barriers

As part of occupational health and safety measures, fixed barriers protect people working on tracks by separating them from passing traffic.

Since 2013, the Aerodynamics and HVAC department of DB Systemtechnik has been responsible for certifying fixed barriers as part of railway technical approval by DB Netz.

The process involves checking documents and testing measurements (deflection tests and electrical tests), and a certificate is issued if the process is successful. DB Netz published new requirements for the use of fixed barriers on the Deutsche Bahn railway network in March 2020.

The aim is to harmonise requirements throughout Europe based on Standard 16704-2-2:2016 "Track – Safety protection on the track during work – Part 2-2: Common solutions and technology – Requirements for barriers". In 2019, DB Systemtechnik added EN 16704-2-2 certification to its portfolio and carried out the first successful approvals. It also developed and implemented requirements for additional components (e.g. sound insulation mats) as part of orders.

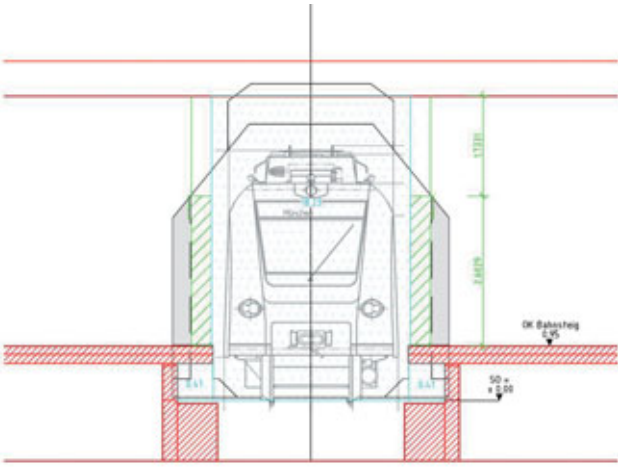
DB Systemtechnik has established itself as an exclusive partner of DB Netz in the certification of fixed barriers and is recognised in the market. It has taken the challenges of new requirements and new products and transformed them into marketable solutions. Manufacturers appreciate the aerodynamics specialist's expertise and are happy to benefit from it.

Aerodynamic loads on platform barrier systems

The Munich S-Bahn is considering equipping the underground stations of the first S-Bahn main line with closed platform barrier systems along the platforms with doors for passengers. The platform barrier systems will enclose the entire length of the track along the platform until an arriving S-Bahn train has come to a standstill and the platform doors open for passengers to get on and off the train. Air exchange between the track and the platform is prevented and the components of the platform barrier systems, such as enclosures and doors, are exposed to the pressure and flow loads from train operation.

The department for aerodynamics and HVAC technology at DB Systemtechnik has calculated these pressure and flow loads that occur when S-Bahn trains arrive using one-dimensional numerical simulations.

The results of these simulations will serve as the basis for further considerations on implementing platform barrier systems and for three-dimensional simulations of the structural design of platform barrier systems.



Photos: DB Systemtechnik, Martin Duffner
Illustration: Hans-Joachim Wormstall-Reitschuste

EURODUAL locomotive approval for Germany

Rail vehicle manufacturer Stadler has developed a new locomotive platform called EURODUAL at its production plant in Valencia. The EURO 4000 diesel locomotive was used as the basis for the new platform. The EURODUAL is a six-axle main-line freight locomotive with a maximum line speed of 120 km/h. What makes it unique is that it can run in both diesel mode and electric mode. The EURODUAL platform is also fully prepared for operations up to 160km/h.

Havellandische Eisenbahn (HVLE) was the first customer to order 10 Eurodual locomotives, which will run on the DB network (15 kV AC 16.7 Hz) and on the non-electrified feeder lines to and on the Rubeland Railway (25 kV, 50 Hz).

DB Systemtechnik was commissioned by Stadler Valencia to perform all the tests required in Germany for locomotive approval in the shortest possible time.

Besides the tight schedule, the new EIGV (Railway Commissioning Authorisation Regulation), which had just come into effect, presented an additional challenge. In-house assessment body certification made it easy to comply with the new approval process and integrate the safety assessments.

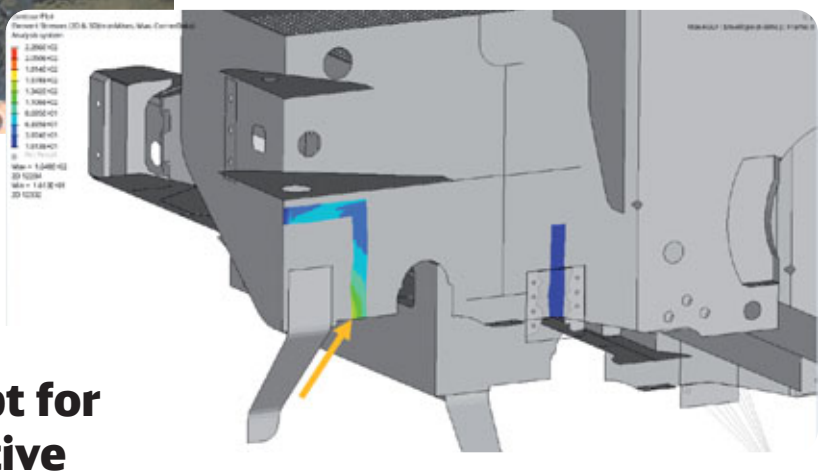
Measurement runs took place using two locomotives in parallel on the DB network, as well as on the Rubeland Railway line, which has steep gradients near Blankenburg in Saxony-Anhalt. At the customer's request, vehicle dynamics tests were carried out on the running gear for a target speed of 160 km/h in order to ensure the approval of faster Eurodual locomotive variants. For this purpose, the test object had to be towed by one of DB Systemtechnik's own locomotives and in combination with a sleeping car developed for Azerbaijan, also manufactured by the sister company STADLER Altenrhein. Compatibility with the overhead line was tested with one and two pantographs raised so as to inspect what is known as ice scraper mode, where the pantograph in front clears ice from the overhead line in winter to improve OHL contact.

An overview of the services provided by DB Systemtechnik:

- Railway undertaking services and approval procedures for test runs on the DB network and on the Rubeland Railway
- Test runs for the following disciplines:
  - Vehicle running dynamic tests, including production of two instrumented wheelsets for measuring wheel-rail contact forces
  - Testing of electromagnetic compatibility (axle counter, interference currents, radio compatibility and human exposure)
  - ETCS track-train integration on the VDE 8.2 high speed line
  - Pantograph overhead line interaction test (contact force and uplift of the overhead line) and simulation of other overhead line types to assist with approval of the locomotive in Scandinavia
  - Braking tests for approval on steep sections
  - Wheel-slip protection testing with the aid of the wheel slide protection mobile test rig developed by DB Systemtechnik
  - Torsional vibration

By using DB Systemtechnik, Stadler Valencia was able to benefit from integrated project implementation. It received a convenient all-in-one package that included not only technical assistance with defining the scope of the tests, but also operational planning and implementation of these tests and measurement services. The measurement campaign was completed in a very short time using modern simulation tools.

Photo: Axel Stelzer
Simulation: DB Systemtechnik



Accident refurbishment: Frame restoration concept for a diesel shunting locomotive

A diesel shunting locomotive suffered damage following a derailment. Although the damage affected some components that could easily be replaced, it also affected the vehicle frame. The locomotive was transferred to the DB Fahrzeuginstandhaltung depot in Cottbus for accident repair.

A refurbishment concept was required for repairing the damage sustained by the frame. DB Fahrzeuginstandhaltung commissioned DB Systemtechnik's Infrastructure Rolling Stock and Diesel Locomotive Competence Centre to draw up the concept and prepare the documents.

An economical and feasible repair solution had to be developed for restoring the damaged areas on the frame, with special focus on the supporting structure of the vehicle. The restoration concept was designed in close cooperation with DB Fahrzeuginstandhaltung and was visualised in a set of drawings.

It was also determined that the restoration required additional welds around the frame's lower flange. DB Systemtechnik's Strength Mechanics Department from Minden was brought into the project to verify the strength of the repaired section. The Materials and Joining Technology Department was involved in the welding design and construction test (since weld certification level CL1 in accordance with EN 15085-2 was required).

The team prepared the restoration concept within the tight timeframe and was even able to hand the necessary documents over to the DB Fahrzeuginstandhaltung Cottbus depot one week ahead of schedule. Once the repair work was completed, the operator was able to put the locomotive back into service.

Installation engineering for retrofitting Wi-Fi in rail vehicles

DB Systemtechnik's Passenger Coaches Competence Centre develops customised installation engineering for Wi-Fi and network-based retrofit solutions for all vehicle keepers and operators specifically for their rail vehicles.

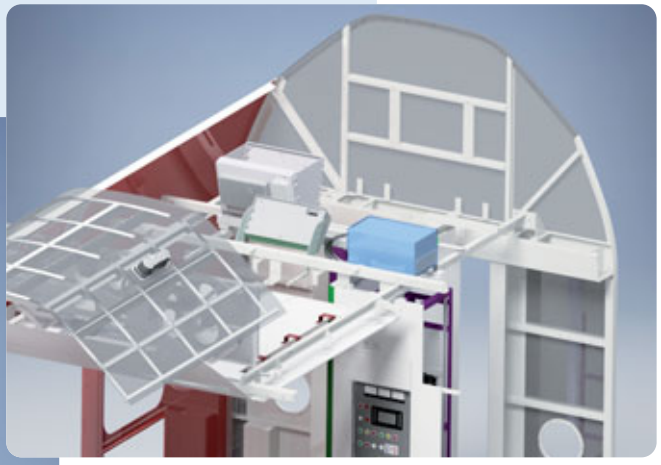
At its Wittenberge site, DB Systemtechnik works very closely with the IT department on the DB Fahrzeuginstandhaltung Colibri (coach link for broadband information interchange) train. DB Fahrzeuginstandhaltung develops these retrofit solutions as a configurable component system. Thanks to many years of cooperation, DB Systemtechnik's experts are familiar with the technical requirements for installing Wi-Fi and network components.

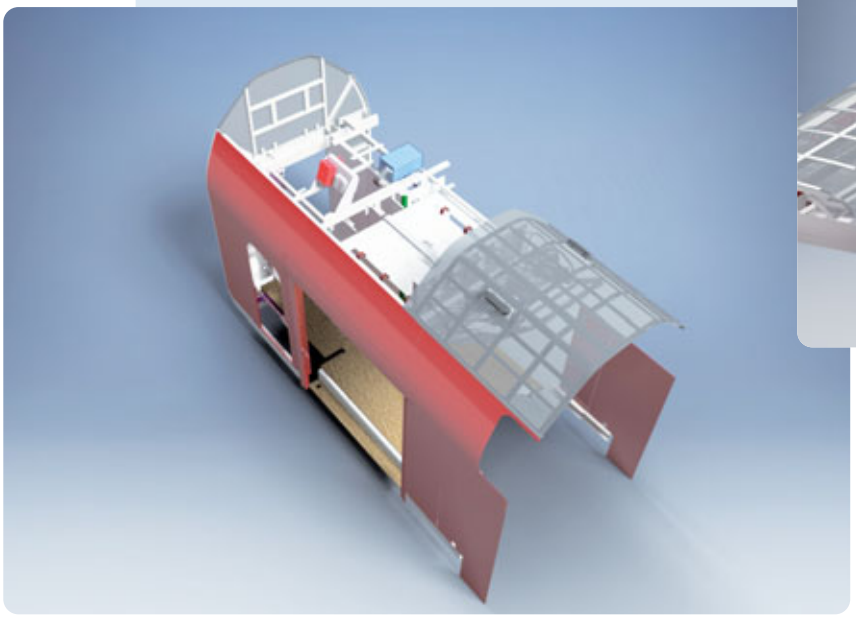
That's why they were commissioned by DB Fahrzeuginstandhaltung to handle installation engineering for a wide range of projects.

This work includes the mechanical installation of components, electrical integration into vehicle signals and the power supply, and documentation and provision of evidence for all vehicle types.
Several orders for Wi-Fi retrofitting have already been successfully carried out for various vehicle operators and a variety of rail vehicles.

In 2019, for example, Wi-Fi was installed on type 781, 786 and 766 double-decker vehicles for the Frankfurt-Limburg route and types 753, 767, 780 and 781 for Network 2 in Baden-Württemberg. DB Systemtechnik also handled engineering for Wi-Fi on diesel railcars on the Merseburg-Querfurt route. Passengers on these DB Regio trains can now enjoy the benefits of a convenient Wi-Fi connection. Additional projects are already planned, as the demand for this convenient technology is constantly increasing.

Simulations: DB Systemtechnik





Switch heater testing in the MEikE environmental chamber

DB Netz relies on switch heaters to keep switches working in snow and ice. Despite this precaution, switches do occasionally freeze. To investigate the effectiveness of switch heaters in more detail, a switch heater for a switch with a UIC 60 rail profile needed to be tested under different winter conditions.

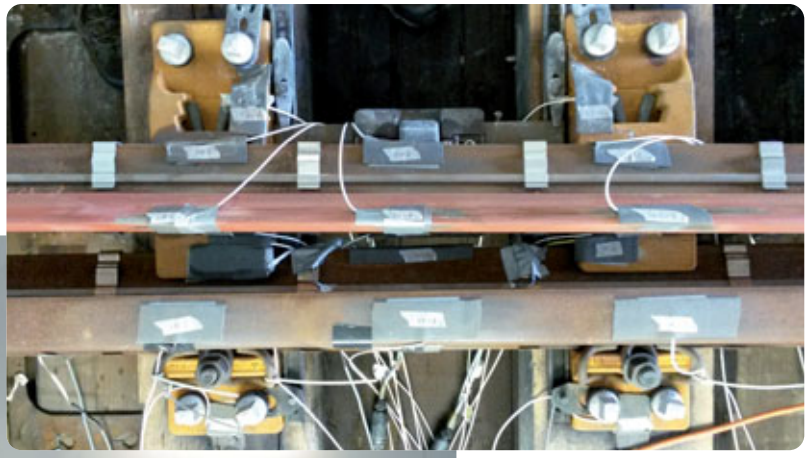
DB Systemtechnik was commissioned to carry out these tests in the MEikE environmental chamber.

The test sequence was as follows:

- The switch was equipped with 84 surface temperature sensors to capture the heating signals.
- The test series were executed at air temperatures from -5°C to -16°C.
- The influence of wind was investigated using three drum fans.
- Precipitation was simulated using two snow cannons.
- The recorded measurement data was then analysed.

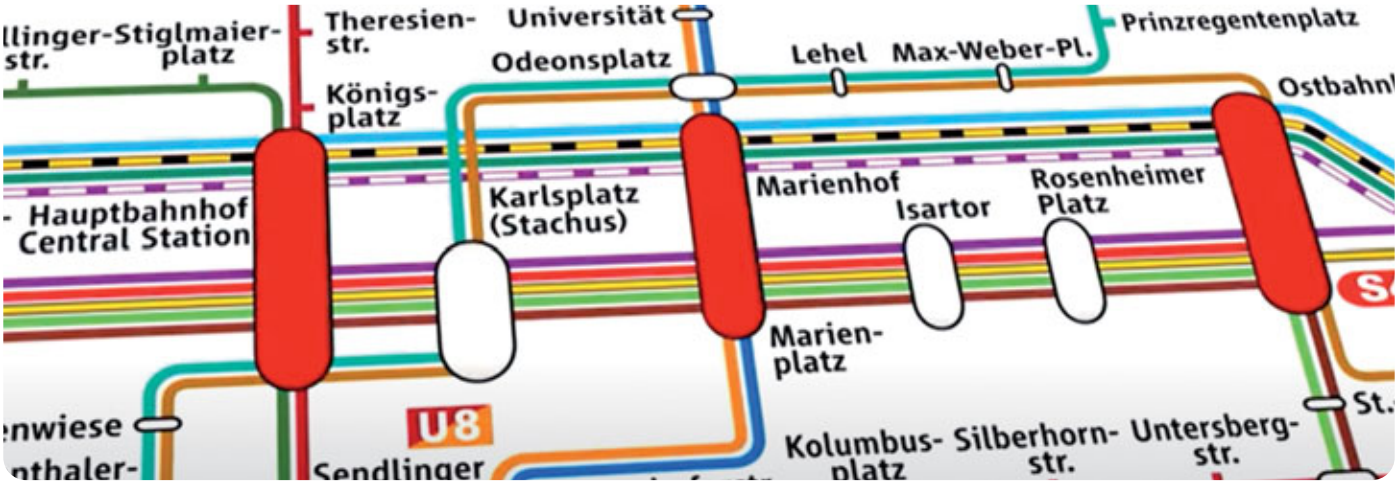
The tests carried out in the MEikE environmental chamber provided information about the impact of wind and snow on the effectiveness of the switch heater and identified shortcomings. These findings will serve as a basis for improving switch equipment. Performance limit values for switch heaters were also determined. In addition, validation data for an FEM* heat transfer model for switches was obtained and handed over to the client.

* The finite element method (FEM method) is a simulation method used for detailed testing of the physical behaviour (e.g. heating, deformation, stress, etc.) of components.

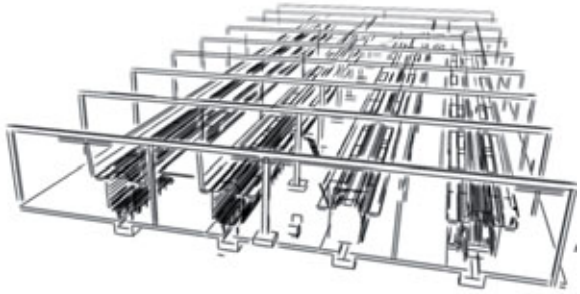


Photos: Edgar Bergstein 2 x

Photos and Illustrations: S-Bahn München



Maintenance 2030: System and project development for the Munich S-Bahn



As the Munich metropolitan area has grown, the capacity of the local transport system needs to grow with it. For the Munich S-Bahn, this means offering more frequent service, extending lines and increasing the use of long trains. Once the second core route goes into service, the company should be able to handle 40% more traffic with new vehicles than it can offer today.

In order to be able to respond to these serious operational changes efficiently and with consistently high quality and performance, the entire maintenance production system must be redesigned. The capacities for exterior and interior cleaning, graffiti removal, de-icing, wheelset processing, maintenance and preparation for operations must be fundamentally re-dimensioned and coordinated, and each of the systems must be organised in the right order for the processes.

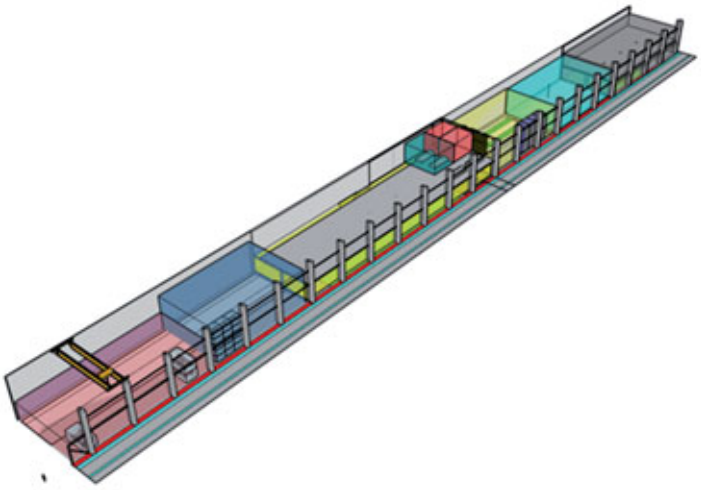
In this demanding project, the experts from DB Systemtechnik in Kirchmoser helped the Munich S-Bahn by providing technical and methodological consulting services.

A working group including employees from the Munich S-Bahn and DB Systemtechnik identified the basic principles of the new system and key requirements for the future infrastructure during a number of workshops.

The result was set out in project requirements specifications for two new-build depots and their peripheral facilities.

Since April 2020, the project requirements specification for the new construction on the premises of the former DB Regio maintenance depot in Pasing has provided the engineering firm hired to build the depot with a foundation and vision for the first new-build depot.

The scenarios developed will enable the new production system to go into operation by 2029 and lay the foundation for the necessary robustness when operations are ramped up on the second core S-Bahn route in Munich.



advanced TrainLab: Engineering and installation of a test platform for digital rail operations

The **"advanced TrainLab"** project is an initiative of Deutsche Bahn. It aims to bring together new technologies and developments for digitalising rail infrastructure and operations in Germany. As part of the project, test activities on digitalising rail operations are being carried out using a class 605 vehicle. The vehicle was adapted and converted into an advanced Trainlab, an innovative test vehicle for components and technologies, for this purpose. Among other things, room was created for components in the front, roof and underfloor areas to accommodate innovative sensors and measuring instruments. Evaluation electronics and IT systems for analysing and evaluating measurement runs were also integrated into the interior of the vehicle.

DB Systemtechnik provided its design expertise for the conversion of the vehicle into a modern test platform.

All of the necessary design and technical measures were implemented and the main evaluations relevant to approval were carried out to equip the vehicle with the appropriate sensor technology for geolocation, environment detection and track geometry measurement. The main challenge was to install the sensors and measuring equipment at appropriate locations on the vehicle and to ensure that everything worked perfectly.

DB Systemtechnik also drafted all of the necessary documentation for the conversion and provided operational support for converting the vehicle and putting it into operation.

Digitale Schiene Deutschland

As part of the Group's Digital Rail for Germany programme, DB Netz aims to increase reliability, capacity and efficiency by systematically digitalising rail operations. Digital technologies open up entirely new possibilities for the rail sector. The test platform on the advanced TrainLab allows intelligent sensor technologies for locating and detecting static objects (such as landmarks) and dynamic objects (such as trains) to be evaluated under real operating conditions. These technologies form the basis of autonomous rail operations.

DB Systemtechnik provides support for the Group's Digital Rail for Germany programme and in doing so ensures the vehicle keeper role of the advanced TrainLab.

Photos: DB AG / Oliver Lang, CRRC 2 x

Optimisation of maintenance at CRRC

DB Systemtechnik was commissioned by the Chinese rail vehicle manufacturer CRRC Tangshan to determine how the maintenance programme for its type B2/4M2T Tianjin U5 multiple units could be optimised.

CRRC wanted to draw on Deutsche Bahn's experience in drafting and modifying maintenance programmes and in maintenance itself. It expressly requested that European or German standards and DB-compliant processes be taken into account.

The review conducted to determine how to optimise the maintenance programme for the multiple units included the specifications of standard DIN 27201-1 and worked through the steps in the process achieved to date.

In addition to optimising the conventional maintenance programme for the trains, DB Systemtechnik was also asked to develop an IT system that would allow real-time vehicle data to be used in maintenance. For this purpose, a train from metro line 5 was equipped with a data box that sends the vehicle's technical and operational data to a land-side back-office solution. This data is then used for operations management and maintenance.

The project covers all contractual issues relating to the implementation of an IT solution for condition-based maintenance and its use to optimise the maintenance programme. It is examining the following points in particular:

- Data box on the train
- Land-side IT landscape
- Condition-based maintenance
- Use of the system to optimise maintenance (use cases)

It is also looking at the interfaces to the maintenance programme optimisation sub-project. A follow-up contract has now also been awarded to install the system in five additional vehicles and link it to a shared visualisation and evaluation platform (dashboard). The entire project is expected to be completed by the end of 2020.

IT connection for wheelset processing machines

Figure: Wheelset on the underfloor wheel lathe

The wheels of rail vehicles wear out during operation and need to be machined at regular intervals using an underfloor wheel lathe. Deutsche Bahn currently operates 32 systems, which consist of twelve different models from three different manufacturers.

Previously, processing data (measured values before and after processing) was printed in a log after each processing operation and then entered manually in the SAP ISI system (DB AG's maintenance documentation system).

DB Systemtechnik has automated this process for several Group companies by developing an interface that now enables data to be transferred directly from the underfloor wheel lathe to SAP ISI.

A variety of tasks had to be completed in a process lasting several years.

First, the interface had to be selected. An existing universal data gateway (UDG), whose structure allows the data to be returned in xml format, was used. Specifications for implementing an interface were created together with an underfloor wheel lathe manufacturer. However, new requirements meant the original interface could not be used, and a new one had to be developed.

The new security requirements also meant that the selection of hardware had to be coordinated and adjusted in multiple stages. DB Systemtechnik facilitated this process between the Group companies and the supplier. One outcome was a master agreement for delivering and installing the required components for all DB depots.

Another of the tasks was to handle internal DB information technology processes (data security). A number of participants classified and evaluated the system in the Bahn-wide Enterprise Architecture Management (BEAM) system, conducted the corresponding business impact analyses, and entered into interface agreements. This work was coordinated by DB Systemtechnik.

To guarantee secure data transfer to the DB AG network (SAP ISI), access points for remote maintenance of infrastructure facilities had to be migrated to a secure system. DB Systemtechnik drafted the requirements for this and, together with the parties involved, found a usable technical and organisational solution.

Before the new system can be used in live operations, the measurement data must be validated. DB Systemtechnik has developed a partially automated comparison procedure for this purpose, which checks whether the data transferred to SAP ISI matches the values stored in the local databases of the underfloor wheel lathes.

The wheelset to be processed no longer needs to be identified manually. A customisation was implemented in SAP ISI that makes it possible to display a QR code for specific transactions. The underfloor wheel lathes were equipped with scanners. DB Systemtechnik prepared specifications for the overall project, and all of the relevant parties were consulted and reviewed the specifications.

Additional extensions and improvements are planned following the current implementation for all underfloor wheelset lathes in the DB Group. For example, the interface will be expanded to mobile wheelset lathes, and there are plans to develop bidirectional data transfer so that data can also be transferred from DB's systems to the wheelset lathes.

Figure: Underfloor wheel lathe in operation

Photos: Hartmut-Joachim Sigrist 2 x, Viven Wenzel 3 x

New construction of a wheelset diagnostics system in Berlin-Rummelsburg

As part of the expansion of the Berlin-Rummelsburg depot, an additional wheelset diagnostics system was put into operation in 2019. The system is an ARGUS II ULM (ultrasound, light section, measuring beam) system manufactured by Hegenscheidt MFD. It is located outdoors and in an uncovered area on the new track 835 of the BRGBA yard at the depot.

DB Systemtechnik helped the DB Fernverkehr project manager in the following areas: drafting of the functional statement of work, procurement support, and construction and trial operation of the wheelset diagnostics equipment.

Metrological approval of the system was granted in accordance with DIN 27201-9 by DB Systemtechnik's Calibration and Testing Unit, a DAkkS-accredited laboratory for rail depot measuring and testing equipment.

DB Systemtechnik also handled **technical acceptance of the machinery and parts of the final acceptance.**

The challenges of the project stemmed mainly from the short period of time between the decision to implement the project and the deadline to put the system into service in time for the winter 2019 timetable change. The contract was awarded to the ULM manufacturer at the end of March 2019.

Once the system was completed and functional testing at the contractor's premises was passed on 24 July 2019, engineering at the site began at the end of August. The track construction company completed the installation of all track modules and the foundations and paving work for the crane and measuring container on 6 September. Just one month later, following successful metrological approval, the system began four weeks of trial operations. On 22 November, three weeks before the original commissioning date, final acceptance was completed and the BRGBA ULM system was handed over to production at DB Fernverkehr.

Lasting just 34 weeks from contract award to go-live, this was the shortest project duration for an ULM at Deutsche Bahn to date.

Adhesive film on class 407 trains to prevent chipping damage

Class 407 trains travelling to France are often damaged by flying ballast, especially in winter. To better protect the side windows from damage, DB Fernverkehr set out to wrap the exterior with a protective film.

The Materials and Joining Technology Department of DB Systemtechnik helped the client select appropriate types of film and evaluate their fire protection properties during the preliminary test phase.

Tests also had to ensure that film would not negatively impact the function of emergency access and escape windows in the event of an evacuation. Once a suitable film was selected, it was tested to determine is resistance to impact.

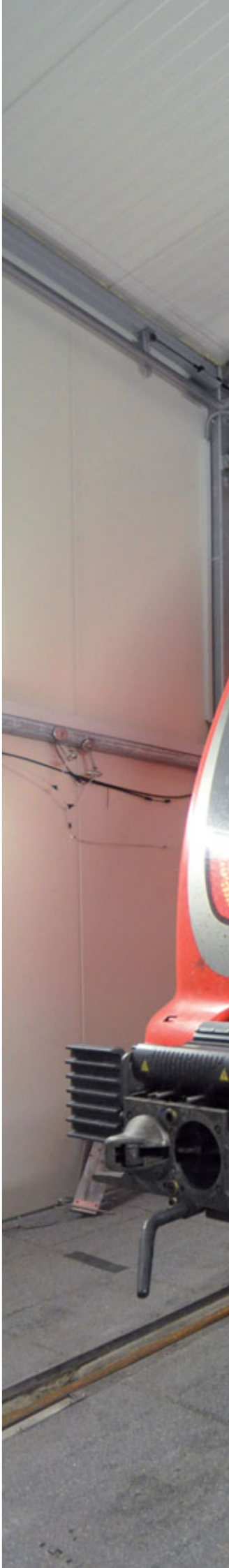
The LOC & PAS TSI (1302/2014) and NNTR checklists specify the requirements for emergency exits used to evacuate passengers from the vehicle that are relevant for emergency access and escape windows. They also describe how to perform a functional test for opening the windows from the outside.
The pane is shattered with a pointed striking tool. Then, the entire glazing unit must be removed within 60 seconds to create a usable rectangular opening for emergency access and escape with a width of 700 mm and a height of 550 mm.

Of course, passengers on the train must also be able to open emergency exits. Functional testing from the inside is carried out in three trial runs by test persons who represent typical passengers (one man and two women).

They must use an emergency hammer to break through the pane at the point of impact and push it out to create an opening as described above. The average of the times of each of the subjects must be less than 45 seconds.

The impact tests proved that additional film applied to the outside of the side window did not prevent compliance with the requirements of the administrative rules governing emergency access and escape windows in terms of the ability to easily create an opening in the window from the inside and outside. A sample train has already been equipped with window film and is in operation for test purposes. An analysis of the results is expected soon.

Figures: Window pushed out following functional testing



Measurement of the energy-saving potential of HVAC systems on Dosto 2010

To further reduce CO_2 emissions in rail transport, Deutsche Bahn is striving to reduce the energy consumption of its vehicles. Since HVAC is the second most energy-intensive feature on a train after traction, technical measures to reduce the energy consumption of HVAC systems were implemented in existing Bombardier Dosto 2010 double-decker coaches.

The energy saved in an IC 2 intermediate car and a regional and local transport railcar was determined based on the DB energy consumption cycle* in DB Systemtechnik's MEikE climatic chamber to prove the effectiveness of the measures.

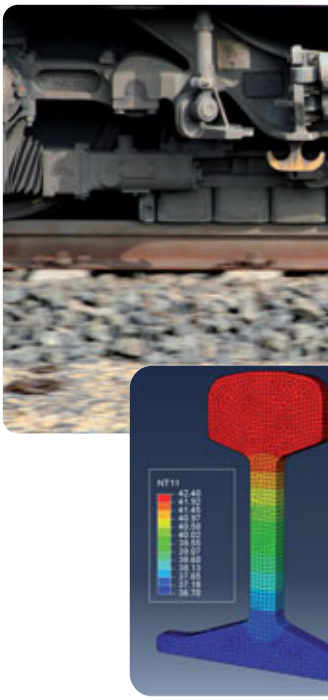
In order to test the CO_2-controlled fresh air volume control, bottled CO_2 was introduced in a controlled manner to simulate the CO_2 exhaled by passengers. The CO_2 concentration was measured with optical sensors at four points in the seating area, at the circulating air intake points and in the climatic chamber. The sensible heat emitted by passengers in the passenger area was simulated using heating mats placed on the seats, and the moisture released (latent heat) was simulated using evaporators. The incident solar radiation was simulated using heating mats placed in the passenger area in front of the windows. In order to prove that the climatic comfort provided by the energy-saving measures continues to meet standard requirements, the carriages were equipped with temperature measuring points and sensors for recording relative humidity based on standard specifications.

The measurements for both vehicles that were examined showed that the measures taken had considerable potential to reduce energy consumption. Energy savings of 35.8% was achieved for the IC 2 intermediate car and 20.5% for the local transport railcar. Occupancy- dependent fresh air volume control was primarily responsible for the reduced energy consumption.

* The energy consumption cycle (duty cycle) is a method developed by DB to determine the annual energy consumption of a vehicle with just a few tests.

Photos: Frank Lüders 2 x, Edgar Bergstein 2 x

Determination of the optimum maintenance interval for the heat exchanger of an ICE 3



The ambient heat exchanger (AHX) of HVAC systems in the passenger area of the ICE 3 1st series plays a key role in creating a comfortable temperature for passengers. Outside air flows continuously through the AHX, which becomes increasingly contaminated the longer it is in use. Cleaning performed on the vehicle is often not thorough enough due to limited accessibility, so the AHX undergoes thorough off-vehicle cleaning every two years. This procedure is time and cost intensive.

DB Fernverkehr commissioned the HVAC experts at DB Systemtechnik to determine a condition-based maintenance interval.

To determine the maintenance interval, they needed to know the degree of contamination of the AHX. The main way to determine the degree of contamination of a heat exchanger is to measure pressure loss. The pressure loss characteristic curve of the AHX was therefore measured on DB Systemtechnik's new HVAC test rig LUDEK in Munich. This could be done as part of a partial commissioning of the LUDEK test rig. DB Systemtechnik used the pressure loss characteristic curve recorded to determine an optimised maintenance interval for the AHX. The maintenance interval is calculated assuming a typical contamination pattern that varies throughout the year (for example, to account for pollen in spring).

Determining an optimised maintenance interval for the AHX ensures a comfortable temperature for passengers on ICE 3 1st series trains and also reduces costs for the operator. Thanks to quick work by the HVAC experts at the LUDEK climate test rig, the DB Fernverkehr order could be carried out at short notice.

Photos: Dr. Peter Claus, Sebastian Terfloth
Illustrations: ECUC, Open Street Map / DB Systel

Figure: ECB of the ICE 3

Simulation: Temperature distribution in a rail cross-section when the ECB is active

Checking conditions for the widespread use of eddy current brakes

Before an eddy current brake (ECB) may be used for emergency braking (EB), the control-command and signalling components on the planned route must be checked to determine whether they are compatible with the ECB. If the ECB will also be used during service braking (SB), the energy input to the rail and the resulting heating of the rail must also be checked. ECBs have so far only been approved after the route has been checked to rule out possible disruption or damage that the ECB might cause.

However, since ECB brakes are contactless, they are particularly interesting as a wear-free brake system for use in rail vehicles. Currently only the ICE 3 (classes 403, 406 and 407) use a linear eddy current brake as a wear-free, approved brake system.

The German Centre for Rail Traffic Research at the Federal Railway Authority commissioned the brake system experts at DB Systemtechnik with a one-year research project. The project aimed to describe the general effects that the use of a linear ECB would have on control-command and signalling (CCS) equipment and infrastructure.

The findings were then used to develop suitable specifications for control-command and signalling components, infrastructure and the ECB itself in cooperation with the transmission systems department. This paved the way for more widespread use of ECBs.

The knowledge gained can reduce the amount of time and effort for the individual checks needed before an ECB is used. In addition, boundary conditions were developed to allow ECBs to be used more widely. In this context, further study was recommended, alternative procedures were suggested, relevant limit values were specified and wording regulations and standards was proposed.

The results were presented to an interested specialist audience at a workshop at DB Systemtechnik in Munich in February 2020.

Figure: ECB approval in Germany
(green = SB + EB; red = EB only, blue = none)

Testing the Talent 3 in the MEikE climatic chamber

DB Systemtechnik was commissioned by the Austrian Federal Railways (OBB) to carry out preliminary climatic testing in the MEikE climatic chamber as part of the acceptance process for the Talent 3 multiple unit train.

Testing involved checking the climatic conditions in the driver's cab and passenger area and carrying out functional tests with two carriages of the complete Talent 3 multiple unit train.

One driver's cab and two passenger areas in the three parts of the carriage were initially equipped with the necessary measuring instruments (see Figure 1). These measuring instruments are able to measure air temperature, air humidity (relative humidity), air velocity, surface temperatures and incoming air temperatures. The air conditioning tests in the driver's cab and passenger area were carried out in accordance with the EN 14813 and EN 14750 standards, respectively. In addition, subsystems (such as the doors in the passenger area and windscreens) underwent functional testing. These tests aimed to prove that the subsystems work perfectly at all temperatures as well as in ice and snow.

The tests performed in the MEikE climatic chamber helped make it possible to:

- Determine the setting parameters for the acceptance tests for the Talent 3
- Optimise the HVAC software that controls the climatic conditions for passengers

All the investigation results were documented and handed over to the client. Once the project was completed, the HVAC aspects of the Talent 3 were ready for acceptance.

New mobile communications terminal on the TGV 2N2

Photos: Edgar Bergstein 2 x, DB AG / Christian Bedeschinski

SNCF wanted to use the new M64B2 train radio unit from Funkwerk on its TGV 2N2 trains for cross-border service between France and Germany. But before the mobile communications terminal could be integrated into the train, the technical compatibility of the device needed to be verified to obtain authorisation from the German Federal Railway Authority to be placed on the market and used.

Under current legislation, an interim designated body is responsible for this verification. Given that DB Systemtechnik's inspection body is an interim designated body, it was the obvious choice for the job.

Determining the technical compatibility of the mobile communications terminal at component level required extensive testing by DB Systemtechnik on the GSM-R network. A qualified DB Systemtechnik expert then conducted the corresponding assessment. In addition to other technical manufacturer documents, the results of the tests were an essential parameter needed to prepare the intermediate statement of verification. For the inspection body, it was the first time that technical compatibility was determined at component level before a system was authorised for market and use. Because of this, it was a challenge to coordinate the content of the intermediate statement of verification with customers, experts and the Federal Railway Authority. Despite the challenges, the job was completed quickly and the mobile terminals were able to be installed and integrated on the trains without delay. The new mobile communications terminals were available for cross-border service between Germany and France within just a short time.

Illustrations: DB Systemtechnik 3 x

3D printing for railways

DB has been using innovative 3D printing technology to produce vehicle parts since 2015. It all started back then with a simple grey plastic coat hook, like the thousands which can be still be found on ICE trains today. Now, just a few short years later, it is even possible to print safety-critical spare parts made of metal. A component that has been damaged in an accident or during operation, or is simply no longer in stock, may prevent that the vehicle from go into scheduled service.

Large and originally cast components cannot usually be procured at short notice. Delivery times of six to twelve months are not unusual for the casting and forging sector. If there is no other way of procuring the parts on time, the entire vehicle must ultimately be taken out of service until the cast spare part is delivered.

The following two examples from the field of 3D printing show the measures that must be taken to use a printed spare part and how DB Systemtechnik helps these projects.

Connecting link for ICE 2 trains

An ICE 2 was in an accident that damaged two connecting links fixed to the underside of the vehicle body in the bogie area, which limit the transverse play of the vehicle body relative to the bogie in narrow curves or switch areas. Because the links are not parts that are scheduled for replacement, none were in stock.

Delivery of the cast component would take ten months, and a minimum order quantity of four components would have to be met. It would cost a good EUR 40,000 to produce the necessary moulds. The WAAM process, a technology developed in 2017 to implement projects like these, meant printed substitutes could be supplied quickly. A Type 3.1 inspection certificate was issued for each part to confirm that it met the requirements for mechanical properties, hardness and freedom from surface cracks.

In addition, DB Systemtechnik in Minden carried out a fatigue strength test on one of the components on a hydraulic test stand. The component passed despite being subjected to a 75% overload. Including the necessary documentation and testing, the delivery time was ultimately shortened by several months and the material costs were reduced by almost EUR 20,000.

Bracket for mounting air mixing units in passenger carriages

DB Systemtechnik was commissioned to design a mounting bracket for a pneumatically actuated air mixing unit. The pneumatic cylinder uses a lever mechanism to adjust the air flaps for temperature control in each of the compartments of passenger carriages. One bracket had been damaged during maintenance. There was no full documentation available for the geometry or design of forces for the bracket.

Because of this lack of documentation and the lack of a 3D model, an original part was sent to DB Systemtechnik in Cottbus, where a 3D-printable CAD model was created by 3D scanning and processing of the scan data.

In addition, the bearing used to accommodate the adjustment mechanism and the mounting technology had to be determined. A replacement for the mounting bracket was requested from various 3D printing service providers certified for DB based on documents that were created, and a manufacturer was selected. The plain bearing bush for the test parts was assembled in house. Following coordination with the department responsible for the product line, the sample was handed over for testing. 3D scanning and 3D printing made it possible to deliver a replacement to the vehicle keeper in a relatively short time and without the high costs involved in manufacturing and storing a mould.

DB Systemtechnik uses its reverse engineering and re-engineering expertise in a wide variety of DB projects to ensure targeted design. It also handles all the necessary tests and documentation to provide urgently needed parts as quickly as possible so that vehicles can be returned to service.

Photo: Peter Deeg

Crosswind validation for Lübeck–Puttgarden route planning

As part of the planning and new track construction for the Lubeck–Puttgarden route, safety when driving in crosswinds on the route needed to be evaluated in accordance with DB guideline 807.04. The route, which has a maximum speed of 200 km/h, travels through wind zones 2, 3 and 4, while the Fehmarn Sound bridge is in wind zone 4.

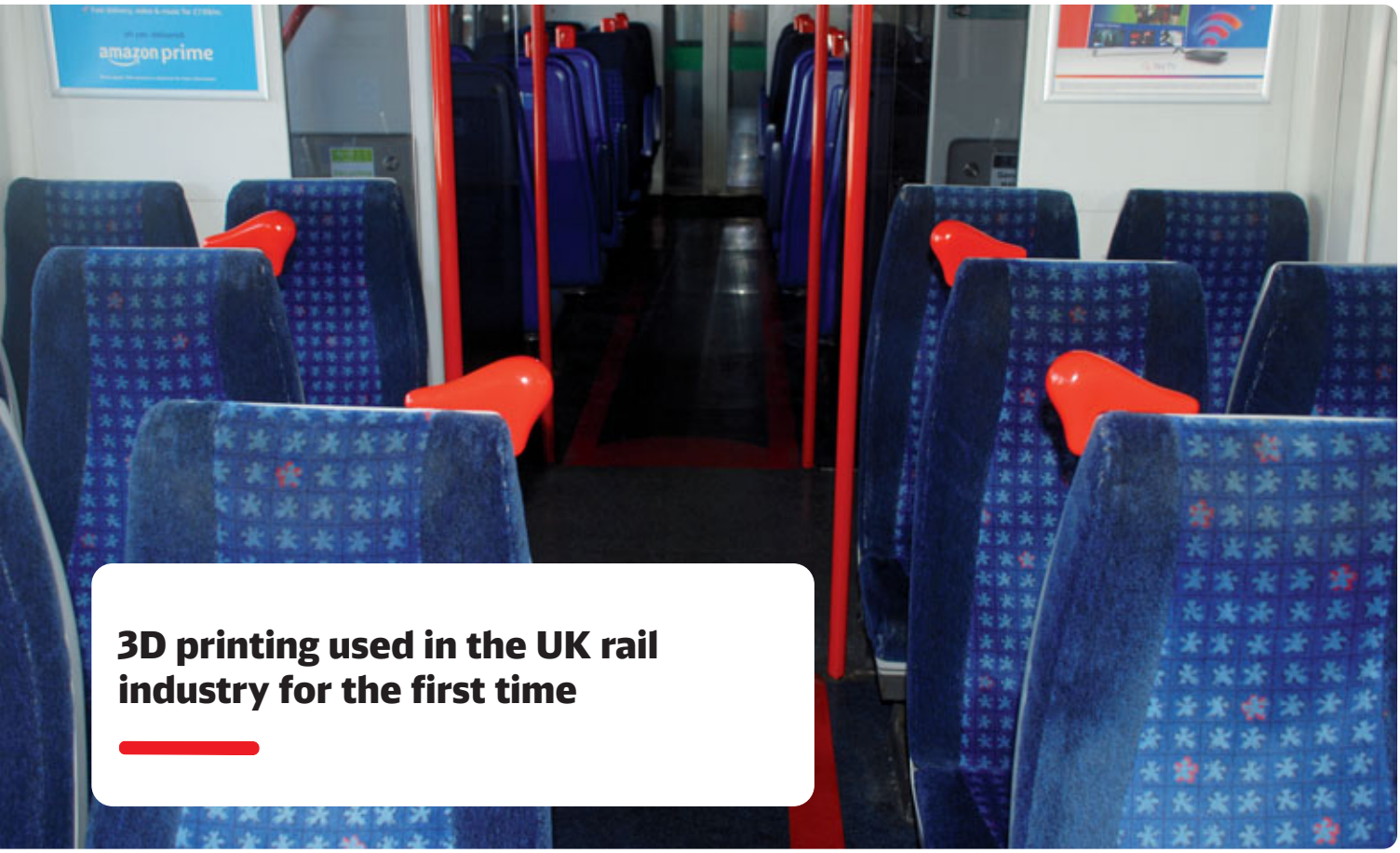
Potential wind protection measures needed to be determined during route planning. DB Netz commissioned the aerodynamics experts from DB Systemtechnik to carry out the project.

For the purpose of the test, the route was divided into six planning approval sections, each of which was examined individually. The first step was a preliminary assessment with regard to potentially high crosswinds. Infrastructure data was compiled from design documents for the sections to be examined in more detail.

This data and internal software were used to calculate the wind level and the characteristic wind curve overshoot frequency for specific reference vehicle classes.

Wind protection measures were then identified. The crosswind tests, infrastructure data and calculations were recorded in reports. An EBA-approved DB Systemtechnik expert in crosswinds prepared an overall expert assessment for the crosswind verification based on these reports. The Fehmarn Sound bridge's own interference with wind flow was also modelled and verified using three-dimensional numerical simulations.

The data recorded by DB Systemtechnik and the necessary wind protection measures will be incorporated into the design for the Lubeck-Puttgarden line and will enable greater planning certainty.



3D printing used in the UK rail industry for the first time

DB ESG is collaborating with Angel Trains on projects that incorporate 3D printing solutions (also known as additive manufacturing or AM) to address challenges faced by the UK's rail industry.

DB ESG is providing the engineering design, assessment and approvals for the introduction of 3D printed components on UK train fleets.

Together with partners Angel Trains and Stratasys, DB ESG has established a process that produces components that comply with rail industry standards and are suitable for use in passenger vehicles. Eight fully certified railway components have been re-designed and manufactured using 3D printing so far. These parts are currently comparable in cost to existing supplies, but reduce lead time substantially and allow just one part to be produced at a time.

Some of these AM parts, such as grab handles and arm rests, have been used on UK passenger trains operated by Chiltern Railways since summer 2019. This is the first time production-ready 3D printed parts have been tested on passenger trains in the UK.

The aim of this cross-industry collaboration is to leverage additive manufacturing to help address the issue of obsolete parts, reduce rolling stock life cycle costs, and enable vehicles to remain in passenger service for longer. This innovation also has the added potential to lower costs for train operating companies, as low-run parts can be manufactured as required instead of needing to be mass produced in vast quantities.

An agreement is already in place to further push the boundaries of the technology and speed up adoption by the wider industry.

ETCS for Siemens Mobility

DB ESG is providing Siemens Mobility Limited with vehicle installation designs for ETCS on freight locomotives.

The project is part of Network Rail Digital Railway's ETCS Freight Train Fitment Programme. Siemens Mobility has a contract with Network Rail for the provision of first-in-class design and installation of Siemens Mobility's ETCS Trainguard 200® on-board equipment in the locomotives.

Siemens Mobility initially sub-contracted DB ESG to provide the mechanical and electrical vehicle installation design and first-in-class support of a ETCS Level 2 on-board and TPWS/AWS solution for Class 66 freight units. DB ESG has now received subsequent orders for an additional four freight classes.

Physical prevention of overspeeding device for Transport for London

DB ESG was contracted to develop, supply, install and commission a physical prevention of overspeeding (PPOS) device for the London tram fleets.

This protection system will operate independently of other tram monitoring systems and will stop a vehicle if it is found to be travelling at excessive speed within pre-defined locations. It will have the flexibility to be introduced on other parts of the network.

DB ESG has sub-contracted Sella Controls to provide the equipment needed for the PPOS system. The system consists of a PPOS controller installed in the tram, together with Sella's proven Tracklink III system, which communicates data from the rail infrastructure to the tram. The Tracklink III system consists of track beacons and an on-tram reader.

If a tram exceeds the speed limit in a speed-restricted area, the PPOS controller will interrupt the power to the PPOS safety relay. This will result in a full-service brake, bringing the tram to a controlled stand-still.

Photos: DB ESG 4 x

Trade fairs and activities

Photos: DB Systemtechnik 2 x

DB Systemtechnik at TRAKO 2019

The railway industry gathered in Gdansk from 24 to 27 September 2019. For the 13th time, the TRAKO trade fair was held in this major Polish city of nearly 500,000.

After 2015 and 2017, DB Systemtechnik used the platform for a third time to promote its engineering, testing and maintenance services at an exhibition booth.

The TRAKO 2019 booth was organised by DB Cargo Polska, together with DB Systemtechnik, DB Fahrzeuginstandhaltung and Arriva.

TRAKO

Poland

Photos: DB Systemtechnik 2 x

Sabina Jeschke, DB Board Member for Digitisation and Technology, and Sigrid Nikutta, DB Board Member for Freight Transport, at the presentation in Minden

DAK

Minden

Live demonstration of Digital Automatic Coupling

The Digital Automatic Coupling (DAC) project was presented in Minden on 31 August 2020. DAC will automate the coupling process using an air, power and data line.

This will save time and the need for personnel. A consortium consisting of six federal and private freight operating companies will choose one of four couplers available by mid-2021. DB Systemtechnik's technical experts will provide the necessary foundation for this decision by testing and evaluating all four couplers based on existing specifications. Field testing of the selected coupler will begin by the end of 2022 at the latest.

NDT SYMPOSIUM

Erfurt

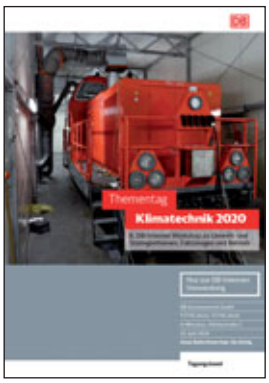
11th NDT symposium held in Erfurt for the first time

The German Society for Non-Destructive Testing (NDT) held its 11th NDT symposium in the rail sector in 2020. The event, which had previously been held in Wittenberge, was relocated to Erfurt due to the high level of interest from over 350 guests.

DB Systemtechnik was represented at the Erfurt conference by NDT experts who gave seven presentations and showed four posters on the subject. The entire range of DB Systemtechnik's services, in particular solutions for accident reconstruction, were presented at an information booth.

HVAC technology day 2020

The 8th DB-internal workshop on environmental and strategic topics, vehicles and operations took place on 25 June 2020 as a virtual event. Over the course of four hours, presentations were given on HVAC technology at Deutsche Bahn. The main topics were natural refrigerants and new types of HVAC systems. The new mobile laboratory test stand, which was commissioned in March 2020 for testing, diagnosis and development support of for HVAC systems, short LUDEK, was presented during a virtual tour.



HVAC DAY

Munich

Photos: HTW Dresden., Dominik Wehbrink 2 x

Wheel-rail conference in Dresden

Around 570 experts from the railway sector attended the three-day wheel-rail conference in Dresden in February 2020. DB Systemtechnik gave six presentations there together with speakers from other companies.

Topics included the load on axles, fire protection requirements for the maintenance of rail vehicles and natural refrigerants in HVAC systems.

Guests also had the opportunity to attend a plenary lecture on the development of the rail wheel, from the beginning of the industrial revolution to the present day

CONFERENCE

Dresden

Great interest in the aTL in Minden

The aTL (advanced Train Lab) test vehicle visited DB Systemtechnik in Minden in July 2020. This was an opportunity to examine the aTL inside and out, and to talk to the project managers for the test vehicle.

DB Systemtechnik is currently working on the aTL on the following topics:

- Autonomous driving tests (e.g. object and obstacle detection)
- Tests with renewable fuels (e.g. bio-diesel)
- Tests with sensor technology from the automotive sector

DB Systemtechnik acts as the rail company and vehicle keeper for all aTL runs.

ATL

Minden

Employees at DB Systemtechnik faced new challenges last year: less physical contact and instead, an agenda full of online meetings and events. They're still hard at work in all areas, despite the new situation. A few of our employees shared what it's like to work during the Covid-19 pandemic.

Keeping up the good work despite Covid

Silvia Eickstädt,
Brake technology expert in Minden

For Silvia Eickstadt, everything revolves around brakes. There is a lot to do, even during the covid virus pandemic. Reviewing specification requirements for brakes as part of the HGV 2.0 project took up most of her time up until Easter. She also handles brake technology enquiries from the Munich plant, works on further developing simulation software that will reproduce the thermal load on brake components during braking, and assists her colleagues in the approval of the BR 407 class of the ICE 3 in Belgium as a brake technology consultant.

"The challenge has been to maintain communication purely by telephone or video calls. We have to make a point to exchange information more often because we don't just run into each other. We've noticed that the development departments of some third-party companies are working shorter hours, which means that enquiries take longer to resolve. Otherwise, everything is working very well and the technology is stable."

Dr Harald Ackermann,
Head of Maintenance Systems and Consulting in Kirchmöser

Harald Ackermann's department optimises maintenance processes for rail vehicles. When the pandemic began, it was focusing on a major project with CRRC Tangshan. His department was working with colleagues from the engineering department to optimise the maintenance of metro trains. Long conference calls with the Chinese client involving up to 20 participants were not uncommon. Despite different time zones and the need for translation, communication and exchange worked very well, even during the lockdown phase.

"It's a challenge to structure the day in such a way as to maintain the same work discipline at home as you would normally be forced to do at the office. It hasn't always been easy to start and end the day and take breaks on time. We often have one online meeting after another. Despite this, the digital development that we have seen is one positive aspect of all this. Sometimes you need a push from the outside. It's a big step forward for us."

Photos: DB AG / Stefan Wildhirt, DB Systemtechnik 4 x

Philipp Kölbl,
Engineering Project Manager in Nuremberg

Philipp Kolbl, engineering project manager at the Nuremberg Maintenance Depot, is responsible for the extensive ICE 1 conversion, which aims to extend the vehicle's service life (LDV). Due to the covid virus risk, he has had to take the unusual step of performing many tasks from home this year. Working more-or-less in remote mode by mobile phone, Microsoft Teams and a laptop from his home in the Upper Palatinate, he is supervising and tracking the ongoing model conversion of the first ICE 1 LDV train.

"Conversion of the ICE1 must continue so that the large fleet of 48 multiple unit sets, each with nine intermediate cars and two power cars, can be converted by the end of 2024 and used by DB Long Distance for another 10 years. Covid doesn't really fit into our plans, considering that many acceptance tests had to be carried out on the sample train this year and we normally conduct these acceptance tests with the project partners on site. But necessity is the mother of invention, and we have had to come up with new solutions. One of these is digitalisation. We now try to handle on-site appointments remotely using videos and photos as much as possible. It has worked very well so far."

Dr Peter Claus,
Head of Component Testing, Aerodynamics and Air Conditioning Technology in Munich

Work is also continuing in the department headed by Dr Peter Claus despite Covid. Three major test projects were carried out this year: **Testing the tightness of an air conditioning compressor** for DB Regio to minimise refrigerant losses in the air conditioning system of the VT 612. The test took place at a test stand in Munich, which was built for this job.
Energy consumption measurement of air conditioning systems in class 440 trains, where colleagues provided the measuring equipment.
Cold start tests of a galley cooling system (deep-freezing and normal cooling in the on-board restaurant). The system was renewed as part of the ICE 3 redesign. Dr Claus and his team are conducting some of the necessary functional testing.

"Mostly I work from home. I try to make it to the site once a week to see my colleagues and look after the facilities. Depending on the job, we may also have to do field work, wherever this is justifiable under the circumstances. We are far from shutting everything down."

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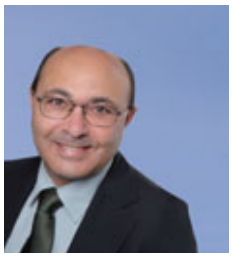

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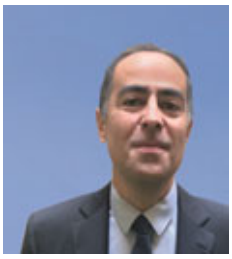

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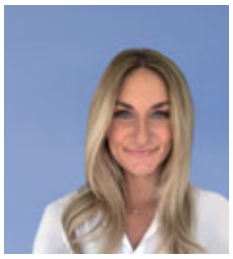

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