DB Systemtechnik
Activity Report
2016/2017

DB Systemtechnik Group

Photos title: Dr Kai-Uwe Nielsen, DB Systemtechnik
Photo right: Dr Kai-Uwe Nielsen, Fotolia

Our knowledge – **Your success**

We have decades of railway experience
We offer all services from a single source
We understand every vehicle
We are able to test every vehicle
We manage the approval process for you: anytime, anywhere
We are a railway undertaking (incl. vehicle fleet and train drivers)
We master the railway system

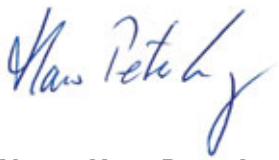
DB Systemtechnik is becoming **more global and more local**

DB Systemtechnik is responding to market challenges. By acquiring the start-up infraView GmbH, we can now offer infrastructure and vehicle operators compelling solutions for condition-based fleet and equipment management. And so our vision becomes reality. By leveraging the opportunities that digitalisation has brought to the industry, we can improve the quality and reduce the cost of maintenance.

To allow us to more effectively meet the international demand for our services, we set up a sales and project office in Vienna during the spring 2017. We are now therefore able to offer our customers in Austria a local presence.

As a result of our expertise in rail engineering and testing, infrastructure and vehicle technology, demand for the services of DB Systemtechnik is increasing player, not only in Germany, but in Europe and further afield in places such as Singapore, Texas and Saudi Arabia. We are becoming a global player in the industry.

This performance report will provide you with an insight into the wide-ranging activities of DB Systemtechnik and demonstrate how our expertise is successfully deployed for customers around the globe.



Yours, Hans Peter Lang
Managing director
DB Systemtechnik

New to the team:
infraView GmbH

infraView joins the DB Systemtechnik Group

At the end of 2016, DB Systemtechnik acquired a 75% sharehold in infraView GmbH from Mainz.

infraView GmbH is a software development company, with a workforce of around 30. The company has developed a generic IT platform for diagnosing and analysing infrastructure and vehicle components.

The platform can be upgraded and extended at any time, making it suitable for recording vehicle and infrastructure data. Networking the data on a single platform provides the basis for preventive maintenance, helping to guarantee equipment availability. It can provide railway undertakings and infrastructure service providers with forecasts and trends that can be used as the basis for recommending appropriate action. To leverage the full potential, the diagnostics and analytics platform is being further expanded to support data-based availability management.

A range of vehicle data from the Continuous Track Monitoring (CTM) project is being processed as part of a joint initiative between DB Systemtechnik and infraView. infraView is also working closely with DB Netz and DB Engineering & Consulting in the field of points diagnostics. Points failures are currently one of the main reasons for infrastructure downtime. State-of-the-art predictive methods enable failures to be reduced by up to 50% on suitably monitored points. All crucial points in the German rail network (around 30,000) will be fitted with this technology before 2020.

DB Engineering & Consulting and infraView are working together to identify further market potential for the predictive maintenance services' portfolio and new products are being developed for our customers. The resulting solutions allow vehicles and infrastructure components to monitor themselves, vehicles (CTM) to monitor the infrastructure, or the infrastructure (checkpoints) to monitor vehicles. We believe that the incorporation of infraView into the DB Systemtechnik Group puts us in an ideal position to leverage the opportunities opened up by digital technology and data analysis in the rail sector. Together we aim to offer customised solutions in the national and international markets.

Illustration: DB Engineering & Consulting/DB Systemtechnik

Contents

Photos: DB Systentechnik, Marcus Seeger

The experts
from DB Systemtechnik are on the move

ICE4

Working around the globe

Last year, DB Systemtechnik employees again clocked up countless miles. 80 test managers alone coordinated customer orders locally – supported by 160 measurement engineers and technicians, as well as 27 train drivers, who conducted the measurement and test runs on tracks around the world. With over 2,500 test days in Germany and further afield, the DB Systemtechnik experts had lots to do both locally and globally.

ICE 4 tests in Switzerland

The necessary acceptance tests required for Switzerland were planned, organised and conducted on behalf of the contractor, Siemens. These included:

- Vehicle dynamics testing on the specific routes in the Lausanne station and on lines with extremely tight curves (Gotthard mountain railway, Spiez-Interlaken)
- Pantograph tests on various reference tracks and in the Lötschberg Base Tunnel
- Operational management of all tests, including EMC and ETCS Level 1 LS and Level 2 tests

Testing for the KISS-WESTbahn double-decker multiple-unit train

In late 2016, DB Systemtechnik started to conduct various approval tests for braking systems and running equipment, on the new four and six-car double-decker multiple-unit trains on behalf of Stadler.

Austria

Brake testing on the ATLAS rail-road excavator

Construction machinery is also tested. Construction machinery manufacturer ATLAS commissioned various tests to approve the new KZW 1404 rail-road excavator. Brake and safety tests to prevent derailing, together with parking brake testing were performed.

Tests on the ED 250 for Polish State Railways (PKP)

On behalf of Alstom, EMC and brake tests were conducted as part of the approval process in Germany for the Polish State Railways (PKP) ED 250 high-speed train.

Photos left: Martin Loibl, Maik Schmidt, DB Systemtechnik
Photos right: Mathias Vogt 2x, DB Systemtechnik

Pantograph tests on pilgrimage line

In spring 2017, DB Systemtechnik engineers performed various tests with the TALGO 350 high-speed train in Saudi Arabia.

The interaction between the pantograph and overhead line was tested. The contact forces between the pantograph and overhead line had to be determined aerodynamically for each direction of travel and directional flow as part of the tests. In May, our engineers and technicians managed to increase the line speed up to the 260 km/h mark. A second series of measurements raised the maximum line speed by another 10%, taking it up to 330 km/h.

Measuring the tractive forces with the new Cargo locomotive

DB Cargo is modernising its freight fleet by acquiring new locomotives from Bombardier. The TRAXX electric locomotive is fitted with a 180 kW diesel auxiliary engine, thus enabling it to cover route sections with no overhead line (the last mile).

As part of this new acquisition, DB Systemtechnik is currently testing the actual tractive forces of the new locomotive for the logistics company. Tests on the line will help ensure that the Class 187 TRAXX locomotive can reliably meet the operating modes specified by DB Cargo (e.g. train loads hauled, speeds, inclines).

Photos: Andreas Sahlmann 2x, DB Systemtechnik

ET 490: new S-Bahn Hamburg

As part of the approval process, DB Systemtechnik is carrying out the relevant vehicle tests on behalf of Bombardier Transportation. The air conditioning equipment, the dynamic torsional load of the wheelsets, the pantographs and the braking and running equipment are being tested. The test runs, for which DB Systemtechnik is also acting as a railway undertaking, are being conducted on parts of the DB railway network and throughout the S-Bahn network in Hamburg.

Hamburg

HARSCO construction machinery for Switzerland

In early August 2017, DB Systemtechnik, acting as a railway undertaking, transferred two additional maintenance vehicles, belonging to Harsco Rail Europe, from Aachen to Switzerland. Swiss Federal Railways (SBB), who has ordered a total of 13 vehicles, will use them in the Gotthard Base Tunnel. These two vehicles are being used in Switzerland to conduct running equipment and braking systems tests, as well as taking pantograph measurements.

Switzerland

Hitachi AT200 for Abellio ScotRail

Hitachi placed an order in 2016 for vehicle testing. The testing programme has been completed at the Velim Test Centre in the Czech Republic, as well as on the German network.

DB Systemtechnik conducted the running equipment tests, in towed operation, in Germany, as well as interior and external noise measurements, traction tests, brake and wheel slide protection tests, together with pantograph measurement runs in Velim. Additional trains were fitted with measuring equipment so Hitachi could carry out its own tests.

Scotland

Vectron tests in Finland

On behalf of Siemens, pantograph and noise measurements were performed on the broad gauge Vectron locomotive Sr3 for Finnish rail operator VR.

Finland

Photos: Guido Fiefstück 2x, Nicolas Meunier

Interaction of **pantograph/ overhead line**

Photos: Claus Weber, Frank Barteld

Interaction of pantograph/overhead line:

Tests and simulations at DB Systemtechnik

Pantograph and overhead lines supply the power to electric traction units. The pantograph has to be in constant contact with the contact wire. To ensure a reliable energy supply, the pantograph and overhead line need to be matched geometrically, electrically and mechanically to each other.

The requirements for the pantograph and overhead lines are specified in national and international regulations and normally govern the interaction between the pantograph and overhead line. Measurement of the dynamic interaction must be conducted according to EN 50317, with a measurement procedure accredited to EN 17025. Simulations must also use a simulation system validated to EN 50318. Parameters that require checking include the contact wire uplift at the overhead line, an assessment using arc measurement, or contact force measurement taking into account the limit values stipulated in EN 50367. Country-specific guidelines also often apply to the approval of vehicles and the erection, acceptance and maintenance of overhead line infrastructure.

Thanks to decades of experience in this field, DB Systemtechnik can offer its customers the necessary simulations, test rig measurements and measurement runsrelevant to pantograph/overhead line as part of a one-stop solution. Through the clever combination of these services, additional synergies can be leveraged, reducing the test costing.

DB Systemtechnik has its own TSI-certified pantographs, fitted with pre-mounted force measurement equipment. It can therefore carry out inspection and acceptance of overhead lines. Alternatively, pantographs provided by the client can also be fitted with sensors and prepared for measurement use.

As part of new vehicle or new pantograph approval, the aerodynamic behaviour of the pantograph provided by the client must be ascertained and adjusted. This involves setting the average force, as per the overhead line infrastructure requirements, using wind deflector panels, or by adjusting the pantograph control system in collaboration with the pantograph manufacturer.

The pantographs are then checked on DB Systemtechnik's pantograph test rig in Munich and the accuracy of the measurement system verified. In the case of extended deployment of the measurement equipment on a single pantograph, the checks are repeated at intervals of one to two years. Following the check on the test rig, the pantograph can be mounted onto the rail vehicle that has been provided for the measurement runs. Measurement runs up to the line speed or vehicle top speed are then conducted, with one or two pantographs on the contact wire.Compliance with the limit values for the dynamic forces and the contact wire uplift at the overhead line is also verified. Outside Germany, arc measurements can be used as an alternative to measuring the contact force.

DB Systemtechnik performs all these infrastructure and vehicle tests using test procedures accredited to EN 17025.

The contact force is measured using force sensors on the pantograph. The force sensors are arranged as close as possible to the contact point. The influence of the measurement equipment on the pantograph behaviour is minimised by using small, lightweight sensor modules to measure the vertical force and acceleration. In addition to the inertial force, the aerodynamic influence of the contact strips is factored in during the measurement. EN 50367 and TSI ENE include specifications regarding the permissible average contact force and specify a limit value for the permissible dynamic force. The aim is to verify that the overhead line can withstand the upper limit forces as a minimum.

Based on the customer’s requirement, the DB Systemtechnik experts can present the results of the contact force measurement in various ways. Plotting the contact force graph against the line kilometre enables defects to be pinpointed where peak forces or force interruptions occur.

A table, including relevant acceptance and maintenance defect locations, provides a quick overview during the acceptance or inspection of overhead lines. Furthermore, the statistical analysis of the contact force for all analysis sections is illustrated in tabular format. These figures can be illustrated clearly as a graph by plotting them against speed. During the measurement runs, the measurement results can therefore be discussed straightaway with the client whilst on board the vehicle.

DB Systemtechnik has access to a range of accredited measurement procedures to measure the contact wire uplift at the overhead line. In the past, measurements were taken using a wire potentiometer mounted on the overhead line. Nowadays an optical measurement system is used. This superior method eliminates the need for lengthy track closures to install the wire potentiometers, the provider no longer requires a rail vehicle with a working platform to fit the equipment. At the measuring point, the camera is positioned outside the hazardous area and aimed at the contact wire.

As the train passes by, the camera records and analyses the change in height of the contact wire. Using an adjustable rotating table, several tracks can be measured from a single camera standpoint. When selecting a suitablelocation for measurement, several areas need to be considered: the measurement is normally made at two successive supports and, where necessary, also in the middle of the area. Measurements should be taken in a mast area where the spacing between supports is as large as possible. The measuring point should not be in the direct proximity of curves, parallel fields, bridge lowering points and fixed points, should be easily accessible for equipment installation, and no other moving objects or vegetation must be located in the background of the image. The rail vehicle must also be able to reach the maximum speed in both directions of travel.

In addition to the measurement, the experts can also simulate the interaction of pantograph and overhead line. This method offers wide-ranging options for examining overhead lines, pantographs and their dynamic interaction.

Photos: Frank Barteld 2x, Benjamin Reffay

The time and effort involved is minimal compared with measurement runs. In this way, further developments and improvements of existing overhead line designs can also be analysed, as well as new overhead line types and components.

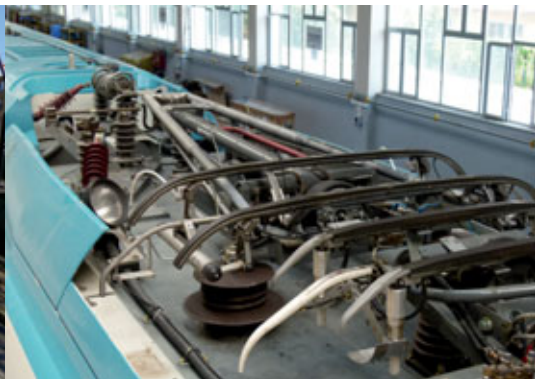
Ultimately, specific questions regarding dynamic interaction can also be examined. It is also interesting to determine the system limits, including the maximum speed, depending on the number and the spacing of the pantographs. Dynamic issues can also be analysed.

When approving new overhead line configurations, it is useful to simulate the dynamic interaction, right from the planning phase. Simulation can help optimise the arrangement of the overhead line based on the initial planning.

The simulations required for TSI approval can also be run. Simulations can help develop and optimise pantographs and pantograph configurations can be developed and analysed in the simulation environment.

Simulation can also help with the approval of new vehicles. In a regional transport context, several multiple units will be joined together. Differing combinations of coachesresult in a multitude of possible pantograph arrangements with 3- and 4-way traction. Financial, logistical and time contracts make it impossible to measure all these permutations. A sophisticated combination of measurement runs, simulations and test rig measurements enables the number of actual measurement days on the line to be reduced substantially. In simulation, the most critical combinations for the contact wire uplift at the overhead line and the contact force are calculated and the necessary measurements then performed for these combinations.

DB Systemtechnik has been providing vehicle and component approval for the railway industry for many years. We also support railway infrastructure companies with the approval and maintenance of overhead lines. Our experts from Munich work globally to drive the rail sector forward, using state-of-the-art measurement equipment developed in house.



DB Systemtechnik on site: in Switzerland, Kazakhstan or Turkey

Photos: DB Systemtechnik 4x, Frank Barteld

Fire protection
in rail vehicles

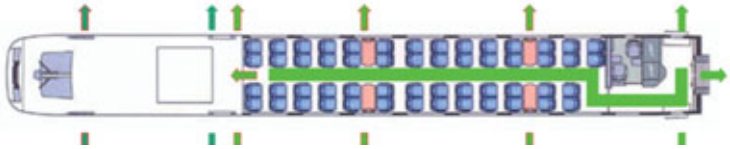
Fire protection in rail vehicles

The testing laboratory in Kirchmöser

European standard EN 45545 replaced national standards on fire protection in rail vehicles in 2016. The standard sets out limit values that specify the extent to which materials used increase the individual fire risks.

Fire risks include any fire phenomena that prevent passengers and personnel from evacuating without assistance. These include flame propagation, heat release rate and fire load, smoke production and fume toxicity. To limit the risks, suitable materials must be fitted in vehicles.

Depending on the infrastructure used and the vehicle design, the vehicle is assigned to a fire risk category. Infrastructure parameters include the tunnel length, the possibility of side evacuation, and the distance between stations, which are regarded as safe evacuation areas. When classifying vehicles, a distinction is drawn between whether the vehicle runs automatically, has personnel on board that are trained for emergencies, or whether it is a sleeping car. All the specified factors have an effect on the time taken for passengers to evacuate.



The emergency rescue and fire protection concept for the ICE 2 was extensively updated in Kirchmöser as part of the redesign between 2010 and 2013.

The longer the time taken, the greater the requirements placed on the materials used. The relevant tests are conducted in a fire laboratory to determine the fire risk of a material.

In 2013, DB Systemtechnik extensively modernised the in house fire laboratory, making it state-of-the-art. New staff also joined the expert team to meet the increased demand for fire protection assessments of parts/components. Since then, the experts in the fire laboratory have been conducting tests for national and international customers.

In the test rigs, these fire tests simulate the scenario of a developing fire. The DB Systemtechnik specialists in Brandenburg-Kirchmöser examine the behaviour of the material and determine the potential propagation of everything from a smouldering fire to a full-scale blaze. To test the lateral flame propagation, for instance, a test specimen in a vertical arrangement is irradiated with a propane gas heater. The criterion applied to this test is the distance covered by the flame front on the specimen surface.

Photos: DB Systemtechnik 4x, Ralf Braum, Ralf Kranert

The cone calorimeter is another test device used. The test specimen is irradiated with an electrical heater to simulate a developing fire at close proximity. The fumes from the burning material are constantly extracted and analysed. The oxygen consumption resulting from the combustion is measured. The heat release rate can be calculated from the consumption curve during the test. This figure can then be used to calculate additional parameters such as the fire load and the material's effective combustion heat. The smoke production is tested in the smoke density chamber.

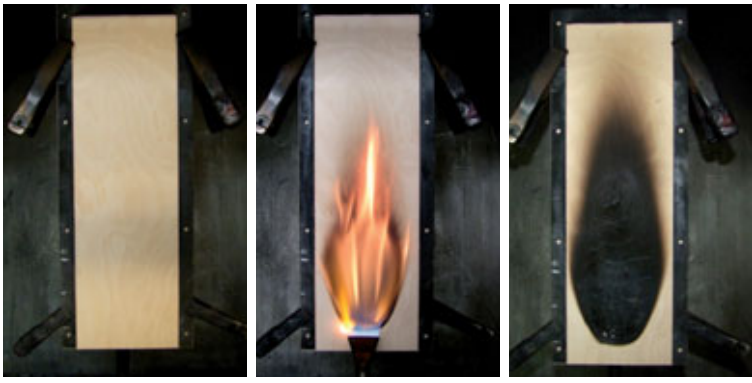
The test specimen is irradiated in a similar way as in the cone calorimeter test. The fumes produced accumulate in the chamber that is sealed during the test. A light measurement path is calculated using a lamp in the floor of the chamber and a detector in the ceiling and this path is used to measure the optical density (opacity) of the smoke.

Cone calorimeter to determine the heat release rate

Taking into account the chamber volume, specimen surface and length of the light path, the specific optical density is calculated as a specific value. In addition, samples of the fumes are removed during the test, then analysed using a spectrometer for toxic components and irritants.

Using the test procedures detailed above, the individual fire risk of materials can be quantified and, in turn, classified. In addition to these fire tests and the specialist advice relating to the European fire protection standard EN 45545, employees in the Fire Protection unit assess fire protection concepts for new vehicles, or draft new concepts in the case of redesign projects or major conversions.

Smoke density chamber to determine the fume toxicity and smoke production



Large fire shaft for tests to determine the flammability, smoke-production and droplet formation class

Photos: DB Systemtechnik

DB Systemtechnik inspection unit: **approval of ICE 4**

DB Systemtechnik inspection unit: **approval of ICE 4**

DB Systemtechnik runs an inspection unit with eight inspection departments. The unit is accredited to DIN EN ISO/IEC 17020. The accreditation is certified by the Deutsche Akkreditierungsbehörde (DAkkS).

This accredited unit carries out various inspection activities, such as conformity assessments, based on European TSI requirements or on national requirements in Germany that are documented in NNTR/NNTV lists (Notified National Technical Rules/Specifications). These inspection activities are required as part of the German approval and authorisation procedures for entry into service, and provide crucial assessment results for the certification by Notified Bodies (NoBo) and Designated Bodies (DeBo).

These bodies provide the EC test certificates and the NNTR test certificates for the entity applying for approval. The European Interoperability Directive 2008/57/EC and the Safety Directive 2004/49/EC envisage, in addition to these specified bodies, an independent safety assessment as per European Regulation (EU) 402/2013. An Independent Assessment Body (AsBo) is set up to this end. In addition, assessments for rail vehicles or their components are undertaken and performed as warranted by the approval procedure in Germany under

the Trans-European Railway Interoperability Regulation (TEIV), or by the acceptance procedure under the Railway Construction and Operation Regulations (EBO).

In addition to the above activities that constitute essential work prior to the national and European commissioning of rail vehicles and their components, the requisite inspections of mobile and stationary equipment are conducted in other inspection departments as part of non-destructive testing (NDT), and to assess NDT test systems for suitability for track testing. Inspections for assessing metallic materials and rail traffic damages are additional challenges.

Services with accredited procedures

Inspection report/expert opinion
in the following inspection areas:
- Brakes
- Running equipment
- Strength
- Interaction of pantograph/overhead line
- Software for rail applications
- Non-destructive testing
- Material and damage analysis

Inspection report
As part of the TSI and/or NNTR conformity assessment in the following inspection areas:
- Brakes
- Running equipment
- Strength
- Interaction of pantograph/overhead line
- Software in rail applications

Safety assessment report
as per regulation (EU) 402/2013
- Independent safety assessment

ICE 4: **approval**

Siemens Mobility won the contract to supply 130 ICE 4 multiple units to Deutsche Bahn. The newly designed trains required an EC certificate of conformity, in accordance with the EU directive on railway interoperability, as well as national authorisation for entry into German passenger service from the Federal Railway Authority (EBA). To this end, the technical specifications for railway interoperability (TSI) had to be fulfilled as part of the European procedure, along with the additional requirements of the EBA (NNTR's) as part of the national procedure. The new Deutsche Bahn 12-car train needed to receive its approval in Germany through the reformed MoU (memorandum of understanding) vehicle homologation procedure.

DB Systemtechnik acted, in this respect, as the Interim Designated Body (iDeBo) to certify the documentary proof required for the national approval. As part of this assessment, DB Systemtechnik tested the following specialist areas, with the work completed in August 2016: general, running equipment including crosswind, bogies, equipment requiring inspection, instrumentation,control systems and functional safety, drinking water and waste-water protection, occupational safety, vehicle demarcation, other safety equipment – sub-area train protection systems and inscriptions.

Together with the partner TÜV NORD as the Notified Body, tests were done to establish whether the requirements of the TSI guidelines HS, CR LOC & PAS, SRT and Noise were also met. DB Systemtechnik's inspection unit employees tested 140 TSI characteristics as part of design testing and 96 TSI characteristics as part of prototype testing (76 with prototype tests). The design testing was completed in early 2015; the assessments for the prototype test phase ran from October 2015 to August 2016. Added to which were extensive quality assurance system testing.

Photos: Siemens AG, DB Systemtechnik

Commissioning **of new-build lines**

Photos: DB Systemtechnik, Karl-Georg Fröbel

Commissioning of new-build lines **VDE 8.2 and VDE 8.1**

Another gap closed in the German high-speed rail network

High-speed trains will soon be running between Berlin and Munich in record time, at speeds up to 300 km/h. They will take people from city to city in around four hours. The German Unity Transport Project No. 8 (VDE 8), the connection between Nuremberg and Berlin, is almost complete.

At the end of 2015 the new Erfurt–Leipzig/Halle line was inaugurated; all nine routes between Nuremberg and Berlin will be complete during 2017, with entry into passenger service coinciding with the timetable change in December 2017. The German federal government approved the ten billion euro project in 1991 to improve transport links between East and West and North and South. It will also close the gaps in the German high-speed rail network. In addition, freight trains will run on the route. DB Systemtechnik conducted a wide range of studies and tests during this project.

Photos: DB Systemtechnik, K+K Ötzner

On the route section - VDE 8.2 Leipzig-Erfurt, bridge load tests, tunnel measurements and ETCS tests were conducted up until the start of trial operations and associated approval runs in 2015.

The work for the VDE 8.1 Nuremberg-Erfurt section began in August 2016 with continuous measurements on bridges. The test runs on the new ICE line between Erfurt and Nuremberg got underway in mid-October. The ICE-S, DB Systemtechnik's high-speed measurement train, started with high load runs, gradually increasing the testing speed with each run. The test runs started at 160 km/h and finally reached 30 km/h. This high speed was achieved for the first time on 20 October 2016. Measurement runs were undertaken on the route section Erfurt-Ebensfeld and the interaction of the pantograph and overhead line, together with the contact forces and vehicle, wheel and rail accelerations were verified.

Studies were also conducted at and in tunnels as part of these runs. Acoustic measurement and aerodynamic tests were completed as part of the work. Additional measuring points for installations and in relation to the micro-pressure wave provided additional insights. Strength verification tests were also done on installations. DB Systemtechnik's wireless measurement crew from Munich was also involved, completing QoS measurements on routes, i.e. GSM-R measurements for upgraded requirements due to the minimum requirement on ETCS lines.

Testing got underway for the new train protection system, ETCS, in spring 2017. On 80 kilometres of the VDE-8 new line, fixed signals have been replaced with the European train protection system ERTMS/ETCS Level 2.

VDE 8.1 and 8.2

The trains and locomotives running on the VDE 8, together with the infrastructure had to be prepared and approved for operation without fixed signals. DB Systemtechnik conducted the necessary network access tests on the VDE 8.2 at the end of April. By successfully completing the requisite test cases, they managed to verify that the multiple units ICE 1, ICE 3 and ICE-T, fitted with the TSI-compliant ETCS on-board equipment "RBC", are compatible with the version of the ETCS trackside equipment "Train-guard 200" installed on the line. In addition to the line approval tests, the experts from the Acoustics Inspection Centre Unit team also carried out noise measurements on bridges, in tunnels, and on the line for this route section. The positional stability of noise barriers, with their tailor-made design, was verified. This was done by testing train-induced pressure loads on the noise barriers and testing the response behaviour with accelerometers and DMS measurement chains.

As part of the permanent measurement points, bridge support measurements were taken. The colleagues coordinated and carried out static and dynamic bridge load tests (heavy freight trains, ICE trains). A safety evaluation of the hybrid operation on the open track was also undertaken at speeds up to 330 km/h. The rail undertaking, DB Systemtechnik, was also involved. For the ETCS acceptance runs for Siemens, DB Fernverkehr and DB Netz completed the operational requirements to the client's full satisfaction.

All the work was finally completed on schedule in November 2017, providing the green light for commissioning in December 2017 – an achievement made possible thanks to numerous colleagues from DB Systemtechnik.

Photos: DB Systemtechnik, Simon Walz

References
2016/2017

Photos: DB Systemtechnik

EMC measurements in Austin, Texas

The Stadler company in Bussnang, Switzerland, delivered four GTW 2/6 diesel multiple units to the North American rail operator CMTA in Austin, Texas. DB Systemtechnik was commissioned to carry out the EMC measurements at the site in Texas.

Its EMC experts were required to perform measurements on the vehicles relating to wireless compatibility, electromagnetic field emissions, and the protection of persons against magnetic fields. The work was conducted on the basis of the applicable European standards. As there are no directly comparable regulations for rail vehicles in the USA, it was this Munich-based team of experts that was enlisted when assistance was required in performing measurements. It had already supported Stadler in a similar project in Romania some years prior, with successful results.

At the end of April, two colleagues from the EMC team flew out to the USA in order to begin the programme of measurements. Just before the journey, they had also received a request from the end customer, CMTA, to investigate the voltage that the vehicles induced between the rails. This represented an entirely new type of measurement work for the experts, as well as posing a challenge: measurements of this kind are not performed in Europe, but at the same time, there were no up-to-date specifications on performing the measurements or evaluating the relevant data available from the USA. However, following an in-depth and highly informative round of discussions between CMTA, Stadler and the Munich experts, it was possible to identify a suitable solution for performing these measurements too. CMTA and Stadler were exceptionally pleased with the progress of the measurements – and impressed by the level of commitment and expertise demonstrated by DB Systemtechnik. There are already follow-up projects either under way or being discussed, some involving other facilities in the USA, as well as Romania and the Czech Republic.

Optimising energy consumption in auxiliary equipment and climate control systems for DB Fernverkehr

DB Fernverkehr is currently incurring relevant energy costs associated with operating its auxiliary equipment and climate control systems. With a view to reducing these costs, DB Fernverkehr commissioned DB Systemtechnik to conduct a study into potential optimisation measures that could be taken in auxiliary equipment and climate control systems in various classes of locomotives and multiple units.

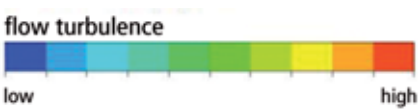
The Electric Traction Equipment and On-Board Power Supply Systems team investigated the potential for optimising the control of auxiliary traction equipment in ICE 1 power cars and locomotives of class 101. This involved ascertaining how auxiliary equipment was being used and analysing the impact of error messages on energy consumption. On the basis of the resulting data, technical measures were designed as a means of reducing losses during operation and their impact. It was not possible to identify any straightforward short-term approaches to optimisation in this case, owing to the way in which the auxiliary equipment is used in response to demand. However, the process illustrates the necessity of conducting investigations into the benefits of various optimisation approaches and how long they take to pay off. It was the experts in environmental control systems at DB Systemtechnik who took on the task of investigating potential areas of optimisation in the passenger-area climate control systems used in the ICE 1. They conducted research into the climate control concepts adopted by the individual cars, and how the components were being used in the climate control systems' various operational modes. The energy consumption in the climate control systems was estimated and compared with other classes; approaches that could be taken towards optimisation were then illustrated and discussed. The steps required for implementation, the financial benefits, the costs that would be incurred, and the potential technical and financial risks were identified. A simplified economic efficiency study served as a basis for evaluating how long it would take for the individual measures to pay off. The study identified potential energy conservation measures for vehicle climate control systems, then evaluated and compared them from a technical and financial perspective.

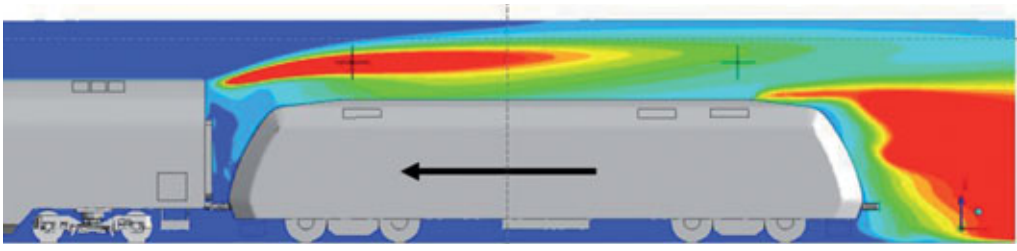
As a result of this study, the operator now has a sound basis for deciding which action is to be taken next.

Numerical simulation of **a pantograph's flow properties within a tunnel**

Aerodynamic effects that occur during journeys through tunnels are largely governed by the cross-sectional surfaces of the train and tunnel, plus the train speed. The air that flows around a train in a tunnel has a significant impact on the contact force present between the pantograph and the overhead line. Changes in the ratio of the vehicle cross-section to that of the tunnel can cause localised flow effects, in turn leading to fluctuations in the contact force exerted on the pantographs of the passing vehicle. The result of this may be either excessive uplift of the overhead line or contact losses accompanied by arcing – creating an increase in maintenance costs associated with the overhead line installed in the tunnel.

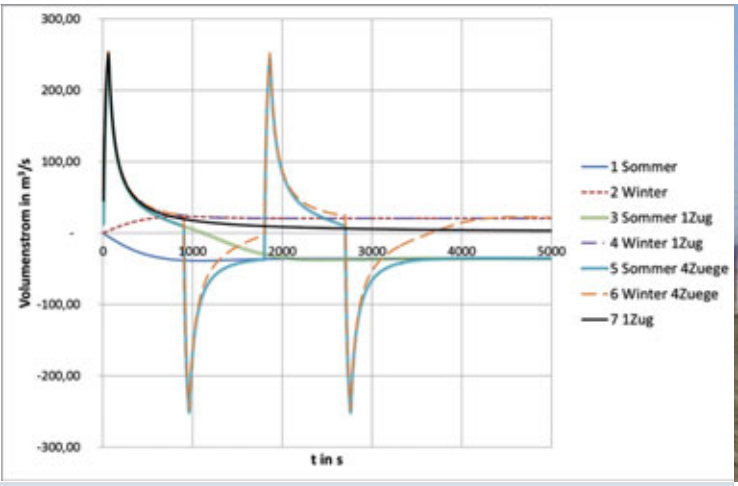
In the past, DB's investigations into these effects were primarily conducted in the form of measurement journeys, with the phenomena affecting the pantographs described and interpreted. Given the sharp growth in computing capacity over recent years, however, there is now the opportunity to investigate flow-related processes on pantographs using numerical data too. For this reason, DB Netz AG has commissioned the aerodynamics experts at DB Systemtechnik to create simulations. High-resolution, three-dimensional flow calculations using commercial software tools make it possible to simulate the composition of a train in a numerical simulation model, with accuracy down to the last detail. This has given rise to an alternative form of analysing flow properties at pantographs while trains are travelling through tunnels. High-resolution field data also provides fundamental insights into the flow that takes place around pantographs. Initial findings from the simulations that have been carried out demonstrate a clear overlap with existing measurement data.





Photos: DB Systemtechnik

Photos: DB Systemtechnik



Simulating ventilation in Germany's **Elleringhauser tunnel**

During the preliminary design phase ahead of converting the Elleringhäuser tunnel's current double-track status into a single-track tunnel, it was necessary to evaluate the natural flow as well as the effect of planned diesel locomotive traffic on the flow in the tunnel. DB Systemtechnik was commissioned to conduct these investigations. Working on the basis of flow patterns, its aerodynamics specialists had the task of estimating the impact of locomotive emissions on the air quality in the tunnel.

The flow in the tunnel was simulated by means of Subway Environment Simulation (SES), using a one-dimensional model. Both the natural flow and the effect of rail traffic in various scenarios were considered. Working on this basis, concentrations of traffic-related exhaust gases and air exchange rates were determined. The results were compared with protection-related objectives that had been researched, both on the basis of occupational health and safety guidelines and through investigations into exhaust gas concentrations in tunnels as well as specific exhaust emissions.

The results that were achieved allowed the contracting authority to reach specific conclusions concerning measures that may need to be taken in later planning phases. A wide-ranging basis for evaluation has also been established during this process, taking into account both aerodynamic and climate control considerations. This will enable the contracting authority to incorporate any aspects that may become relevant as the planning process continues – for example, those concerning occupational health and safety.

Quality acceptance **for rail grinding**

As a means of controlling noise in the Coburg–Hallstadt line upgrade – part of the German Unity Transport Project 8.1 – the planning approval process decided that the upgrade should use not only conven- tional noise barriers, but also something known as a specially monitored track (SMT). This is a recognised noise reduction technique that is designed to deliver a permanent reduction in the rolling noise of passing trains through the use of an extremely smooth track surface. It requires a rail grinding process that is specifically designed for smoothing, as well as regular monitoring of the limit values that need to be adhered to.

Once the track construction work had been completed, the specified track grinding measures were performed as an initial grinding stage. Later on, the final step involved checking the grinding quality from an acoustic perspective by performing sound measurements after the work was finished. This step had to be conducted soon afterwards and in line with DB Netz Guideline 809. The measuring device used in this case was DB Systemtechnik's noise monitoring train. Acoustics experts provided DB Netz, the contracting authority, with a full-service package – encompassing everything from planning to the measurements themselves and all the way through to the test report, based on the requirements of SMT acceptance criteria. As the rail company executing the work, DB Systemtechnik also provided the rolling stock for the noise monitoring train – consisting of a traction unit and three track recording cars – plus the expert personnel (the test manager and train driver).

By using the noise monitoring train, a method that the German Federal Railway Authority recognises as a valid reference point for determining noise emission levels on railway tracks, it has been possible to provide the customer with a full-service package in a format with which it is familiar. The test report that was created is an integral part of the German Unity Transport Project 8.1 commissioning process, and is suitable for submitting to the German Federal Railway Authority.

Artworks:

Evaluating ventilation in an S-Bahn station

The Ostendstraße S-Bahn station in Frankfurt am Main has been modernised as part of the Zukunft Bahn programme, whose focus is on the future of rail operations in Germany. The artworks created in the underground passenger transport installation used paints from aerosol canisters containing toxic substances. DB Station & Service commissioned DB Systemtechnik with the task of investigating the impact of these substances.

Specialists in aerodynamics and environmental control systems investigated the air quality that could potentially be present during the process of creating the artworks, applying two ventilation scenarios. The first involved no ventilation, while the second involved air exchange in line with publication DS 800 03. The boundary conditions were identified and the limit values for the toxic substances being used were researched.

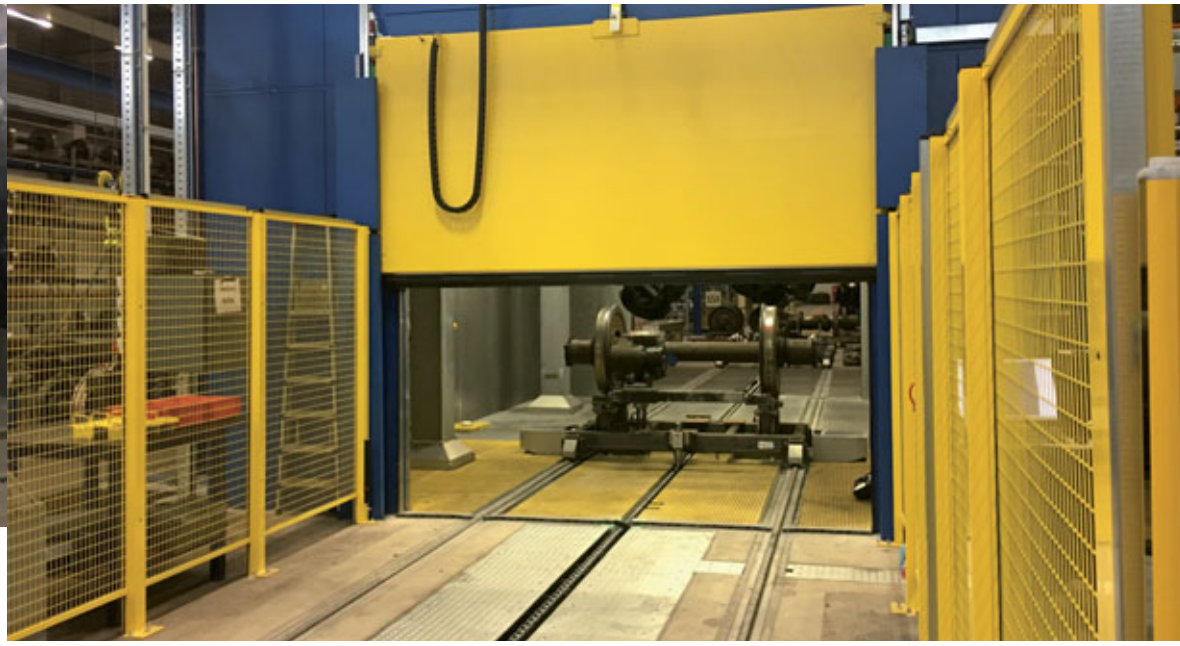
The concentration of toxic substances in the two ventilation scenarios was calculated, compared with the limit values that had been researched, and then evaluated.

The assessment of the existing ventilation, plus the calculations for any additional ventilation required, contributed to the process of ensuring that the artists could benefit from sufficient ventilation during their work. As a result, any health risks for the artists – as well as any unnecessary additional costs for the customer – were identified and kept to a minimum before the work even began.

Frankfurt

Photos: DB Systemtechnik

Fotos: DB Systemtechnik



New technology for **overhauling components**

For C depots, heavy maintenance work increasingly means carrying out repairs as a result of accidents, as well as retrofitting work and component maintenance. The depots are also required to contend with a liberalised market environment in which numbers of providers are growing. DB Fahrzeuginstandhaltung is setting new benchmarks for efficiency in wheelset maintenance, by concentrating this work on the basis of wheelset type and increasing the grade of automation that will be present in wheelset depots in the future. As a whole, this project is focusing not only on adapting the infrastructure to the needs that customers are expected to have in the future, but also on creating innovative developments for wheelset production technologies. Its vision is to make the wheelset depots Europe's most techno-logically advanced facilities for this product spectrum.

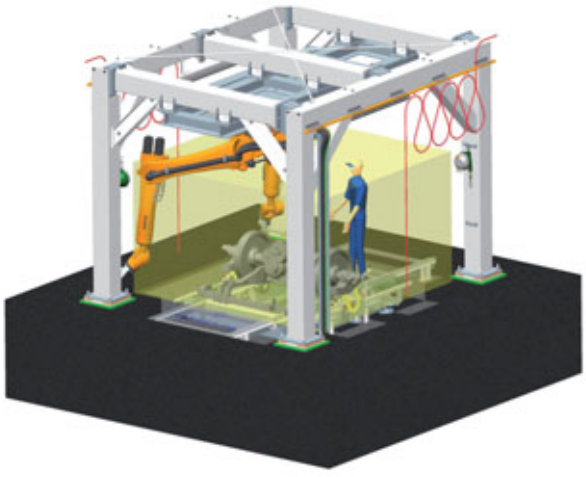
The new technology has required extensive adaptations to maintenance procedures, layouts and mechanical equipment. One example of a significant new feature has been the introduction of a fully automated maximum-pressure water jet for washing and paint stripping. This has been a part of the new depots since 2017 and uses multi-axis robots. The quality standards and maintenance times achieved as a result are unprecedented.

Between 2014 and 2017, a new operational system was introduced in the Kassel, Paderborn and Wittenberge depots. DB Systemtechnik was in charge of planning, providing its support over a period of six years from the initial idea right through to commissioning.

The focal points of the activities were:

- Analysing maintenance processes
- Identifying and selecting technology
- Developing layout options
- Detailed layout planning
- Drawing up specifications for the conveying technology and mechanical systems
- Providing support during procurement
- Providing technical support for commissioning and acceptance

Certain objectives for the wheelset depots were also identified when implementing the project: these were applying and implementing the DB Fahrzeuginstandhaltung operational system in full, and preparing the technology for Industry 4.0. The customer will benefit from reductions in throughput time amounting to as much as 25%. Additionally, the project will deliver improved vehicle availability and ensure that fewer components are held up in the work-in-progress stage.



New radio remote control system in Nuremberg marshalling yard

DB Cargo uses Nuremberg marshalling yard as a train formation yard (TFY) for pushing freight cars via remote control. It is Germany's only gravity marshalling yard – and also has the unusual feature of using a different remote interface from DB Cargo's other TFYs.

As a result of this situation, the manufacturer of the remote-control system had been required to keep a stock of the interface components (the transmission device in the signal box and the receiving device on the locomotive) available exclusively for use by the Nuremberg TFY.

When the system reached the end of its service life, it became uncertain whether it would be possible to obtain spare parts in the future. This prompted DB Cargo to assess the prospect of replacing the remote-control components, and then have this work carried out.

DB Cargo commissioned DB Systemtechnik to conduct this complex project, based on the latter's many years of experience in rail vehicle remote control and push control. Once the specifications had been drawn up, specialists from DB Systemtechnik coordinated the work that the various parties involved would be carrying out. These were DB Netz, DB Cargo, the manufacturer of the remote-control components, plus the German Federal Railway Authority – an especially important player because one of the key steps in the process involved obtaining its approval for using the new remote-control components. The final challenge lay in commissioning the new system while keeping disruptions to operation to a minimum. For this reason, a fallback concept was also developed in the event of problems arising, although fortunately it did not have to be used in the end.

Installing the new remote-control system provided a seamless solution for ensuring that the Nuremberg TFY could continue to be used for its intended purpose. This marked a successful conclusion to the project and eliminated the threat of obsolescence.

Sound measurements on retarders during unmanned, uninterrupted service.

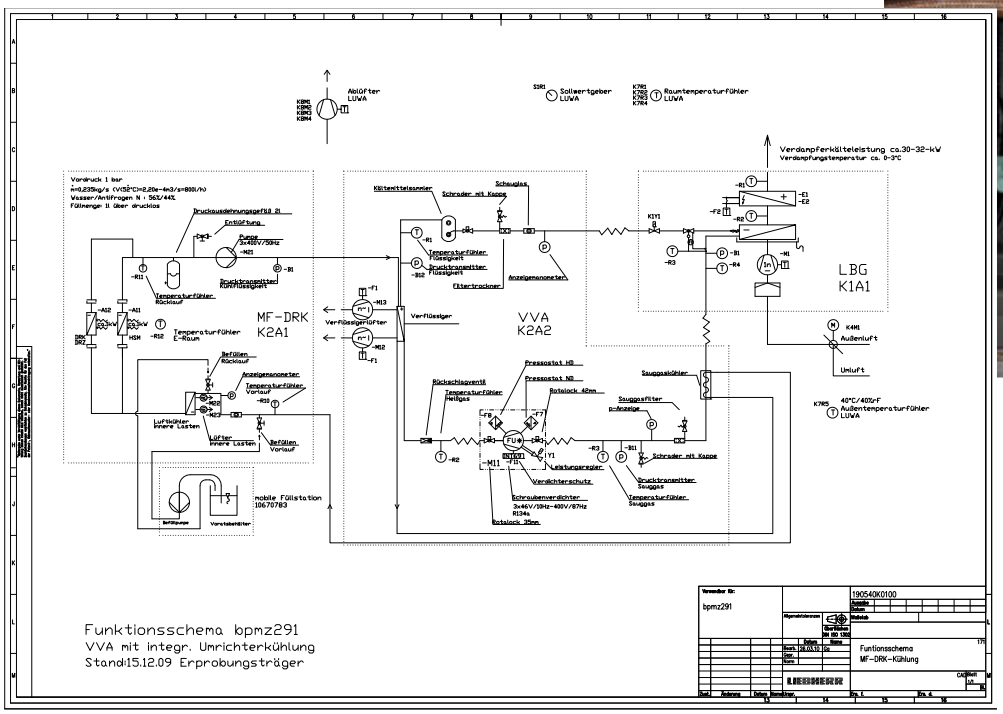
To ensure that sound measurements on retarders in classification yards are compliant with the applicable standards, it is essential for them to be performed in an uninterrupted manner. In the past, measurements of this nature were performed with the assistance of staff at the site. An employee from DB Systemtechnik's acoustics team had to be present at all times, both ensuring that the measuring instruments were functioning correctly and performing calibrations. This was a time-consuming, cost-intensive process. Additionally, the conventional ½" free-field microphones that were used at that time presented a higher risk of accidents occurring in damp weather conditions.

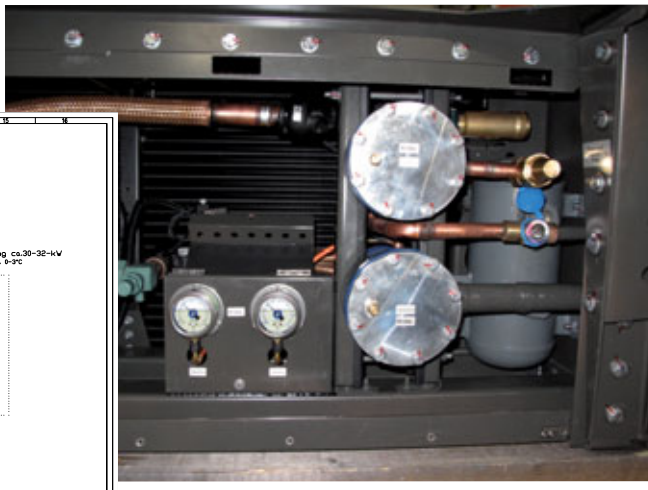
Weather-proof microphones were therefore obtained in order to ensure that measurements could be carried out safely even in damp weather, and to reduce the presence of employees on site. These microphones are equipped with a built-in calibrator that can be controlled remotely. A WiFi router was also procured for the purpose of controlling the microphones remotely and monitoring the measuring equipment.

These steps have made it possible to perform unmanned, uninterrupted measurements. Data can now be transferred, measuring equipment monitored, and microphones controlled remotely from any computer with Internet access. The measuring equipment can also be used over extended periods to perform other emission and immission measurements; for example, if residents in the nearby areas raise complaints due to braking and curve squeals. Employees only need to be present on site to set up and dismantle the measuring equipment. Additionally, the results can actually be evaluated while the measurement process is still taking place.

As a result, DB Systemtechnik is now able to offer its customers affordable uninterrupted measurements for a period of up to 12 weeks.

Fotos: DB Systemtechnik





Maintenance documentation

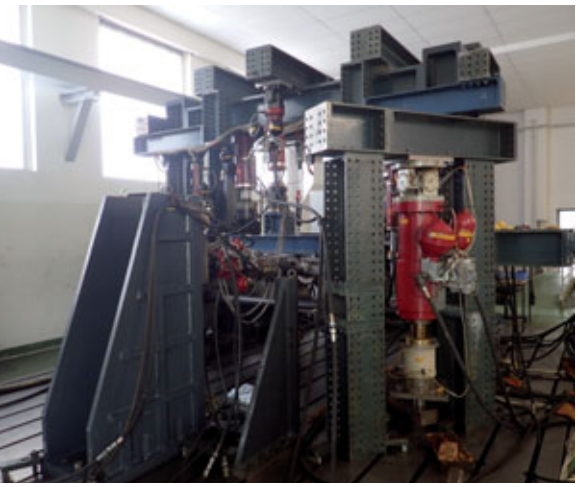
for new climate control systems

The Bmpz passenger cars of DB Fernverkehr feature what is known as a split system, which is a climate control system consisting of a compressor/condenser assembly, or K2 assembly, and an air treatment unit, or K1 assembly. The supplier of a compressor that had been used in the K2 assembly discontinued it, making it no longer available as a new part. For this reason, components including new K2 assemblies from a new supplier have now been purchased. These are intended to replace some of the previous K2 assembles and ensure the continued availability of replacement assemblies. As a result of this, it has been necessary to update existing documentation in a way that reflects the new technology.

Commissioned by DB Fernverkehr, environmental control system experts from DB Systemtechnik checked the documentation provided by the manufacturer for completeness, and converted the information into the format used by DB's own work instructions. A particularly important work instruction (WI) for DB is the WI dealing with maintenance and testing: this specifies and structures the individual work steps for maintenance stuff at the maintenance depots.

It was also necessary to revise and expand two further WIs (pre-summer tune-up and pre-winter tune-up) in order to reflect the new K2 assembly and its water-cooled power supply. The specified maintenance intervals were aligned with the points in time at which DB is required to perform certain inspection tasks.

The prescribed methods of maintaining and servicing the climate control system are now outlined in individual, manageable work steps, and can be used to check, verify and ensure that the climate control system is operating reliably while the vehicle is in use.



ECO Train – Fatigue testing on a motor bogie frame

As part of the ECO Train project, rail vehicles in the 642.4 class are being retrofitted for environmentally friendly hybrid propulsion. This kind of work produces additional weight from integrating batteries and other components into the vehicle – inevitably leading to the vehicle getting heavier. As a result, the regulatory approvals that vehicles in this project once had are losing their validity. In order to regain them, it has been necessary to conduct further laboratory-based fatigue tests on a structurally revised and enhanced motor bogie frame.

Gaining empirical evidence in a laboratory environment required the following activities:

- Creating a test specification for the motor bogie frame being tested
- Designing and creating a test rig structure
- Applying the necessary measuring instruments to the motor bogie frame
- Constructing the test rig
- Performing static tests
- Performing dynamic endurance testing involving 10 million empty/loaded changeovers
- Subsequently obtaining evidence of freedom from cracks by means of magnetic particle inspections
- Drawing up documentation to show this evidence

The laboratory-based fatigue testing was performed on the basis of European standard EN 13749:2011. A period of six weeks was required to perform these tests on the motor bogie frame. Over this time, it was possible to prove that the structurally revised and reinforced motor bogie frame had been sufficiently dimensioned, even with the vehicle weight having increased beforehand.

New first class for double-decker cars

DB Regio in Bavaria is planning the purchase of six 756.9 double-decker cars, manufactured in 1994, from DB Regio's fleet of vehicles. As part of this, the first-class areas on the upper deck need to be adapted through a reworking of the existing design. The Wittenberge depot of DB Fahrzeuginstandhaltung is performing the conversion work, with DB Systemtechnik receiving the contract to provide the engineering services for the redesign project.

As part of preparatory work for the project, installation analyses were performed with a view to implementing each of the individual requirements. The project was divided into mechanical and electrical design components, plus calculations and assessments. The experts at DB Systemtechnik drew up design documents for the steel structure and fittings on the upper and intermediate decks – including those in first class and the upper-deck seating arrangements – as well as documents for converting the glass partitions with swing doors.

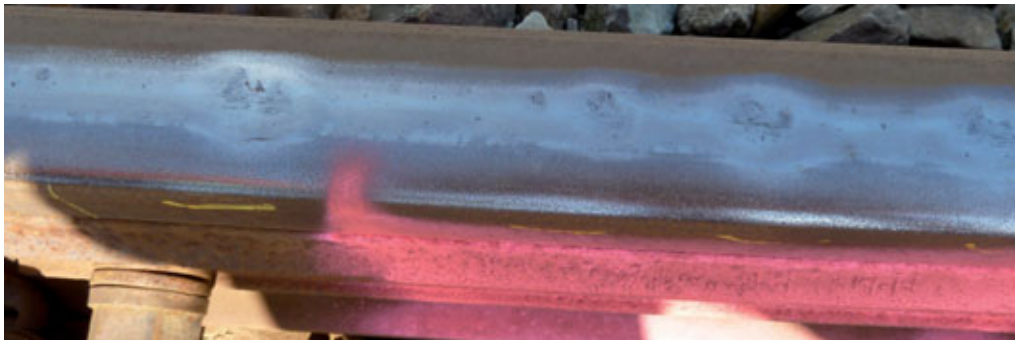
As part of the electrical design work, documents including electronic circuit designs, EMC records as well as plans for installing lines and cables for laptop sockets were produced. Calculations relating to wheelset axle capacity were performed (taking service weight and overall weight into account), as were brake calculations. The fire protection concept produced for the conversion work, plus the escape and rescue route concept, were both assessed by experts. In the final stage, the list of drawings was amended and the lists of spare parts completed for each of the new systems.

One of the cars has also been equipped with LTE WiFi components so that the region can test out this system. If it is well-received, the same equipment will also be installed in the remaining cars. The conversion work on the six vehicles is likely to reach its completion in October, enabling the vehicles to re-enter operation when the timetable change takes place.

Fotos: DB Systemtechnik

Fotos: DB Systemtechnik

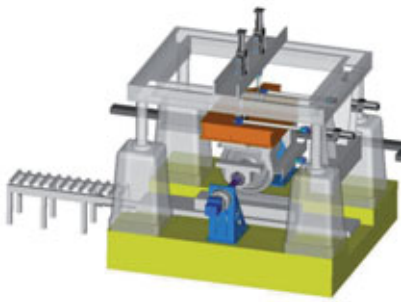
Squats and corrective measures



For some years now, every European railway has increasingly been required to focus its maintenance procedures on squats – fatigue cracks on and beneath the running surface of rails, produced as a result of rolling contact. Series of squats – which refer to cumulative occurrences of cracks of this nature, sometimes over several kilometres – are especially responsible for incurring significant costs, as they often require the rails affected to be replaced as soon as the damage is discovered. It is also essential to note that there is no single cause behind series of squats, and that they require in-depth investigation in order to identify the right corrective measures and prevent high maintenance costs.

In 2016, DB Netz commissioned DB Systemtechnik to conduct a project study into the occurrence of squats and, as part of this, draw up a project proposal on preventing and eliminating squats with the aim of developing an effective maintenance strategy.

Austrian Federal Railways, Swiss Federal Railways, and DB Netz are now working together to complete a cross-border analysis of the applicable parameters by the end of 2017, so that they can establish a statistical basis for evaluating and weighing up the various influencing factors.

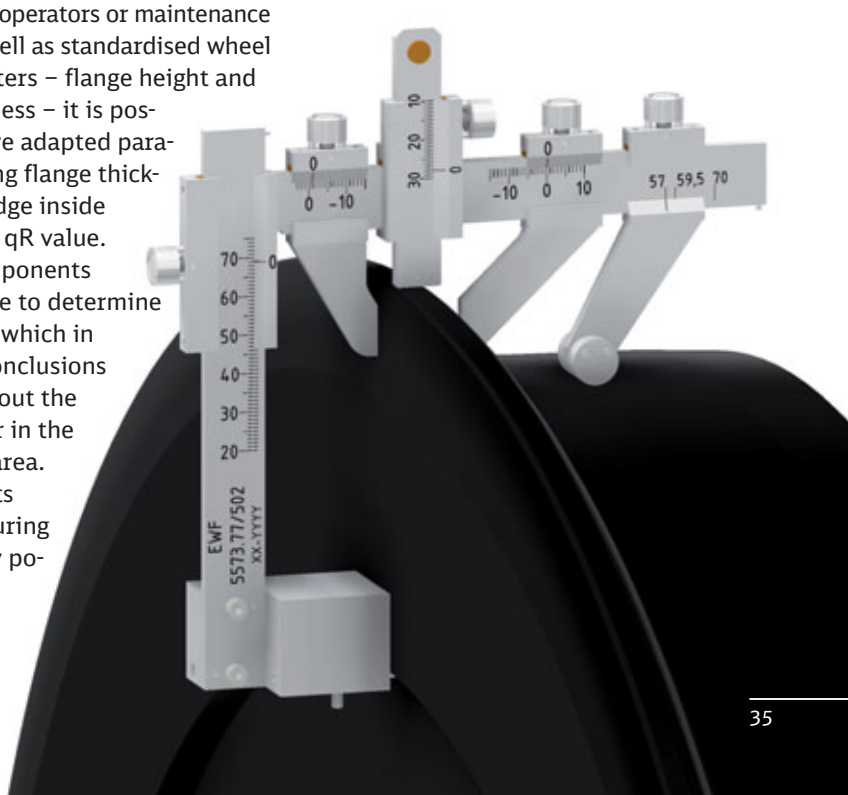


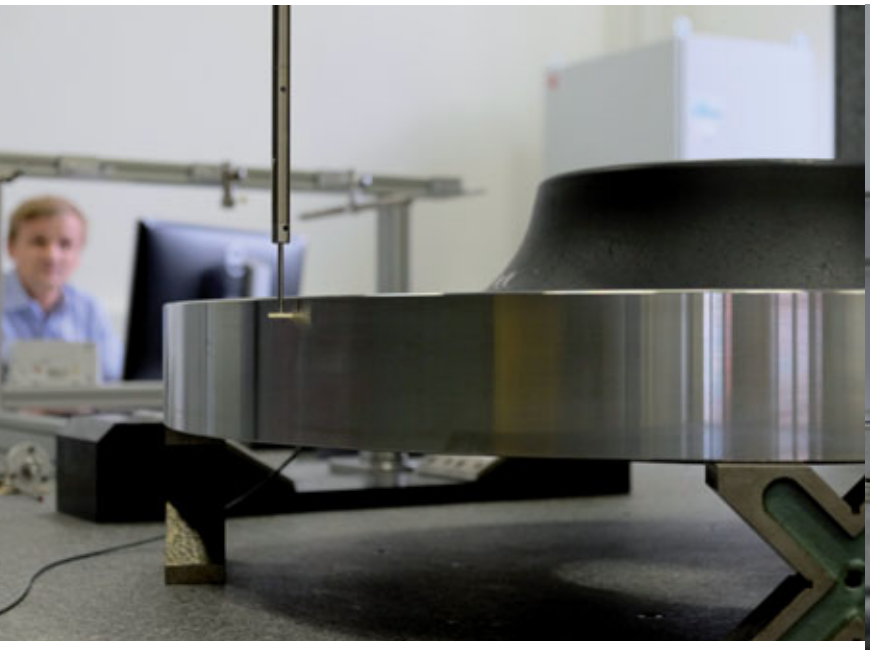
Following this, the intention is to perform tests on a roller rig. To this end, DB Systemtechnik's test rig B in the German district of Kirchmöser is being modernised so that it will be possible to incorporate not only normal and transverse forces, but also longitudinal forces into the wheel/rail contact in the future. Slippage between the wheel and rail is one of the key factors in the production of squats; it also plays a significant role in causing severe disintegration of wheel treads. On the test rig, it is possible to calculate aspects including the speed with which defects of this nature grow and, ultimately, determine the test intervals that are required for them. The phenomenon will be examined in depth over the coming years.

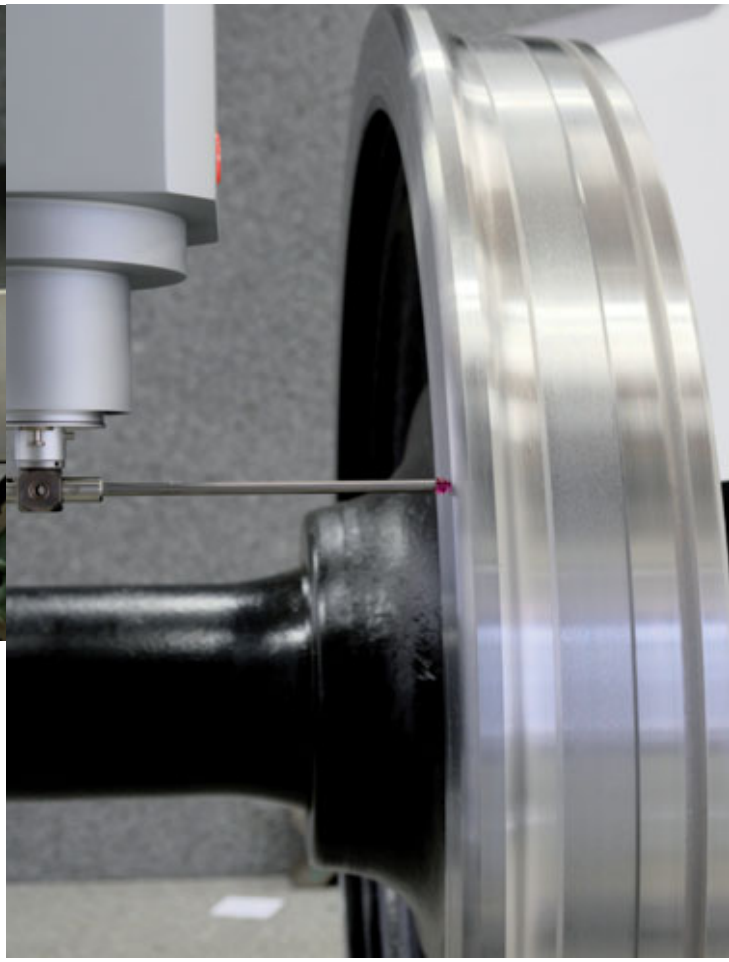
Developing a wheel **profile measuring device** for trams

When different rail-borne vehicle and infrastructure segments in long-distance, regional and local transport are combined and harmonised, it becomes necessary – and makes sense – to pool and develop the expertise that already exists, and ensure that the new departments benefit from it. To achieve this, measuring devices and processes need to be adapted in order to suit a whole range of different requirements. The Calibration and Inspection Body plays a key role in this, particularly when it comes to assuring the quality of testing equipment.

Working on this basis, a wheel profile measuring device has been developed in order to satisfy the requirements and measuring conditions of the German Railway Construction and Operating Regulations (EBO), the German Federal Regulations on the Construction and Operation of Light Rail Transit Systems (BOStrab), plus the standards and directives that apply in this area. The measuring device has a modular structure and can be assembled in a way that suits the purpose for which it is being used, plus the wheel profile parameters to be determined, based on the requirements of manufacturers, operators or maintenance providers. As well as standardised wheel profile parameters – flange height and width or thickness – it is possible to measure adapted parameters including flange thickness, trailing edge inside micrometre, or qR value. Additional components make it possible to determine tyre thickness, which in turn enables conclusions to be drawn about the wheel diameter in the measurement area. Built-in magnets keep the measuring device securely positioned on the rim face, while the position chosen for the magnets prevents the device's performance being compromised by wear on the inner rim face. The measuring device was developed for the Chemnitz Citylink lines and is being used on trams in central Germany's local transport networks.







New high-precision, large-scale **coordinate measuring machine**

The new measuring machine for production assistance, calibration and development

Among the work performed by rail vehicle manufacturers and maintenance depots is the production and reprofiling of wheelsets. Precise, calibrated reference wheelsets are essential for ensuring that what is produced satisfies certain standards and continues to do so over the long term.

On sections of rail track with corrugations, the level of noise produced by rail vehicles passing over them is significantly increased. These sections therefore undergo regular inspections using corrugation measuring devices, in order to ensure that limit values are being adhered to in the interests of both passengers and residents in the nearby areas. Checking and adjusting these high-precision measuring devices requires exact, calibrated corrugation standards. The processes involved in producing and maintaining rails occasionally result in problems such as components not attaching to wheelsets as they should, or the finished product failing to meet the applicable quality requirements. It is often difficult to identify why this happens, so it is good practice to check the dimensional stability of the components being used.

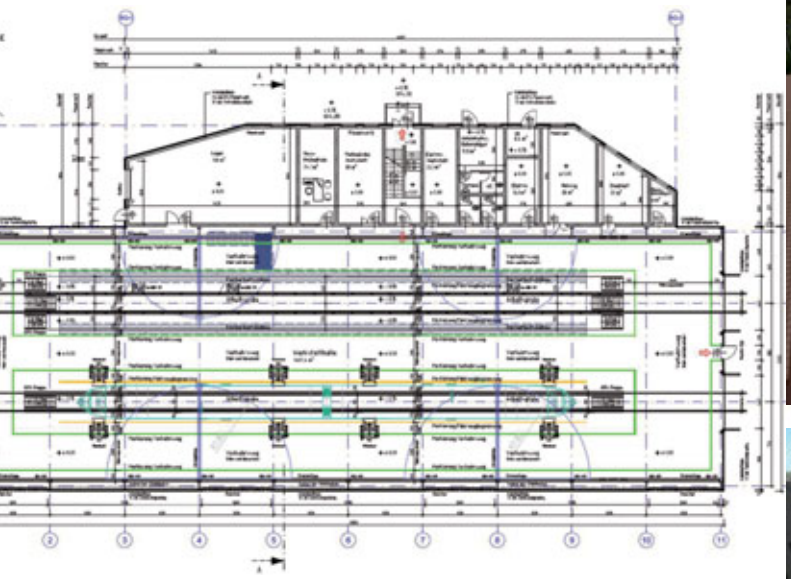
On large, heavy and complex components alike, the challenge is the same: checking for extremely small deviations from the correct shape, running pattern and position with micrometre accuracy.

To find a solution for these and similar tasks, DB Systemtechnik's Calibration and Inspection Body has extended its fleet of measuring systems to include a high-precision, large scale coordinate measuring machine. This can be used for measuring objects with a volume of up to 3 m x 2 m x 1.6 m, where measurements in the micrometre range may be subject to uncertainty. The system is also able to perform deviation analyses using CAD data sets, or reconstruct (re-engineer) CAD data sets with maximum precision on the basis of measurement data. It uses sophisticated measurement methods that are specifically designed to suit the requirements of the rail sector, tackling measurement uncertainties at a small scale. The laboratory responsible for coordinate measurements in this case performed its work in the calibration department. Even the reference measurements proved the approach was producing the right results:

- Precision measurements of the bearing seat measurements are helping the customer to optimise the maintenance procedures carried out on gearboxes for rail vehicles.
- Highly accurate measurement data is allowing a maintenance company to identify the causes of quality issues encountered when manufacturing wheel centres and tyres.

Photos: DB Systemtechnik

Fotos: DB Systemtechnik



From transport contract to commissioning – **A new main-tenance depot in Korbach**

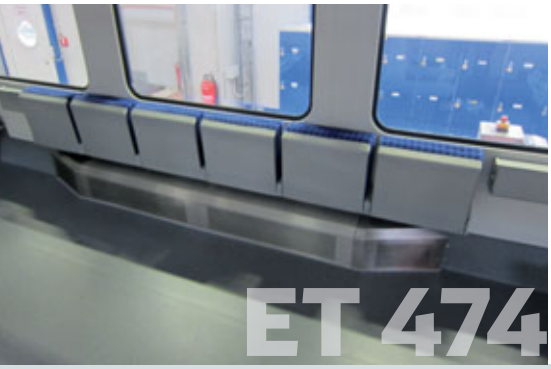
The Kurhessenbahn, a regional rail network operated by DB RegioNetz Verkehrs GmbH, responded to an invitation to tender for the provision of transport services around Korbach, a town in the German state of Hesse. There were several options available for the network to deliver maintenance work on diesel multiple units in the future:

- Continuing to have maintenance performed by external service providers
- Insourcing; acquiring and converting an existing depot in the city of Kassel
- Building a new dedicated depot

Based on its role as an advisor to the Kurhessenbahn network, DB Systemtechnik's services were enlisted at an early stage of preparing a bid for the tender. It was asked to evaluate these maintenance options and produce configurations for the maintenance infrastructure that the planned rolling stock would require. Potential depot layouts were developed, costs were calculated and schedules drawn up for all the options. The results of the investigations showed that building a new depot at the centre of operations in Korbach represented the most cost-effective option that could be included in the bid. Even before the bid was accepted, DB Systemtechnik was commissioned with the task of preliminary design (HOAI basic evaluation phases 1 and 2). From October 2015 onwards, and working together with DB Engineering & Consulting, it produced a total of seven possible versions of the Korbach depot. The challenge lay in identifying the most effective way of accommodating all the necessary systems for maintaining the vehicle fleet on the plot of land. Once the transport contract had been awarded, the process of planning the design and planning for the building permit application began. During this, DB Systemtechnik advised the contracting authority on overarching issues relating to the maintenance concept and assumed responsibility for providing the depot equipment. A final design and functional tender documents were produced for this purpose. DB Systemtechnik is continuing to provide its support in the process of bringing the project to fruition. Final acceptance of the system is scheduled to take place at the point of the 2018 timetable change. In summary, the project comprised the following key aspects:

- Building a new double-track workshop building with side pits and central pits for carrying out work
- Erecting a new operations building with ancillary workshops and staff facilities
- Building a new exterior cleaning facility with washing equipment and a waste-water treatment facility
- Installing and adapting outdoor equipment
- Mechanical equipment: crane system, roof working platform, jack system, exhaust gas extraction system
- Workshop equipment
- Warehousing and logistics concept

Redesigning **Hamburg's S-Bahn**



With the third series of Hamburg's ET 474 S-Bahn vehicles failing to meet the requirements being imposed by the upcoming franchise, the vehicles are now having to undergo extensive modernisation. The interconnecting gangways represent a major element of the re-design programme; it is these components that make it possible for passengers to move along the entire length of the three-car trains. The Neumünster depot of DB Fahrzeuginstandhaltung is providing the site for the conversion activities, with DB Systemtechnik receiving the contract to deliver the design services. Hamburg's S-Bahn operator provided the system performance specifications as a basis for the work. In addition to managing the project at the Neumünster depot, DB Systemtechnik's experts provided engineering services with the aim of producing a prototype vehicle. Following this, technical drawings were adapted into versions that were ready for series production and handed over to the contracting authority.

The new and brighter interior design concept for the vehicles now affords passengers more comfort as well as enhancing the feeling of safety. A new multipurpose compartment in the intermediate car provides more space for bicycles and buggies, which in turn gives passengers with reduced mobility more freedom to move around in the front and rear areas. Additionally, the trains now feature a new, state-of-the-art passenger information system. The screens are being installed gradually and the passenger television system that has been planned will go into operation from 2017 onwards.

Following the launch of the ET 474 Plus prototype in January 2015, the extensive programme of modernisation began in January 2016 with vehicle 474 004. Over the course of that year, more than 20 trains were overhauled. By 2021, all 112 S-Bahn vehicles from the current 474 series will gradually undergo the redesign process.

Training for **braking staff**

DB Systemtechnik's specialists in brake operation, simulation and couplings are responsible for creating, maintaining and developing regulations relating to brake operation.

With a view to establishing standardised operations for the entire rail sector, the content of DB Guideline 91501 has been adopted and enacted in full – with no amendments – as part of document 757 of Germany's Association of Transport Companies (VDV), entitled "Bremsen im Betrieb bedienen und prüfen – Bremsvorschrift" ("Operating and testing brakes – Braking rules").

It is the responsibility of rail companies to implement these rules for braking. They are required to communicate the expertise and skills necessary for this to operational staff, enabling them to perform their duties correctly. Additionally, the rail companies must perform inspections or other take other appropriate measures to ensure that staff actually do possess the expertise and skills they need.

Based on its many years of experience in creating, maintaining and developing braking rules, DB Training has commissioned another body within the DB stable – DB Systemtechnik – to carry out basic and advanced training for authorised brake test engineers as well as conduct preparatory courses for rail safety managers. These courses will also be provided for external training facilities and rail companies.

In sessions that reflect reallife practice, participants will receive comprehensive fundamental training in performing brake tests as well as operating brakes on goods and passenger trains. The content will focus on both operational and technical aspects, and will be tailored to the specific needs of each rail company. Experts from DB Systemtechnik will provide an extensive insight into the special features of the regulations on brake tests, brake operation and irregularities. This content will also include user-focused training documentation for passenger trains, freight trains, rail-cars, multiple units and high-speed trains.

Through this training, DB Systemtechnik's braking experts will have the opportunity to pass their knowledge on to participants from every area of the rail sector.

Photos: Bartlomiej Banaszak, DB Systemtechnik

Fotos: DB Systemtechnik, DB AG/Rico Emersleben

Availability increase of air conditioning systems

Environmental chamber tests deliver proof

In recent years, the availability of Bpmz-type climate control systems in IC carriages was reduced when spring and summer temperatures were high. To stabilize the remaining useful lives of the vehicles, two groups of topics were investigated as part of tests conducted at DB Systemtechnik's MeiKE climatic test facility in Minden.

The tests included capturing and analysing the basic system parameters under summer conditions. The parameters acquired enable the control variables of the climate-control software to be evaluated and further developed. To improve the target state, optimised valve settings have been defined. The tests were conducted in a temperature range from 15°C to 45°C. The loads imposed by the sun and people were simulated using heating mats and evaporators.

To create the parameter space, the outdoor temperature, sunlight and the number of persons were varied in individual experiments. The resulting steady-state system conditions were captured together with the following parameters: mean ambient temperature, pressures and surface temperatures of the refrigeration system as well as air temperatures in the air-treatment unit and in the duct system. The results were used to derive changes to the maintenance specifications. In addition, the effectiveness of technical improvements to the climate control system was verified.

These improvements include fitting ambient-temperature sensors, changing the flow behaviour for the evaporator, increasing the supply air volume, enlarging the evaporator surface and deploying a new type of compressor.

In this way, the environmental chamber test has contributed significantly to improving air-conditioning in IC carriages.

Retrofitting climate control systems **in double-decker cars**

During 2016, double-decker rolling stock in the Baden-Württemberg regional unit of DB Regio in Germany was retrofitted with climate control systems. Before the series of work itself began, a test vehicle was retrofitted as an initial step – requiring tests in an environmental chamber in order to provide evidence that the operator's requirements had been met. Similar rolling stock had already been retrofitted and tested in an environmental chamber as part of a previous project. In this case, the task was to gain evidence that the two sets of results aligned with one another. Specialists in environmental control systems at DB Systemtechnik were assigned this work. In the lead-up to the tests, the contracting authority was consulted on the operator requirements that needed to be tested, and in-depth programme of testing was developed on this basis. The concept behind this makes it possible to not only test requirements by assessing the system's conformity with previous tests, but also test the effectiveness of the outdoor air supply, whose performance depends on the vehicle's occupancy. As a result of the engineering specialists in Munich working closely with colleagues operating the MEikE environmental chamber in Minden, DB Regio now has a solution that comes from a single source. The two groups of experts had already played a significant role in the previous tests conducted on the double-decker rolling stock. The contracting authority was kept constantly informed about the progress of the tests. A statement compiled information about the tests in relation to the quality of the occupancy-dependent fresh air supply. Now, the test results will give the contracting authority the ability to provide dependable evidence of properties it has committed itself to delivering. Based on the evidence of the performance delivered by the occupancy-dependent fresh air supply – an energy-saving measure that was reasonably easy to implement – the customer is able to benefit from potential energy savings amounting to €2000 per car every year. As a result, this retrofitting work will not only reduce costs, but also enable passengers to travel in more comfort in the future.

service life tests **of concrete sleepers**

DB Netz has extensive experience with concrete sleepers and their operational reliability on actual track. It is responsible for approximately 33,300 km of rail network, making it one of Europe's largest railway infrastructure managers. To underpin this experience by systematically testing the service life of concrete sleepers, DB Systemtechnik was commissioned to develop a testing procedure for estimating the service life of concrete sleepers. These tests aim to improve the planning of line closures by modifying maintenance intervals. All of which reduces costs for DB Netz while increasing track availability at the same time.

The previous testing options were limited to quasi-static tests. Hitherto it was not possible to estimate the service life of concrete sleepers on actual track from the test results. In the Fatigue Inspection Center a test system for dynamic testing was developed in close collaboration with DB Netz. The test rig simulates the passing of trains across a permanent way. In order to achieve this goal, a test programme was developed that enables a virtual train to be driven over the concrete sleepers so that the mechanical loading from a service life of decades can be verified within a few weeks. Relevant customer requirements can be quickly incorporated and implemented in this programme. To conduct testing under lifelike conditions, the condition of the permanent way, the various forces exerted by the rail on the sleepers as the train passes, as well as the impact of diverse weather conditions were considered.

The test rig has successfully been in continuous use for the past two years.

Fotos: DB Systemtechnik, Dr. Kai-Uwe Nielsen

Karte: Bing, Fotos: DB Systemtechnik, Fa. Windhoff

Automated intra-plant logistics
in the ICE depot at Munich central station

Deutsche Bahn AG's ICE high-speed trains have maintenance performed on them in the ICE depot at Munich central station. In the majority of cases, this work takes place overnight. The tasks that are carried out depend on the maintenance regulations and the evaluations performed while the train is approaching the depot. Once it has arrived there, maintenance work begins immediately. For this sequence of events to succeed, any necessary materials have to be ready and waiting at the site. It must also be possible for the materials to be delivered at short notice.

To prevent employees from having to spend significant amounts of time on transporting materials, the ICE depot at Munich central station is introducing automated material transport systems. Small parts, weighing up to 2.5 kg, are transported through a pneumatic tube system (a more advanced version of the well-known type of pneumatic system used for transporting items such as paperwork within companies). Once the employee has placed the necessary materials in the canister, the transportation process can begin. Controlled by a computer, the transponder-coded load carriers (canisters) are rapidly conveyed to the receiving stations – at up to 20 km/h – directly alongside the train.

This means that the employee is able to obtain the materials and install them in just a few steps. Employees use an app on their work tablets to not only request the materials they need, but also acknowledge their receipt.

Picked materials, placed on Euro pallets or in mesh box pallets, are delivered by driverless transport systems to the maintenance tracks as if by magic. The systems are fully automated and are even able to move from one floor to another using lifts. Laser scanners and 3D cameras, along with a range of other safety and security systems, ensure that the driverless transport systems operate reliably. The computer used for control and management is where the transport processes are optimised. It also ensures that the vehicles remain available 24 hours a day, 365 days a year.

DB Systemtechnik GmbH has played a leading support role for the project implementing the automated intra-plant logistics system in the ICE depot at Munich central station – from the feasibility study to the functional performance specifications, all the way through to successful implementation. The first expansion stage is set to reach its completion on schedule by the end of April 2018, once the trial operation has finished.

Trier West Railway – Sound and vibration investigations

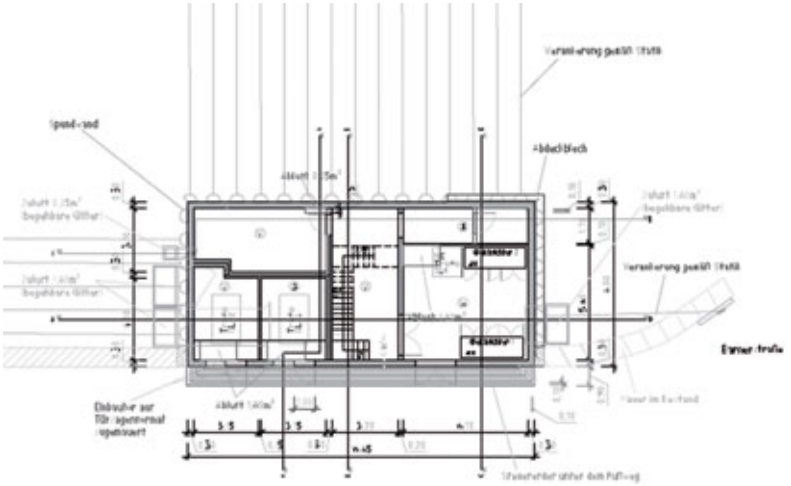
Although Trier West Railway is used exclusively for freight transport nowadays, the intention is to restore its operation of PSO services in the future. A package of construction measures is being planned with this in mind: reactivating a connecting curve, building or refurbishing six stations, and demolishing Ehrang station, also located in Trier. The measures are taking place over a section measuring approximately 15 km.

As part of the planning for the building permit application, DB Systemtechnik was commissioned to perform sound and vibration investigations as well as an estimate of the construction noise likely to arise. For this purpose, experts from its Acoustics and Vibration team conducted investigations in three areas. First, an acoustic dispersion model for operational sound was constructed. The noise situation was then calculated, depicted and outlined. The third step involved developing a sound prevention concept. At the same time, dispersion measurements were conducted in relation to operational vibrations. The future vibration situation was forecast and evaluated on the basis of the measurement results. In order to estimate the sound situation during the construction phase, an acoustic dispersion model for the construction noise was created, the sound emissions produced were calculated, and noise-reduction measures were developed.

For the purpose of planning for the building permit application, DB Netz was able to receive sound-related and vibration-related investigations for both operation and construction, all from a single source. The investigations into the construction noise situation at the planned stations were sent to DB Station&Service. As a result, all the commissioned services were delivered on schedule.

Sound and ventilation concept for the rectifier plant in Hamburg's Lessing tunnel

DB Energie is planning the construction of a new rectifier plant in Hamburg, a process that will involve building a full enclosure for the transformer systems and the rectifiers. A fundamental step in gaining the permit for this kind of construction requires the project owner to obtain an expert report on the sound immission affecting neighbouring residential buildings. As a boundary condition, it is important to consider that any mechanical ventilation required for transformer boxes will represent an additional source of sound.



As part of this project, DB Systemtechnik's team responsible for environmental control systems clarified at an early stage whether a natural source of ventilation would be sufficient for cooling the transformers. As this was not the case, however, a ventilation system was designed in order to deliver the necessary cooling. The result was a realisable ventilation concept for the supply and exhaust air, with specifications concerning the fans that would need to be used. At the same time, colleagues specialising in acoustics conducted the sound immission prognosis, working in close consultation with the relevant experts when it came to certain technical questions. This meant that it was possible to give consideration to the results of the ventilation design – that is, the ventilation-related and acoustic-related characteristic data of the required fans – during the very process of recording information about the boundary conditions for the sound immission prognosis. As an example of the outcomes, identifying structural sound-proofing measures has removed the need to install sound absorbers.

With the teams of experts also working in parallel and in coordination with each other, it was possible to prevent work being duplicated. The expert report required for the process of planning for the building permit application arrived with the customer on time – and the customer simultaneously received a realisable design proposal for the ventilation required in the transformer areas.

Fotos: DB Systemtechnik

ICE 4 arrives for **maintenance**

Performed as part of maintenance procedures, non-destructive testing (NDT) of vehicle and route components is exceptionally important in ensuring that rail vehicles are able to deliver technical reliability and remain available. The ICE 4 is the latest vehicle fleet generation to begin undergoing this type of maintenance. When ICE 4 started approaching this point, DB Fernverkehr commissioned DB Systemtechnik to adapt existing systems designed for fully mechanical ultrasonic wheel testing (underfloor testing stations or UTS), as well as hollow axle inspection systems (HPS), to suit the needs of the new vehicles.

This process was piloted at the Munich depot. Certain technical aspects of the ICE vehicles differ from their earlier counterparts, which required the test systems to undergo additional changes. With the traction wheelset axles demonstrating a larger longitudinal bore diameter, the systems needed new carrier elements for the testing heads. Additionally, unlike all the previous designs, the idler axles feature inside bearings. This meant that it was no longer possible to maintain the same HPS positioning and centring on the axles. Additional positioning aids were developed and produced in order to overcome this.

Not only were new test axles and wheelsets developed, the testing programmes were also adapted for the first two underfloor inspection facilities and the first six HPS, staff at the site given the appropriate briefings, and the inspection instructions extended. As well as this, three HPS were upgraded at the Hamburg-Eidelstedt depot as a fallback measure for inspecting the ICE 4 axles.

The first ultrasonic tests have since been successfully performed on ICE 4 vehicles, playing a significant part in ensuring that these multiple units are able to remain reliable and available during operation. Now that adapting the systems has got off to a flying start, other mechanised test systems across Germany are set to undergo the same work and be equipped with test axles over the coming years. This will take place at the Hamburg–Langenfelde, Berlin, and Cologne-Nippes maintenance depots. By 2020, six HPS and two underfloor inspection facilities will have been upgraded at each site.

Redesign of **double-decker cars** in Baden-Württemberg, Germany

DB Regio in Baden-Württemberg carried out a planning process with the aim of participating in the invitation to tender for the Netz 2 line. This involved the conversion of existing double-decker cars from the 1997 and 2003 series, encompassing both cab cars and intermediate cars. DB Fahrzeuginstandhaltung commissioned DB Systemtechnik to deliver the design services required for the conversion work. Preparatory work for the project involved evaluating the system performance specifications. Drawings of the original vehicles were also researched, consultations held with the vehicle keeper and the conversion depot, and the first overview and project drawings produced.

The conversion work itself required changes to the seating layouts and replacements for tables, rubbish containers, seats, glass partitions and overhead luggage racks. The first and second class areas were provided with laptop sockets, and the vehicles were also required to be equipped with WiFi and CCTV. Additionally, handrails and bicycle holders had to be installed in the new and expanded multi-purpose compartments. Updating the vehicle documentation involved tasks such as drawing up EMC plans and earthing concepts.

As part of a sub-project involving assessors, the escape and rescue routes were evaluated, a fire protection file was created and crowd management calculations were performed for all the designs.

The conversion work itself then began in April 2016 at the Wittenberge depot and will continue until March 2018, with the rolling stock put into operation directly afterwards.

Photos: DB Systemtechnik, Georg Wagner

Trade fairs **and activities**

Photos: DB Systemtechnik

DB Systemtechnik at **InnoTrans 2016**

DB Systemtechnik was present at InnoTrans in two separate locations. The Deutsche Bahn booth showcased the entire range of services provided by the Engineering and Inspection Centre Units.

Together with DB Fahrzeuginstandhaltung, the outdoor area provided customers with an interesting exhibition from both companies. Interesting exhibits, such as instrumented pantographs and instrumented wheelsets, showcased the range of rail depot measuring and testing equipment, along with projects such as hybridising a diesel locomotive (HELMS).

Aerodynamics Day in Munich

In November 2016, the aerodynamics specialists from DB Systemtechnik invited guests to Munich to join them for the first DB-internal aerodynamics theme day. Speakers from DB Systemtechnik, along with guest speakers, gave presentations on the themes of "Infrastructure" and "Vehicles" with reference to aerodynamics. The areas covered ranged from simulation calculations to air surge, fire protection measures on underground lines, through to experience with flying ballast, ice and snow.

Photos: JET Kranert

Final symposium **"Micro-pressure waves"**

DB Systemtechnik and the Japanese Railway Technical Research Institute (RTRI) set up a partnership in 2014 to look at the issue of micro-pressure waves ("sonic boom phenomenon"). Since its inauguration, the two companies have been working closely together. A formal final symposium was held on 18 July 2017 at RTRI in Japan, with participants including representatives from various JR rail companies and several Japanese universities, as well as the German Aerospace Center (DLR). Following the symposium, the RTRI held an additional specialist aerodynamics workshop covering the topics fume propagation in tunnels and safety with cross-winds.

General Meeting **JR East and DB** in Japan 2016

For over 20 years, JR East and DB have held meetings to share expertise and these visits have included a Board of Management visit. In 2016, attendees, including DB Systemtechnik, gathered in Japan. Agenda items included: plant visit to Toshiba Battery Technology, visit to JR Freight, tour of EV-301 hybrid train, meetings on hybridisation techniques and energy efficiency, inspection and maintenance of the E200 with hybrid drive, Railway Museum of the East Japan Railway Culture Foundation in Saitama.

Photos: DB Systemtechnik, Mackbrooks Natalie Parker

Photos: Björn Simnacher/Eichstätt, DB Systemtechnik

RAILTEX Birmingham

On a shared exhibition stand at RAILTEX in Birmingham (9 - 11 May 2017), ESG Rail, DB Systemtechnik, DB Engineering & Consulting and DB Fahrzeuginstandhaltung showcased the wide range of technical solutions offered by the DB Group. For the first time, the four companies had a combined trade show presence for the UK market.

RAILTEX
9 – 11 May 2017

Vienna Sales office

DB Systemtechnik inaugurated a project and opened a sales office in the Austrian capital in May 2017. Over 70 people attended the celebratory event and were provided with an overview of DB Systemtechnik's capabilities.

World Congress on Railway Research 2016

Some 1,000 participants from more than 30 countries gathered in Milan for the 11th WCRR in May 2016. 240 presentations and 170 e-posters devoted to Rolling Stock, Infrastructure, Railway System, Passenger Mobility from door to door, Freight Logistics, Sustainability, Economics and Policy, Operations and Safety were presented at the Congress, three of which were from DB Systemtechnik colleagues. The next WCRR will be held in Japan in 2019.

The running equipment test laboratory celebrates its birthday

The DB Systemtechnik "Department for Running Equipment and Vibration Technology" celebrated its 55th birthday on 12 January 2017. It was founded in 1962. Around 300 guests, customers, employees and even former departmental colleagues joined the celebrations at the Minden location. Hans Peter Lang, Chairman of the Board of Managing Directors of DB Systemtechnik, provided an exciting overview of the challenges ahead "Tests from a current perspective".

5th DB-internal **HVAC theme day** in Munich

Some 40 participants from all areas of DB took the opportunity, in March 2017, to share their professional and personal insights. Eight presentations on HVAC topics from the areas of "Environment and Strategy" and "Operations/Vehicles" were held. The wide-ranging topics covered everything from retrofitting energy-saving measures with verification of the energy-savings potential, the use of natural refrigerants, through to the presentation of measures for stabilising coach HVAC systems and HVAC procurement projects.

IAF Münster

Together with DB Bahnbau and DB Training, DB Systemtechnik was present at the 27th International Exhibition on Track Technology in Münster. Over 15,000 visitors, of which 90% came from German-speaking countries, attended the event. As part of the specialist presentations, Dr Klaus Uwe Wolter gave a speech on Predictive Maintenance (CTM).

Photos: DB Systemtechnik

DB Systemtechnik:
Our products

Testing

The 250 employees of the Business Line Testing support you with their comprehensive knowledge of systems, suitable test methods and tools, along with well-founded technical trial expertise.

Testing
- Vehicles
- Infrastructure
- Components

Approval
- Vehicle approval
- European requirements (TSI certifications NoBo)
- National requirements (DeBo)
- Partial releases for infrastructure
- Expert opinions
- Safety-critical changes (AsBo)

Measurement technology
- Sale of measurement and diagnostics systems

Engineering

With a total of 350 employees at various locations the Business Line Engineering support you in all topics of construction, engineering and digitization for vehicles and components.

Engineering design
- Design support:
  New and existing vehicles & components
- Conversion and redesign
- Damage and accident refurbishment

Engineering
- Supervision of production assets
- Fleet management
- Procurement accompaniment
- Supplier/product qualification
- Conducting studies & expert reports
- Operating regulations
- Representation on committees
- IT use & diagnostics
- Accident and damage analysis
- Assessment of financial benefit (RAMS, LCC)

Maintenance systems

Our 150 employees of the Business Line Maintenance Technology are pleased to advise and support you in all engineering services for design, construction and optimization of all maintenance system elements in the field of railway technology and infrastructure.

Maintenance systems
- Development and supervision
  of maintenance concepts
- Condition-based maintenance
- Works planning and intra-plant logistics
- Testing and diagnostics equipment
- Non-destructive testing
- Metrology/calibration technology
- Materials engineering
- Welding and adhesive bonding

DB Systemtechnik

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Our knowledge –

Your success

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