



DB Systemtechnik

Activity Report

2013/2014

Engineering expertise

Service quality

Innovation capability

International

Neutrality

For people. For markets. For tomorrow.

Interaction of infrastructure and **rolling stock** **technology**

Liberalisation and Internationalisation

are what characterises the train in our period

Ever more and different operators with the most diverse business models and a multitude of different vehicles from international manufacturers use our European rail network these days. At the same time, the dissolution of traditional structures with their engrained distribution of roles and functionalities, such as owner, maintenance provider and operator, is responsible for an increase in interfaces in the chain of value creation. Especially under such changed framework conditions, what matters is a partner who is competent, neutral and European, and who masters the questions of interaction of infrastructure and rolling stock technology as well.

For one year we have been offering our services to customers from the sector of underground and tramway as well. The bespoke solutions that we offer to the urban and suburban sector benefit greatly from our experience in full-scale train operation. We intend to further expand these activities in the future.

As we have been doing in the previous years, in this performance report we should like to give you a little overview of the activities that we have been carrying out for our customers in Germany, in Europe and worldwide.



Hans Peter Lang
Managing Director

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A new customer: HOCHBAHN in Hamburg

HOCHBAHN entrusted us with the technical evaluation of existing vehicles type DT3 by LHB. In the scope of an inspection, our specialists examined components such as wheelset guidance, bogie frame and vehicle body. Regulations by BOStrab as well as the general rules of maintenance, experiences made therein, vehicle diagnostics and calculations form the basis of such evaluations. As far as possible, the stringent standards that we apply in the inspection of such vehicles are the same as the ones used for new vehicles about to be licensed, and the same level of safety needs to be proven.



The highlights of **DB Systemtechnik**

Acoustics laboratory with flexible accreditation

The acoustics testing laboratory of DB Systemtechnik was accredited by the Deutsche Akkreditierungsstelle GmbH (German Accreditation Institution) on 11 June 2014 as the first flexible accredited laboratory for acoustic and vibration inspection services within the rail domain. Base for this is the internationally recognised norm DIN EN ISO/IEC 17025 which determines competency requirements for testing and calibration laboratories. "Flexible" means that this laboratory is not restricted to a certain set list of select norms, but that such a list contains merely examples of relevant norms, and that indeed the laboratory has the right to test according to other standard or assimilated norms and procedures as long as they fall within the defined scope of testing.

Besides the acoustics testing laboratory, further testing laboratories in the areas of air conditioning technology, aerodynamics, braking and driving technology as well as for non-destructive material testing have been flexibly accredited by DAkkS.



Prima II

A further milestone in the expansion of our France activities occurred in autumn 2013 within the scope of the Prima II project. After successful approval by the French regulatory body EPSF, we conducted for the first time measurement runs in the Champagne province with a non-licensed vehicle in standard operation mode, that is, without closing rails for this purpose. In addition, these runs were in part carried out at speeds of $V_{max} + 10\%$.

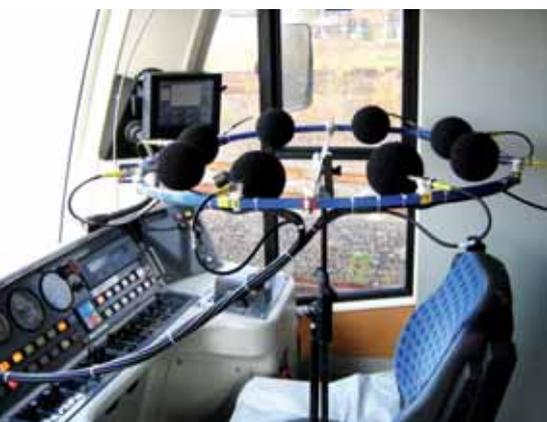
New combustible materials laboratory inaugurated in Brandenburg-Kirchmöser

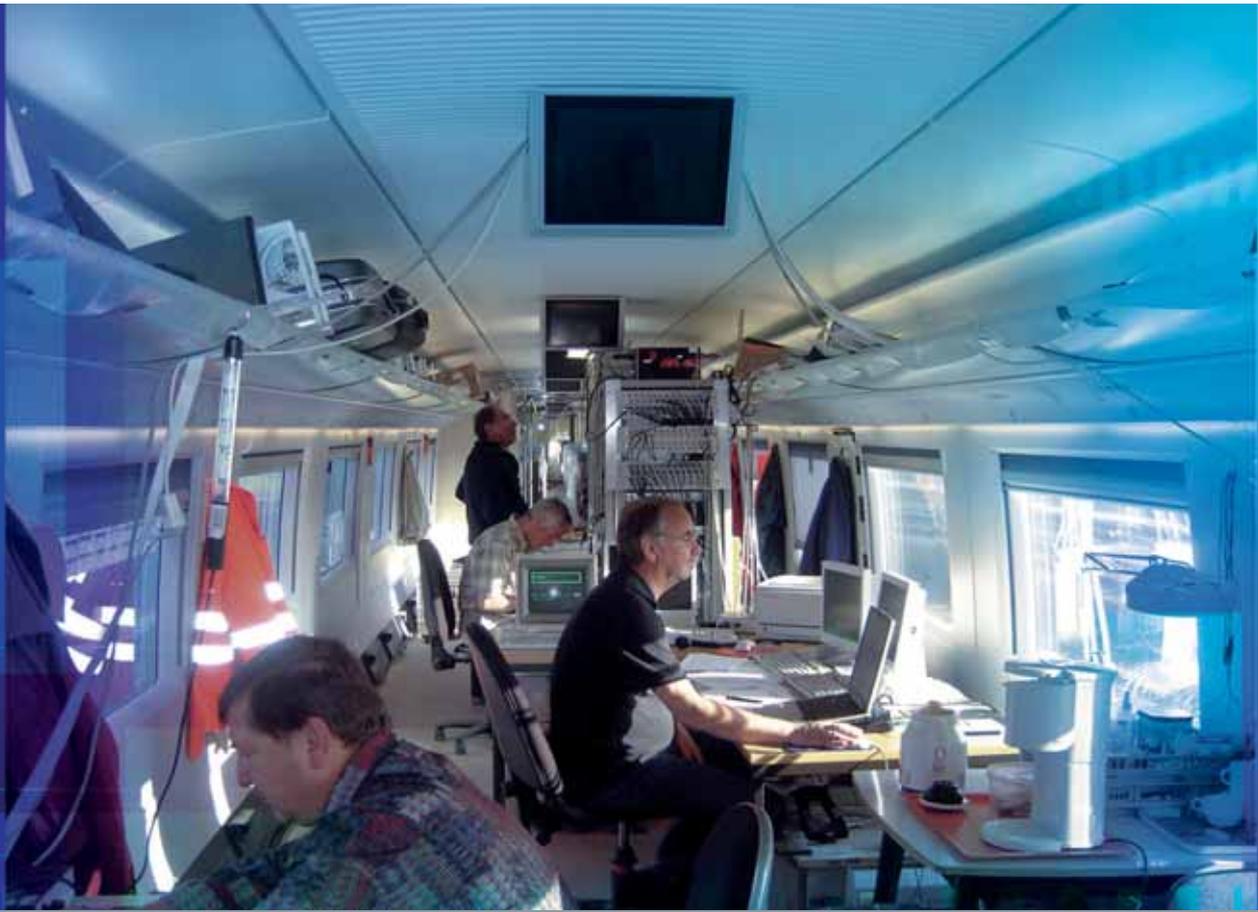
In Brandenburg-Kirchmöser a new combustible materials laboratory has been inaugurated. This laboratory now allows to test materials according to the most recent norms. State-of-the-art equipment is used to test elements such as flammability, smoke density and toxicity of rail vehicle components. Examples of such materials are wall coverings, floor covers and roll-down sun visors.

Such inspections are required in the licensing process of new vehicles and in the refurbishing of rail vehicles. This new combustible materials laboratory enables DB Systemtechnik to test materials of rail vehicles according to national as well as international norms, including also the new European Norm DIN EN 45545-2:2013.

Testing equipment:

- Cone Calorimeter
- Smoke Density Chamber and FTIR
- Floor Radiant Panel
- Spread of flame apparatus
- Combustion shaft
- Combustion box





Optimised approval management

Approval management at **DB Systemtechnik**

In Summer 2013 a "Memorandum of Understanding about the creation of new approval procedures for rail vehicles" (MoU) has cast the basis for a reform of the approval procedure in Germany.

This MoU greatly improves procedures such as for approval in the scope of technical safety, where operational technical safety is tested. The trade-specific inspections and the safety evaluations necessary in the course of this are conducted separately and independently of the authority normally responsible for safety, by the three bodies Notified Body (Benannte Stelle NoBo), Designated Body (Benannte Beauftragte Stelle, DeBo) and the Safety Assessment Body (Sicherheitsbewertungsstelle AsBo).

DB Systemtechnik takes on all three roles mentioned and is thus an important partner within the vehicle approval business on behalf of the rail industry and the operators.

TWINDEXX Vario by Bombardier



Project description:

- Manufacturing of instrumented wheelsets
- EBA approval for test runs
- Aerodynamic position statement for test runs
- EMV track installed switching device (2013)
- Trials and expert statements in the area of running technology
- Examinations to measure the quantity of fresh air
- Examinations in the climate chamber
- Examinations TSI Noise and PRM



But what are the root causes of the well-known delays in the approval processes for new vehicles in Germany, and which levers may we use in order to simplify and to accelerate the approval process? This approval process was substantially redefined by a cross-sectorial group of experts, and this group also made sure that the new process corresponds to European requirements. The so-called Round Table approved the end result. The new process delegates important tasks of the trade-specific inspection to new organisations yet to be created (DeBo, NoBo, AsBo) and their roles and responsibilities within the approval process have been defined. This way of doing greatly increases the expert capacity required for the examination of documents. A stable framework of rules and regulations to be used for the approval procedure increases planning security. Another lever for successful approval procedures consists in having fewer interfaces during the conduct of inspections. Where inspection services are contracted out to a multitude of suppliers and service providers, this by itself increases the effort necessary to co-ordinate all these activities.

One source of such increased effort is the fact that some tests are redundant, that is, happen twice or more, with all the associated expense of building up and taking down measuring equipment. Some tests also have to be conducted in different countries.

Photo credits: DB Systemtechnik



But what exactly needs to be done to improve the approval process?

DB Systemtechnik offers here a holistic concept for the best possible approval processes as concerns both financial and time aspects, involving several or all associated factories, and a concentrated coordination of all activities in combination with a one-stop metrological and operational organisation. In addition, we build our own sites and undertake co-operation ventures with local testing companies or rail companies in other countries within Europe, to enable a transnational planning and conducting of trials.

For commissioning a new vehicle, or to increase the scope of action of an existing vehicle, DB Systemtechnik takes over the management of the approval procedure and carries out the approval both domestic and abroad for our clients, and we associate the operators at the earliest possible stage of development. We thus offer an early consultation about the different requirements for inspection and approval, and this reduces the effort substantially and greatly speeds up the approval process especially in European procedures.

DB Container Carrier Sgkms 698.1



Running test: Removal torque test, on-line running test, evidence that smaller wheels are safe; manufacturing and commissioning of two instrumented wheelsets; brake technical test

What is it that constitutes a well-functioning approval management?

- Determination of the desired country-specific licenses
- Identifying the European (TSI), national (NNTR) and customer-specific requirements
- Planning and optimisation of the approval procedures
- Agreement as concerns approval strategy, with the national safety authorities
- Selection of evaluation bodies (NoBo, DeBo) and the testing organisations
- Planning of the trials including preparation and follow-up time of the approvals procedure
- Rail network access
- Organisation, execution and documentation of trials, creation of evidence
- Evaluation by DeBo and NoBo including the required certificates by AsBo
- Approval management



Approval out of one hand means that risks for the customer are kept as low as possible. To concentrate on one single partner means that there are fewer interfaces and that the methods used are cross-discipline and customer-specific. All this results in an increased overall efficiency. A further advantage is that we know national specificities, a knowledge which accelerates the whole procedure. One central point of contact will take care of all train-related matters such as rail network access, EBA approval, train path, schedules and drivers. Other partners are not needed.

An experience of many years means an increased level of acceptance of DB Systemtechnik with EBA and other national safety authorities in Europe. 18 accredited testing laboratories with several measuring teams attached enable a high level of flexibility.

In addition to the subject matter experts of the scientific-technical expert organisation, over 50 experts recognised by EBA will establish statements and opinions in a timely manner.

DB Systemtechnik is an autonomous railway undertaking and can therefore carry out all test runs itself, independent of others. This completes the interaction of the various different actors within approval management. As such, we co-ordinate the schedule of the conformity assessments with respect to TSI requirements with NoBo, the national requirements with NSA or DeBo, as the case may be; we take care that AsBo produces the necessary safety compliance reports, and we co-ordinate all operational activities under one roof by our project management and the testing body.

This may be in the individual case:

- a measure-technical supervision of assets that have not yet been inspected, establishing declarations of non-objection;
- Control of the execution of test runs with the testing laboratories;
- Application for the technical access to the rail network of DB Netz AG according to directive (Ril) 810.0400 taking also into account the rail network usage conditions;
- carrying out the application procedure for exceptional permits according to the Eisenbahn-Bau- und Betriebsordnung (EBO) (Railway engineering and operation regulation) or the TEIV for test and transfer runs with the Eisenbahn-Bundesamt (EBA) (Federal Railway Authority);
- Scheduling of multiple unit drivers and trial and test managers for the execution of trial runs;
- operational planning and execution, preparation and co-ordinating of trial runs and the application procedure for access into the schedule with DB Netz AG, taking into account associate requirements from EBA decisions and the requisites of DB Netz AG (with a notice period of four weeks for test runs and six weeks for trial runs);
- Taking over general safety-related obligations on behalf of the railway undertaking DB Systemtechnik from Art. 4 Par. 1 of the Allgemeines Eisenbahngesetz (General Railway Law) (AEG).

Photo credits: DB AG/Uwe Mieth

TSI-Certification of new axles for ICE-T



TSI certification of the new ICE-T wheelsets according to TSI-Highspeed as an associate partner of EBC

Another significant advantage is the ability to simultaneously carry out of trials in several disciplines. To carry out all these test runs in parallel means savings in time and cost: for the customer. In a serial procedure, on the other hand, the full scope of trials and inspections needs to be organised anew for every asset separately. In the case of a high-speed multiple unit, this means an expected time requirement of about one year.

Here an example of approval procedures for a high-speed train:

Specialist department	Measurement	Preparation time
Running technology	45 days	15 days
Brakes	50 days	8 days
Pantograph	23 days	8 days
Traction	10 days	9 days
Power bogie / wheelset	25 days	15 days
EMV (Radio, Track switching devices, protection of persons)	10 days	4 days
Acoustics	20 days	3 days
Aerodynamics	10 days	8 days
Air conditioning	5 days	9 days

Photo credits: DB Systemtechnik



DB Systemtechnik offers an all-encompassing procedure to minimise the time requirement. This is possible because we test several trains in parallel and measure a number of assets simultaneously. Obviously, this requires a large capacity as concerns testing tools and expert personnel. For example, DB Systemtechnik during the last year tested as many as eleven trains at the same time in the scope of approval procedures. And this, not just in Germany but in the whole of Europe. There are further advantages associated with building up a European trade-related expert competency within the test and trials business. In the ordinary manner, all tests and trials had to be carried out to the full extent, for every country involved.

DB Systemtechnik has an all-encompassing procedure that transcends this traditional manner of doing. Because our expert competency is Europe-wide, we can decide already in the planning phase which overlapping requirements may be tested only once. This further minimises time and effort for testing and leads to an efficient cross-country approval process.

In the course of this, our offer of services for testing is not limited to certain localities.

Part of this are certain tests and trials that do not depend on the existence of certain specific infrastructure, such as brake, driving technology, acoustics and aerodynamics. As an example, we carried out brake testing for an international high speed for France and the Netherlands just once, in Belgium. Other trials, which are not location specific but do require a special infrastructure, may be carried out on test-tracks or -rings. As such, we are able to optimise pantographs in the testing centre Wildenrath.

3-part machining train by HSM Gleisbaumechnik Brandenburg (GBM)



- Trials running technology
- Trials brake
- Trials electromagnetic compatibility / track-installed switching devices

Loram Grinding device RGI 9/10



- Running technology
- Electromagnetic compatibility / track-installed switching devices
- Load / Strength

Running technology trials on BR LINT 41



Running technology testing: Removal torque testing, running technical track tests, running comfort measuring, evidence that smaller wheels are safe, evaluation of the touching geometry, lateral spring suspension characteristics, brake technical testing in single traction and multiple traction (4 x LINT 41)

Tests and trials that relate to infrastructure specific items such as parasitic current, pantographs / overhead contact lines and control and command technology must be carried out within the respective rail network where the train is to be used. For example, DB Systemtechnik carried out the track shunting ability testing for France in Plouaret. These trials were necessary for the approval of Prima II by Alstom. This task included the requirement for a cross-border approval between Germany and France according to both TSI and national rules and regulations.

In France, before a trials campaign with a new rail vehicle starts, a specific test has to be conducted concerning the track-side train recognition. Here, the track reports electronically whether it is occupied or not. This is the so-called shuntage test. The test track to determine this is situated in Plouaret-Tregor in Brittany.

Further tests such as the overhead line lifting test are currently being carried out as per requirements, by four defined reference points that belong to the infrastructure operator.

A further milestone in the expansion of our France activities occurred in autumn 2013 within the scope of the Prima II project. After successful approval by the French regulatory body EPSF, we conducted for the first time measurement runs in the Champagne province with a non-licensed vehicle in standard operation mode, that is, without closing rails for this purpose. In addition, these runs were in part carried out at speeds of $V_{max} + 10\%$. This is how we save time and money by an optimised approval management.

A transnational planning and control already in the development phase of new vehicles ensures the best possible sequence of events within the least possible time and avoids problems in the further course of the project.

Alstom Prima EL II in France



- We obtained permission to carry out test runs on the French rail network at speeds of $V_{max} + 10\%$
- Execution of Pantograph testing at 25kV AC in Champagne and 1.5 kV DC in the Tours area
- Carrying out of parasitic current tests at 25kV AC in Champagne and 1.5kV DC in the Alsace province
- Carrying out track-side switching equipment tests at 1.5kV DC in the PCW

Photo credits: Alstom, DB Systemtechnik



Vehicles:

Construction, Operations & Maintenance

Vehicles today and tomorrow

In Germany, more than 400 different railway undertakings contribute to an attractive rail-bound traffic. Deutsche Bahn alone, every day uses more than 25,000 trains of the most diverse types of construction. Reliability and economy of the means of production used as well as the mastery of the Railway system are a requisite for a sustainably successful rail traffic within Europe. What kind of contribution can technology make? We shall show here a selection of technical topics to highlight today's challenges of railway technology.



The overall system

Railway technology means a close interaction of infrastructure and rolling stock. This concerns not just the energy supply and the command and control technology. It is especially the operation-related wear and tear that influences design and maintenance of infrastructure components and, hence, the operational cost.

One of today's examples for this is the topic torsional vibrations in powered vehicles, which of late has been making headlines especially in licensing procedures within Germany. These torsional vibrations appear most often in acceleration from standstill and then again in the characteristic frequency of the axle, and their cause is related to the intense usage of unfavourable traction conditions between wheel and track. This is a significant phenomenon not just for locomotives but also in general for all powered vehicles with modern drive technology. Torsional vibration is not limited to vehicle technology, however. High dynamic strain in the contact surfaces of wheel and track also contributes to the wearing out of the rail surface, such as in the so-called Head Checks.

Today's solution as concerns the problematic of rail surface wear consists in preventive rail maintenance, especially by grinding and machining, but also in the use of specially developed rail material and in the special shaping of the rail head in the most sensitive zones of the cross section. For the future, then, to avoid torsional vibrations altogether, something that may be achieved by an adequate design of the drive control, will make a significant contribution to an economic usage of infrastructure.

Software

Modern vehicle software is another great challenge for the economic usage of vehicles during the whole lifecycle. In modern powered units, it is the software which determines the fundamental vehicle functions.





Photo credits: DB Systemtechnik

The degree of complexity of software has been for a long time already much higher than that of the mechanical construction, and yet many operators have not found an adequate response yet to the question of proper software care and maintenance throughout the life of the vehicle. In this, the operator mostly has to rely on the manufacturer, especially as concerns safety relevant software. Where subsequent changes are made, a financial risk looms, a risk which is compounded by possible availability problems in case that the required specialists are not immediately at hand. There is, then, an understandable desire for more flexibility and more transparency in cost, and this requires that the so far existing dependency on the software manufacturer be severed.

This means that key requirements have to be implemented already in the development phase, in order to generate a healthy amount of competition, as has happened already in the area of mechanical construction. Part of this is a traceable documentation of the functioning and the architecture of software, to be handed over to the operator, so that other persons besides the original software developer will be enabled to do changes in the software and to remedy faults. It is necessary, in this context, to clearly segregate safety relevant software from the non-safety relevant one. Doing this will support a speedy clearing of the licensing procedure in case of software changes as well. In addition, open interfaces on the hardware side are necessary in order to permit one or more technology changes during the useful service life of the asset.

Maintenance

One of the key requisites for an ongoing intense usage of assets without compromising on security is to possess highly developed maintenance programs. Most often, the conventional maintenance systems that are based on time or mileage have reached the end of their development and expansion possibilities. The next step in development, then, is the transition to a future-oriented maintenance. This requires that vehicles are capable of being diagnosed, but equally, to know in what way the condition of the relevant components and functions will develop. For the conceptualisation of a maintenance program it is decisive, therefore, to establish reliable prognostics as to when impairment in functioning will likely occur and at what time a maintenance measure will become necessary. DB Systemtechnik is currently working intensely on this complex issue together with partners, in order to establish new concepts of maintenance.

The crucial know-how here is not the diagnostic and the data-transfer-technology. What matters most is the knowledge of vehicle properties, and hence, to be able to make a prognostic about the functional condition and the required maintenance measures that follow. At this time, a variety of concepts with different ranges and types of vehicles are in the trial phase, and these extend also to infrastructure components. The experiences so gathered will then be the base for the ongoing further development of the maintenance programs.





Photo credits: DB Systemtechnik, DB AG/Volker Emersleben

“In lightweight construction proceed with a lot of caution.”

Refurbishment

Vehicles change during their long service life. It could be that certain components perform less than satisfactorily, that additional functionalities need to be integrated, that some spare parts stop to be available, such as, components of the power electronics, that environmental requirements become more stringent in matters such as emission of noxious substances or noise. It will also occur, and this is the rule not the exception, that interior design and passenger information systems are being upgraded to respond to customer requirements. Therefore refurbishment is a key component of the lifecycle of a rail vehicle.

Even at the stage of a new concept, a developer has to already take into account the requirements for a later upgrade in the design of the vehicle. Openly accessible and standardised interfaces and good vehicle documentation are a requisite for being able to change, after 20 years or more of continuous use, the way of operation, the type construction, or to proceed to modernising the vehicle, all this at reasonable cost.

Lightweight construction

Lightweight construction is and remains a core challenge for a developer of rail vehicles. Lightweight construction saves energy - the amount of energy that it saves should not be overestimated either - and lightweight construction lowers the dynamic strain on both the track and the vehicle itself. There are some components, however, that require special caution and where lightweight construction can only be implemented with the utmost care. Axles, wheels and undercarriage frames are some such components, for whose solicitation and consequential wear over a long

usage period it is difficult to make accurate prognostics. What matters here is a sufficient dimensioning of such parts taking into account additional reserves, even if the components become slightly heavier as a consequence. Lightweight construction was an item very much en vogue in developments dating from the 1990's decade. New methods of calculation and high tensile steels which came from other technical applications suggested new possibilities for a reduction of unsprung masses.

As a result, designs entered operational service which used the reserves inherent in both the regulatory framework and the materials themselves to their very limits. In the final analysis, this extreme usage of design inherent reserves has not proven satisfactory. Massive operational restrictions after component damage and very short intervals between NDT inspections, while they enabled ongoing safe use, are not in the long term an economically feasible option.

Expensive exchange programs were the consequence of this. If on the other hand only a few hundred kg of total savings in weight have been realised, it becomes clear that the utmost care must be exercised as concerns lightweight construction with such components. The more successful path to savings in weight, then, is a functional design, e.g. with a clear flow of force throughout, lightweight design by principle, such as supporting the bogies on the inside, more compact brake units and, sometimes, simply to delete components that are not functionally necessary, such as a damper here and there. This requires extensive know-how and elaborate pre-testing, but it does pay off in the long run.

Photo credits: DB Systemtechnik, DB AG/Michael Neuhaus



“Key technology is the storage technology”

Environmental requirements

Rail-bound traffic is seen today as the most environmentally friendly means of locomotion. This bonus that we have achieved must be continuously developed and actual successes realised must be adequately communicated. When today the word electro-mobility is mentioned, this in most cases refers to electric cars. However, there are only very few of them as yet. In rail-bound traffic, however, electro-mobility has been an everyday reality for the last 100 years. This must not induce the sector to neglect the ongoing development and implementation of new energy - and resource saving technology.

Even though right now in the area of the Deutsche Bahn about 92% in total of the transport effort are being made with electric traction, some sections of the network are still not electrified. It is a challenge, therefore, to introduce electric traction also for these parts of the rail network.

The advantages are obvious

- Energy savings by recuperation of energy from braking
- Reduction of noxious substances emission and noise as well as
- to avoid having to change the traction vehicle as the train transitions to a non-electrified section of track.

All this combines aspects of environment protection with cost saving ones. The key technology here is storage. In some years from now, new battery technology will be available that will allow to run with electric power even in the non-electrified sections of the rail network, and this, with ranges that are acceptable from an operational point of view. Since in the German rail network, the vehicles alternatingly travel on electrified and non-electrified sections, it is quite possible to charge the energy storage means while running.

To achieve these ends, Deutsche Bahn currently works on a variety of projects in which existing diesel-powered rail vehicles are being modified to receive rail technology. Hybrid vehicles make use of the storage technology that is available today and allow even now to benefit from significant advantages of electric traction.

These few select examples may suffice to show that solutions that are sustainable in the long term require considerable competence and attention to detail, but also and especially, an understanding of the interaction of the various elements of the railway system, as well as experience from both operational use and maintenance. This is the standard which DB Systemtechnik employees aim to achieve in their work, every single day. For the success of their customers and as a contribution to the long-term success and sustainability of railway as such.



Sales and Production

How our distribution is structured **DB Systemtechnik**

Within the new department "Business development and projects", four business segments are currently active. These are closely connected to the product, and their function is to market and sell all services offered by DB Systemtechnik worldwide.

In this they are supported by the Paris office, which carries out sales and distribution in France and southern Europe and is responsible for all projects conducted in France.

For all tasks in Great Britain, we have our wholly owned subsidiary ESG - Number 2 in the British market - a most competent partner with many years of experience in the British railway sector.

In summary, DB Systemtechnik offers especially the following bespoke services for vehicles, their components, infrastructure and interfaces:

- transnational approval management,
- services for refurbishment,
- expert subject matter knowledge in fleet management,
- Tests and expert opinions because of a further increase in the significance of standards and regulatory framework.

The products of **DB Systemtechnik**

Technical **Engineering**

Technical engineering expertise

Technical fleet management
Operations equipment maintenance
Procurement support
Studies and expertise
Calculation and simulation
Accident analyses
IT-Systems
Representation on national and international committees
Qualification of suppliers
Technical operating rules and regulations

Maintenance and **Construction**

Maintenance technology

Planning for vehicle maintenance in-
frastructure and workshop equipment
Manufacturing support
Diagnostic systems (in the vehicle
and stationary)
IT-systems
Non-destructive testing systems
on vehicle and track components
Design

Construction

Construction support for new vehicles
Class modification and reconstruction
Refurbishment for rolling stock
Damage and accident damage repairs



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Approval/ Tests

Rolling Stock

Approval management
Running tests and trials
Safety assessment
Risk assessment
Expert´s report
TSI-Certification Rolling Stock

Infrastructure

Condition monitoring infrastructure
Part release infrastructure
Tests and trials on the track
Expert´s report
TSI-Certification infrastructure

Components

Certification of components/materials/
working materials
Laboratory tests and trials
Expert opinions
Calibration of measuring and
test resources
Weak point analysis
Damage and accident investigation

Measurement and diagnostic systems

Measurement and diagnostic systems

Pantograph/catenary
Checkpoints
Instrumented wheelsets
Rail-type measuring and
testing methods
Inspection systems for rail
and switches



670 employees in **five specialist departments**

Matters of railway technology are becoming ever more complex and more international.

Production offers for this a concentrated know-how combined of licensing, operational and maintenance matters, all this to achieve operationally useful solutions for the benefit of our customers.

Approx. 670 employees in five technical departments form the expert backbone of DB Systemtechnik. With their competency in more than 40 different thematic fields, these experts deal with over 70 large projects and currently have more than 1000 orders on hand at home and abroad.

The know-how of DB Systemtechnik goes from systemic knowledge on vehicle level up to detailed knowledge about the modules and components in the railway sector. Also in infrastructure related topics and in questions of cross-section and interface, the experts have an abundant treasure of trade-specific know-how.

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DB Systemtechnik's know-how on rolling stock, infrastructure and interfaces

Rolling Stock

General vehicle

- ICE
- IC
- Locomotive
- EMU, DMU
- Freight wagon
- Passenger coach

Moduls, Components, Spare Part

- Battery technology
- Bogies
- Brake technology
- Buffing and draw gear
- Coating systems and corrosion protection
- Coupler
- Data bus systems (train bus) for passenger traffic
- Energy supply
- Fatigue strength
- Fire protection
- Glue assembly
- Heating, ventilation and air-conditioning
- Lubricants, oils
- Materials engineering
- On-board electrical systems
- Pantograph
- Passenger information systems
- Running technology
- Tilting technology
- Traction technology
- Vehicle software
- Welding technology
- Wheelsets

Interfaces

- Acoustics and vibrations
- Aerodynamics
- Electromagnetic compatibility
- Electromagnetic fields (EMF)
- Interaction pantograph/catenary
- Safety
- Telecommunication
- Transmission systems
- Vehicle-track interaction

Infrastructure

- Battery technology
- Lubricants, oils
- Maintenance shops
- Maintenance technology
- Materials science
- Passenger information systems
- Systems engineering



References

2013/2014



Ice impact tests:

Testing of resistance to winter conditions in laboratory

In the course of track inspections, DB Netz found an increasing number of damages on components in the track area. An interdisciplinary working group comprehensively examined the issue and came to the conclusion that the damages are due to ice being projected from vehicles.

In harsh winters with lots of snow, this phenomenon keeps occurring and sometimes causes significant damage to the equipment in and around the tracks. As a result, DB Netz has limited the speed on high speed tracks to 200 or even only 160 km/h. This has caused significant operational restrictions whose effects are being felt throughout the whole rail network.

The running test department of DB Systemtechnik has been asked to examine a variety of components for their usability under winter conditions. The department determined the requirements to be applied and defined an evidence procedure in order to assess the stress criteria. For the examination itself,

an ice-projecting cannon of the Deutsche Zentrum für Luft und Raumfahrt (German Research Centre for Air travel and Aerospace) DLR in Stuttgart was used, and so the suitability of components determined. These tests also help improve reliability of the components.

In order to be able to determine their ability to serve under winter conditions already during product development in a practice oriented manner, these newly developed tests have now been accepted as requirements for licensing and approval in order to run above certain line speeds. We used this procedure also with products that came from hot box detector manufacturers. With support from experts of DB Systemtechnik these companies carried out ice projection tests within the DLR facility.

These ice projection tests make it possible to avoid damages in and on the track already in the scope of development and approval/licensing. This helps reduce operational restrictions and downtime significantly.

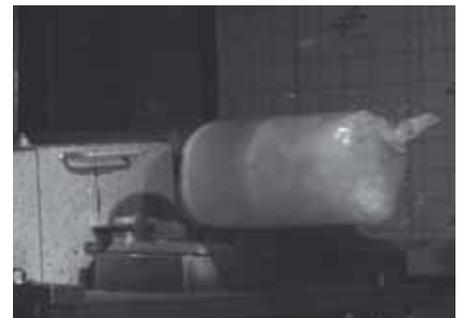


Photo credits: DB AG/Georg Wagner, DB Systemtechnik



Measurement of friction losses in Saudi-Arabia

Saudi-Arabian Railways operate between Dammam and Riad a track for passenger traffic of 450 km length and another one of 550 km for cargo. Because of the ambient climatic conditions, an abnormal wear on wheels and tracks has been consistently found over the past years. Department materials and joining technology of DB Systemtechnik in Kirchmöser received a task from the Saudi Railways Organization (SRO), through DB International, to perform an analysis of causes for the significant loss of material on wheels and rails, and to suggest remedial measures.

To accomplish this, a comprehensive analysis was carried out of operational framework conditions and the way that wheels and rails are maintained. This included profile measuring on wheels and tracks including friction value measuring on different spots along the two railway lines. A tribology expert from DB Systemtechnik München came to support the rail and wheel materials experts of Kirchmöser for the friction value measuring, and similarly, two employees of DB Systemtechnik Minden arrived to sustain the effort of profile measuring.

On site, five DB Systemtechnik employees carried out measuring on the track between Dammam and Hofuf (Dammam Main Station, between Dammam and Hofuf) and also between Hofuf and Riad. This required the installation of the corresponding measuring points.

The wear study for SRO concluded on time at the end of 2013 and, on occasion of a further on-site appointment in January 2014, the wheel and track experts of Kirchmöser presented this study together with colleagues from DB International to the client.

As the recommended measures are being implemented, availability of vehicles and tracks of the client SRO is going to increase.

Photo credits: DB Systemtechnik





Noise-technical examination for the building of **a new converter station in Schwerin**

DB Energy plans the building of a new converter station in Schwerin. In the scope of the building permit procedure, the future noise situation has to be presented and evaluated according to the Bundes-Immissionsschutzgesetz (Federal Immission Law). This concerns on one hand the noise emission of the individual aggregates built into the converter station, and on the other, the existing noise load, that is, the noise that neighbouring industry radiates. DB Systemtechnik has been entrusted with performing a noise-technical examination. Neglecting the existing ambient noise aspect at a first stage, it needed to be determined whether the noise load stays below the noise radiation values of the TA Lärm (Technical requirements decree Noise) by at least 6 dB(A) (which corresponds to 34 dB(A) for a normal residential area).

The experts of the DB Systemtechnik acoustics department used the software Cadna/A to create an acoustic model of the planned facility on base of the key values that the client had presented for the noise-producing machinery. Subsequently, the experts determined the noise radiation caused by the operation of the new converter station in the form of lines of equal noise level (Isophones) and with select exemplary individual points.

Calculations made it apparent at a first stage that using the originally planned concepts of DB Energy for noise radiation, it was not possible to stay below the required limit values. The study also showed, however, that if the noise radiation of the most important sources (transformers) were to be reduced by 2 dB, the limits would be respected. As a result, it became clear that suitably dimensioned noise reduction walls would have to be built and so DB Energy was able to obtain their building permit for the new facility, without the necessity to lower the planned noise radiation level.

In the short term project management, it was possible, in conclusion, to quantify the level of noise emitted, to determine necessary dimensions of the noise control measure, and to give important advice to our customer DB Energy for the further decision processes.

Development and application of new measuring procedures

When characteristics of materials and systems that are subject to solicitation and wear are to be examined, often questions appear that have never been answered before. That is why there is not always a suitable measuring procedure readily at hand. Also in the year 2013 DB Systemtechnik was confronted with such situations.

To measure wear and tear on powered axles, it was necessary to measure the flexion and torsion tensions even in spots where the shaft surface was not easily accessible or not accessible at all. Experts of the department measuring and evalua-

tion technology running technology developed a procedure of strain gauge using oblong holes of the axle shafts, which permitted to apply high accuracy measuring spots within a few hours and without the necessity to take out or disassemble the wheelset. These experts also developed a data logger that can be built into the axle shaft for continuous measuring and which yields genuine operational data in a highly automated manner.

This solution is a lot less expensive than the onerous permanent measuring undertakings of the more traditional kind.

Another example are examinations of the wear characteristics in the wheel-rail contact area, where the contact angle of the wheel needs to be continuously monitored from the vehicle. Engineers from DB Systemtechnik conceived a measuring procedure for the non-contact determination of the wheel contact angle, using a system that operates from within the vehicle.

During a trial run, it was then determined that the values obtained are plausible, and so this procedure was found to be suitable in the future for trial runs with the most diverse tasks.



Photo credits: DB Systemtechnik

The data logger will be housed together with the strain gauge measuring points in the oblong hole of a wheelset. These up to four strain gauge measuring points per wheelset are fixed inside the axle at any suitable depth using an application device and connect to one each of the available CAN input modules at the data logger amplifier.

The data logger takes care of supplying electric energy, conditioning the signal and storing the data as time-based sequential measuring. In such a configuration, the measuring system is able to capture and record data for at least three weeks with a capture rate of up to 2000 values per channel and per second and an accuracy of 15 bit. If in addition the data capture is disabled during periods when the train is at standstill, the mission time of the data logger can be several times longer than the three weeks mentioned, without the need to empty memory in between. The maximum speed up to which the data logger is able to operate is 2400 min^{-1} , which depending on the wheel radius corresponds to a vehicle speed of more than 400 km/h.



Photo credits: DB Systemtechnik

Operational testing **bridge inspection vehicle**

The company MOOG designed and built a new bridge inspection vehicle, called MBS, in order to examine the bridges of the high-speed train track Cologne - Rhein/Main Airport. This vehicle uses the fringes of the bridge to drive and is fitted with a tower that uses the bridge front side surface for support. Inspection itself is carried out with a pivotable cantilever arm below the tower. This cantilever arm connects to the tower and pivots around a joint. It can therefore swivel around to reach the area below the bridge for inspection. On base of an assumed load spectrum, analytical validation of resilience during the passing of trains made it clear that both the vehicle and the rail traffic were facing considerable risk during the operation of the vehicle.

It was then decided to test resilience by testing the contact forces and reactions during the time when train-induced loads act on the vehicle. This was to be measured in real-life scale and during operation. The task was to determine real-life loads at a moment when ICE 3 high-speed trains pass the spot at up to 300 km/h in single and double traction, for comparison purposes. The infrastructure management company DB Netz commissioned DB Systemtechnik's aerody-

namics testing lab to conduct the necessary tests. Because the MBS vehicle cannot be accessed during operation, a concept needed to be developed in order to install measuring instruments in prologue, with the proviso to carry out real-time monitoring and analysis. The undercarriage of the MBS vehicle was at a first stage sent to the colleagues of the Department Instrumented Wheelsets in Minden to apply the strain gauge needed to measure the contact forces.

The equipment was then put back together, the remaining parts of the measuring instrumentation connected to the MBS vehicle and the whole made ready for loading. Final assembly occurred during a night time break on the Lahntal bridge of the high speed track Cologne/ Rhein/Main. During that night, also, further measuring equipment was installed on the bridge in order to record the boundary conditions. On the day that the equipment was to be used for the first time, a long-range laser-based distance sensor was built below the measuring spot in order to enable measuring the movement of the MBS vehicle over a distance of 250 m. From this spot all the measuring equipment was remotely monitored. In order to be able to simultaneously integrate the strain gauge

readings into the measuring data recording, a far-reaching network was erected and built into the measuring network of MBS. Recording was done by a measuring computer in continuous mode, built into the casing of the machine. A directional radio connection allowed to monitor the data packages and to analyse them online. This stand-alone installation was capable of continuous operation and this made possible to record night time train passages without any additional effort in terms of personnel and to evaluate them the next day.

An accurate planning at the preparatory stage, an enlarged set of competencies by associating other departments and measuring equipment and an excellent co-operation during the pre-assembly phase allowed to monitor the MBS vehicle in real time even in its inaccessible position, to analyse the data stream and to document its positional stability.



Re-stamping of pressure vessels in freight wagons of type BA 559

All freight wagons possess pressure vessels as a part of the brake system. These store the necessary energy for braking. This is about 800 car carrier wagons of type BA 559 which thus have two pressure vessels built in according to norm DIN EN 286-3 Type B. Different from other vehicles where vessels of the Type A are mounted, these vehicles here require an increased testing effort due to shorter testing intervals and specially trained testing personnel. In order to save cost, the operator of these vehicles, DB Schenker Rail Germany, intended to change the built-in vessels to others of the type A.

In addition, DB Systemtechnik, Brake technology department, was called upon to examine possible alternatives to a change of the vessels. Engineers of DB Systemtechnik then established a concept on how to keep using the existing pressure vessels without causing addi-

tional expenditure for maintenance. The Paderborn works conducted document inspections and physical exams on site, where two of these pressure vessels were cut open, the shape of the construction and the testing depth of the pressure vessels evaluated.

DB Systemtechnik was able to prove that these pressure vessels had been wrongly labelled and that therefore an expert was able to re-stamp these vessels to type A without changing the pressure vessels. These vessels can henceforth be treated as Type A as far as maintenance is concerned, being substantially similar. In April 2012 the re-stamping of the vessels started in the scope of ordinary periodical maintenance (G 4.0).



Cold start trials with a diesel locomotive

The company Voith Turbo Lokomotivtechnik, in its Kiel works, manufactures diesel-powered shunting and long-distance locomotives of the product family Gravita. During the design phase of this vehicle, trials had to be conducted to determine the starting ability at very deep temperatures, to see if the pre-heating system functioned, and to be able to observe the starting behaviour of the engine under reproducible boundary conditions.

DB Systemtechnik was commissioned to carry out these trials inside their climate chamber in Minden. Two locomotives of type Gravita 10BB, where the client had previously carried out several preparatory measures, were cooled down to a temperature of -25 °C. Once the set temperature was reached, the locomotives were pre-heated and then the diesel traction engine started.

The client and his suppliers observed and recorded the starting behaviour of the engine and its diverse subsystems. It took the two train engines two days, a weekend, to cool down to -25° C. The subsequent trials then took another four days during which the client was able to gain important insights into the behaviour of their vehicles. MEiKE, the climate chamber for rail vehicles that DB Systemtechnik operates, was able to provide the required climatic tests at a low cost. A special advantage in this context was that improvement measures could be implemented instantly on the tested object and the effect of such measures observed in further trials.

These series of trials were instrumental in reducing the risk of vehicle failures and operational downtime.

Damage examination on newly manufactured rails

In the preparation phase prior to welding in the lashed construction rail on the line Radebeul - Dresden, substantial pitting was observed in several spots at the base of the newly built-in rails. These pittings had been at a first stage examined by the Halle Welding technical training and trials centre (SLV) according to principles of materials science.

Expert statement on damage by SLV was presented in October 2013. It was planned to inaugurate the track under construction at the beginning of November, after formal opening of that stretch of track. The expert statement of SLV stated that grinding grooves and deposits of martensite had been found on the rail surface and that these were the cause of the pittings. It was not possible to say for sure whether it was a fault in manufacturing and all the rails of that shipment were affected or this defect concerned only a few rails and was in

fact caused by handling. The timely formal opening of that stretch of track was at risk the DB Netz representative in charge was unable to confirm acceptance of the track because of the existing insecurities. In order to still attempt a release of the track within the delays, DB Systemtechnik was entrusted by DB Projektbau (Project engineering) to form an expert finding as soon as possible. To do this, further selected rails from that construction section were immediately examined by DB Systemtechnik to see their material technological properties. Only one week after the client had requested that intervention, a first expert finding could be issued in which the grinding grooves were named as the cause for the pittings and these grinding grooves were clearly the result of faulty handling of the rails. Further examination showed that a quick and low-cost visual examination was able to identify the faults with certainty.

Photo credits: DB Systemtechnik



Rails affected could be individually replaced as needed, an expensive and lengthy changing of all the rails in the whole section was averted.

Vibration prognosis for S-Bahn Berlin

The intention was to build a second track between the operating locations Strausberg Station and the stopping point Hegermühle, both belonging to Suburban Train S5 of the line Spandau - Strausberg Nord. This was planned in order to enable a more frequent succession of trains on the said line between Berlin and Strausberg Nord.

The intention was to build a new track in parallel to the existing one on the rail support surface in its current state. In the preparatory phase to the establishment of final planning documentation



in order to start the approvals procedure according to Art. 18 of the General Railway Act, it was necessary to issue expert findings about the expected vibration impact, including the secondary airborne sound. The department acoustics and vibration of DB Systemtechnik was called upon by DB Netz to do the requisite examination. The planned building and expansion measures were closely examined with respect to the changed emission effects caused by them. As a first step, the existing emission ranges of S-Bahn Berlin measured in the course of comparable building projects were examined.

Subsequently, the corridor or the affected zone was determined.

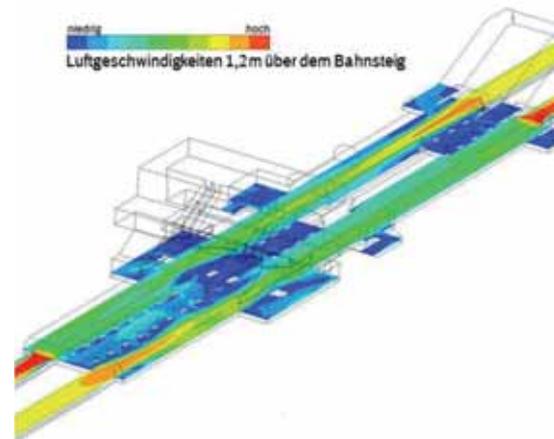
After determination of the future expected vibration level for the residential buildings in question within that corridor, for two basically different situations - with and without the planned construction measures - the calculation results were evaluated according to the limits provided by DIN 4150-2 (Vibrations in Construction). DB Netz AG now receives a vibration technical examination of the track section affected in order to complement planning documentation.

Flow investigations of the air pressure surge in subterranean Suburban train stations

Within tunnel tubes, at the platforms and in the escalator shafts coming from the subterranean stations, substantial pressure variations and airstreams occur because of the so-called piston effect that the trains cause. These pressure surges can lead to customer complaints and can also in the more extreme cases represent a threat to safety at the platform.

Already at an early planning stage of the said subterranean Suburban train stations, DB Systemtechnik was asked to detect problematic spots within the stations and to suggest measures to reduce the airspeeds present by appropriate countermeasures to an uncritical level. Since

there are no reference values enshrined in the regulatory framework for what is and what is not a safe and comfortable level of airspeed at a station, the aerodynamics experts first had to undertake an extensive literature study in order to find even approximate values for the evaluation of the situation in different subterranean stations. The planned tunnel station system was then examined in respect of train-induced pressure changes and airstreams using 1 D simulation devices. Based on this, 3 D simulations with high resolution were made for these Suburban train stopping points. This gives us a detailed picture of the air surge effect zone. Especially the



airstream situation in places near the rails and inside the stopping point as well as within the staircases is meaningful here. After comparison with the recommended limit values, possible construction-side remedies were examined, and these will now be part of the final track planning. In future construction projects, planners will be able to benefit at an early stage from these examination findings and can then take suitable constructive countermeasures.

Repair of a car carrier wagon that has had an accident

When a Diesel locomotive of the type VT 218 collided with a stabled car carrier wagon of type DD 992 of the Sylt Shuttle traffic system, this latter one was severely damaged. Owing to its asymmetric construction, this car carrier wagon can only be used in the traffic to the island of Sylt from Niebüll to Westerland. These vehicles must not be turned around, nor can they form part of other regular trains. There were only two options here, to repair the car carrier wagon or to scrap it and build a new one, since this vehicle cannot be replaced by another. After thorough examination it was decided to repair the wagon.

A suitable component of approx 3 tons weight was designed and built by the Paderborn shop of DB Maintenance. DB Systemtechnik - welding technique rail vehicles - then took over the welding construction testing Part 1 (Design testing).

All preparatory works not relevant to the welding itself, such as the cutting off of the destroyed headstock, were done by the mobile repair intervention department of the Paderborn works right on site in Niebüll. The Niebüll workshop only has a certificate for welding up to level CL 2.

The welding work that was to be done here came under the higher certification step CL 1. In order to enable the Niebüll works to nevertheless go ahead with the job, experts from DB Systemtechnik came to the rescue, coached the crew on site intensely and documented the whole process by doing a welding construction testing Part 2. All this resulted in being able to use the car carrier DD 992 once more after a rebuilding time of approx. six months. This averted the need for purchasing a new vehicle, which would have cost a lot more.





Harmonising the on-board amplifier for Regio multiple units

The existing on-board amplifiers of type EV5 built into the series VT 64x vehicles (except 648.3) have during the last six years taken a development in diverse directions because of regional modification projects. At this point in time they do not correspond to the current and required state of technology. Also, a multitude of different firmware is in use and these versions are incompatible with each other.

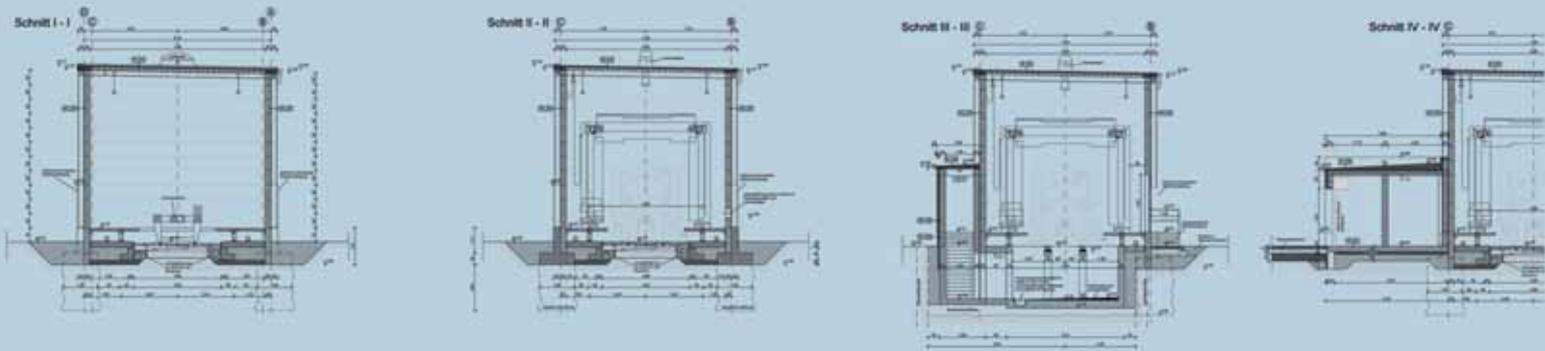
These EV5 type amplifiers needed to be fitted with a uniform priority-based control and to be adapted to the various different sources of voice communication within the vehicle (driver, train attendants and passengers). Part of this harmonising operation of the various different versions of firmware was to create additional audio in connections in order to enable the connection of an external announce-

ment device and direct announcements by the transport management through GSM-R-train radio within the passenger compartment. Additional channels are to be provided for an outside sound system, to enable a flexible reaction to possible future tenders by client bodies.

DB Systemtechnik was commissioned by DB Regio to make an initial examination of the existing amplifiers within the in-house IT laboratory and on the affected vehicles. When this was finished, the employees of the testing laboratory made a technical requirements list for the new on-board amplifier and accompanied technical purchasing of DB AG in the scope of the purchasing operation for the new on-board amplifier. The experts, furthermore, examined the corresponding requirements specification.



In addition, the new amplifiers, once they arrive, shall be submitted to intense testing and acceptance by DB Systemtechnik in their own IT laboratory as well as within the vehicle itself. The harmonisation operation will enable to reach the required operational state. The now available additional channels for information will contribute to an even better quality of customer information.



A new washing and de-icing facility for S-Bahn Berlin

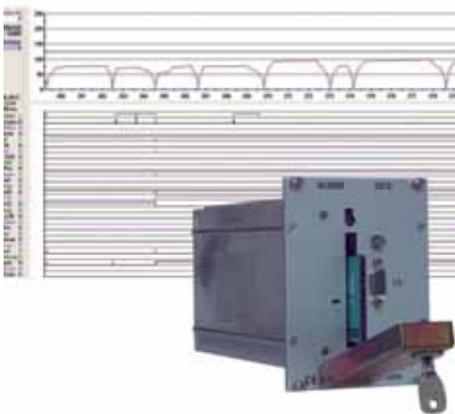
The S-Bahn Berlin train operation in and around Berlin was substantially divided into three different traffic networks. One result of this is the reactivation of the Friedrichsfelde workshop as a Regional workshop for network 1. For the necessary processes of maintaining and making available the trains, the technical infrastructure is missing to carry out vehicle washing and de-icing. DB Systemtechnik (Facility planning) was called upon to prepare the new building of a washing and de-icing facility. The experts from Brandenburg-Kirchmöser take over the planning for the design, building permit procedure and execution of the facility, as well as the bill of quantities.

The technical framework conditions on site are not easy, owing to the position of the workshop on one of the islands surrounding Berlin and the resulting single-track connection. Also, the washing rail needs to be used as a sorting line as well.

In the scope of re-activation of the site a new rail No 36 was built. On a length of 136 m a combined vehicle outside cleaning and de-icing facility is to be built on top of this rail. The facility is large enough to receive and treat two coupled half-trains at the same time. The resulting wastewater is going to be treated physically and biologically and the

cleaned water shall be used again in a circuit. In addition in the centre of the hall there will be a pit for coarse pre-cleaning. Federal Railway Authority approved the plan in June 2013 and the project is currently in the execution phase. Commissioning and hand-over to the operator are planned for August 2015. This new facility will on one hand enable a better cleanliness of the vehicles and avoid the corresponding contractual penalties, on the other, availability of vehicles in winter will increase. This new facility respects the most current standards of environment protection and has a high rate of water recycling.

Evaluation of DSK data



Some vehicles of the multiple unit series of DB Regio showed faults during operation and, in part, a higher than normal wear rate at the magnetic track brake. DB Systemtechnik was asked in consequence to perform a static evaluation of the data in DSK (data storage cartridge for the intermittent train-running control) over a longer period of time.

Within a period of three months, all hard braking operations were determined and the related level of deceleration displayed. The hard braking operations were examined separately per each vehicle and per day, as well as per region. In the subsequent statistical evaluation of DSK Data for all vehicles of this series, the data were also compared with the

hard braking rate of other types of vehicles, in order to explain a possible higher wear rate or to exclude causes that might affect the whole fleet.

A large quantity of real-life operational data was obtained and this allowed to suggest to the operator both operational and technical measures in order to remedy the problem. When all these suggested measures are implemented, this will lead to a reduction of the frequency of hard braking and will lower the wear rate, enabling cost savings in the final analysis. One of the multiple units was thus fitted with low-wear pole shoes as a trials platform and is currently undergoing testing for one year.



Certification of a system of fixed barriers

For rail vehicles, there exists a close-knit licensing procedure that requires interaction of manufacturer, testing organisations and authorities. For the use of rail suitable infrastructure components and the respect of company-internal requirements, on the other hand, DB Netz is responsible.

Fixed barriers are a basic component of the technical safety measures that are implemented for workers in the rail area. DB Netz has improved the process of railway technical approval which requires a type certification of those barriers as concerns the respect of the constructive requirements. With their considerable know-how, DB Systemtechnik is able to evaluate such fixed barriers in a cross-discipline manner ranging from aerodynamics over solidity and impact up to control and command technology. This is confirmed by a report and certificate on base of DIN EN ISO 9001.

In the course of this, manufacturer documentation that relates to requirements for system efficiency, build type, assembly, documentation and maintenance is also evaluated.

Our accredited test laboratories are able to produce the required testing protocols and reports. The first certification by DB Systemtechnik was made on behalf of the manufacturer RSS and its highly innovatory fixed barrier "Spoormagnet". Part of this was to make sure that the rapid-mounting magnetic device that holds the barrier to the base of the rail shall not influence the train command and control system.

In such exercises, the following system is always used:

- In a first stage, manufacturer makes available all documentation for the system that shall be evaluated.
- In a preliminary assessment, these are read and evaluated.
- Subsequently, the individual points of requirement are audited and compared to the available documents and reports.
- After this and on base of the audit, a report is made wherein the results, restrictions and apparent faults, if any, are mentioned.
- Provided all requirements have been met, a certificate is issued. This certificate is valid only in connection with the report.

When the whole evaluation process has concluded, the manufacturer RSS now has the possibility, with this certificate, to obtain the railway technical approval in a representative, transparent and cost-effective manner.

The type certification of fixed barriers supports DB Netz in that components are evaluated by DB Systemtechnik, whose experts come from a wide variety of disciplines, in an all-encompassing manner including items such as aerodynamics, solidity, impact on the train guiding system etc. This allows for leaner processes within DB Netz and also for the purchasing of DB AG. It therefore makes sense to use this type certification procedure also for other components.

Modification VT 612 Thüringen (FIS)



The existing passenger information systems of the diesel-powered multiple units BR 612 by DB Regio shall be modified to comply with today's operators requirements as well as to correspond to the current state of technology. In contrast to the now existing system, it is required to implement a solution that is without feedback from the train command and control system. The on-board amplifiers, too, do not correspond to the required state of technology.

Enough reason to task DB Systemtechnik to make a concept and a requirements specification for the new passenger information system. On base of experiences made by our IT testing laboratory with passenger information systems (FIS) of the most diverse types, and in the scope of preliminary trials on existing systems both in the laboratory and in vehicles, a concept was found where the train command and control technology can remain unchanged, unnecessary components will be removed and the new system integrated into the multiple units without any adverse effects. DB AG decided to

source this system by way of an unrestricted tender, after the standards and technical detail had been defined in the requirements specification. The functions of the new passenger information system in this case reflect the requirements of both the contracting authority and the operator.

Testing of components and the qualification of the manufacturer were done in accordance with the clear requirements of the DB Systemtechnik testing laboratory, so that the system has now reached the required degree of maturity and can be used in actual passenger transportation. In addition this system allows an asynchronous balanced mode with only a minor loss in quality and so avoids operational restrictions during the one-year conversion period scheduled to run until June 2015, and in case that vehicles are exchanged with neighbouring regions.

Should it be desired, the new system allows an easy and inexpensive change of the passenger information system software or the data supply.

Renewal of the mobile worklift platform fleet



DB shop Hamburg-Eidelstedt are the first long-distance rail traffic workshop which has been dedicated to the maintenance of high-speed trains. To completely separate the working level from the transport and logistics level, all eight tracks have been elevated to the height of 2.4 m. Underfloor works as well as activities in the area of the skirt flaps are carried out using electrically powered worklift platforms. These are custom-made, battery-powered and can be recharged in specific recharging bays. The works have a fleet of 70 of these vehicles on hand. After 20 years of operational use, this fleet of mobile worklift platforms needs to be renewed. In the course of this, a more efficient battery charging and operation technology shall also be introduced. The contract comprises a volume of 9 Million EUR for the purchase of new technology.

On behalf of DB Fernverkehr (DB Long-distance traffic), DB Systemtechnik established the planning documentation

for this project as well as the functional service descriptions for the battery charging technology and the worklift platforms, supports the offeror evaluation, testing and acceptance of the prototypes, their commissioning and any warranty issues.

State-of-the-art, microprocessor controlled chargers enable a rapid charging that is gentle on the batteries, within 15 min. These vehicles have the most modern energy - saving technology in order to give the longest possible intervals between charging. In the course of the project it is also examined whether solar power can be used for the charging of the batteries. This procurement process will allow for a reduction in cost of usage and downtime of the worklift platform fleet, in a sustainable manner.

The planning documents were made during 2012-2013, the tender is carried out in 2014. Delivery, installation and commissioning of the new fleet of worklift platforms is foreseen for 2015-2016.



Overhead line acceptance tests with the ICE-S in Switzerland

The line Basel – Konstanz, operated by DB Netz, has been expanded on a certain section to two tracks and newly electrified. Within the scope of this expansion, DB Projektbau (Project engineering) asked DB Systemtechnik to carry out the overhead line acceptance tests.

These trials must be carried out according to the Swiss regulatory framework, using a narrow Swiss pantograph head and speeds of $V_{\max} + 10\%$. Therefore, a close co-operation between the Swiss Federal Traffic Authority (BAV), the German Federal Railway Office (EBA), traffic planning (DB Netz Karlsruhe) and the project management of DB Projektbau was necessary.

At the same time, it was needful to come to an agreement between the two national supervisory bodies, as this track runs for the most part on Swiss territory, with the exception of the Erzingen terminal, yet is operated according to DB regulatory framework and it was necessary to exceed the maximum authorised speed on that line. Then also, the application for runs with "constant green light" (Ril 408.1431), which in case of runs over German territory is to be made to the German Federal Authority EBA in this case needed to be submitted to the Swiss body BAV for approval. The good relationship between DB Netz and the Swiss colleagues was a great help in this case for an efficient communication and the respect of deadlines.

The tests themselves were carried out using an ICE-S that belongs to DB Systemtechnik, and which immediately before had been fitted with a Swiss pantograph as fixed equipment. A high speed trial was conducted during five days in the course of which the set maximum speed of ($V_{\max} + 10\%$) that is, 165 km/h, was reached. Besides the measuring team for overhead lines, the testing group drive technology was also on-board. That team monitored the behaviour of the vehicle during the time when the maximum permitted speed was exceeded.



Modification of the **E-Contact couplings of BR 485**

One of the suppliers, who had hitherto manufactured special 5/2-way valves for the contact couplings on multiple units of the type BR 485, fitted with automatic couplings of the type Bautzen by DB Regio AG (Suburban system Berlin), went out of business, so these couplings could no longer be procured. A preliminary interim solution was implemented, but this was not safe. Under certain circumstances it could bring about a direct hazard for personnel and material, leading even to a dangerous contact with electric current for people in proximity to the contact couplings.

DB Systemtechnik was tasked to find the causes for such hazards and to elaborate remedial measures. A first analysis led to a variety of solutions being proposed to the client. Subsequently,

experts from the departments of brake systems, simulation and couplings together with a reputable coupling manufacturer established a solution that enables completely safe use of the system such as in the original version, while keeping the version specific characteristics.

In May 2013, this newly developed type of coupling by DB Regio was approved for introduction in the scope of field maintenance. Since the vehicle documentation needs to be adapted first, the practical implementation of the new system is scheduled to start in the course of 2014. This enables a solution for the E-contact clutch which is safe to operate, reducing in the process the hazard potential as well as the availability of vehicles.

BTE – from Private Coach Owner **to their own maintenance entity**

Bahntouristikexpress GmbH, the travel and coach entity, asked DB Systemtechnik to adapt the maintenance intervals of their 26 coaches of diverse types, including restaurant cars, sleeper cars and passenger coaches. The current scheme is that these cars or coaches run by means of a siding contract as private coaches with DB Fernverkehr (DB Long distance traffic). The regulatory framework changed, and this resulted in a potential and unnecessary shortening of maintenance intervals by 650,000 km. DB Systemtechnik was therefore entrusted with a feasibility study, evidential procedure and legally sound documentation to the effect that the now current revision interval of 1.2 million km should be maintained.

In 2013 DB Systemtechnik established a safety technical way of proceeding and conducted the proof of similarity in construction for the safety relevant vehicle components. The results of this

exercise are now part of the own BTE set of rules. 2014 verification was done according to DIN27201-1 “Proceedings to establish and to modify maintenance programming” and the coming into force of the now own body of rules of BTE. This way of proceeding was chosen in order to pre-empt certification of BTE as its own maintenance entity (ECM), that is, a body competent to carry out its own maintenance according to EU directive 2008/110/EC and AEG Art. 4a, for which an own maintenance program needs to be available. The fact that an own body of rules was established and the relevant proofs administered permitted to avoid

a doubling of the mileage-based revision costs for the passenger coaches in question. At the same time, the coming into force of their own maintenance programs was a key component to the exercise of an own responsibility as ECM managers. ECM Management supervises and co-ordinates the executing functions, ensures the agreement of the vehicles with rail traffic system requirements and generates a process-oriented maintenance management system. This is how the intended migration and completion facilitated the processes to administer the required proofs of certification maturity ECM until the year 2015.



Photo credits: DB Systemtechnik



Optimization and pantograph tests in Kazakhstan



Company Alstom, France, supplies KZ8A double locomotives to be used for freight traffic in Kazakhstan. In this context, it was desired to optimise the pantographs of these locomotives and to make the necessary measuring for the licensing.

DB Systemtechnik was asked to support Alstom in Kazakhstan in this venture. In a first step, the experts of the inspection department overhead lines/pantographs generated a list of concrete requirements and a schedule. Since the transport of the measuring equipment, originally foreseen to be done by Alstom, was not possible from France owing to certain formalities, this transport, too, needed to be handled by DB Systemtechnik and their partner DB Schenker at very short notice.

In June 2013, with the support of Kazakhstan Railway, the proper trials started with a maximum speed of 140 km/h. In this, the contact force measuring system and the arc detection system were both simultaneously used. Both systems had been developed by DB Systemtechnik themselves and have been in use for many years worldwide. Four experts of the measuring group pantograph/overhead line came to Kazakhstan and stayed there for three weeks, including the time required to erect and to take down the measuring equipment.

Even though the simultaneous use of German, English, French and Russian made for certain language difficulties, it became once more apparent that a technical co-ordination work does not require all that many words to be made and that technical agreement can be achieved via drawings. The technology of railway and their representatives understand each other in any case. As this first task was successfully concluded, a follow-up contract was signed to test the pantographs on the KZ4A locomotives.



New supplier for
air spring systems
in the Görlitz VIII-Bogie



For the air spring systems in the Görlitz-VIII- bogies used by the double-decker coaches of DB Regio only one supplier was extant. To reduce the maintenance costs for these vehicles as far as possible, it was necessary to qualify at least one additional manufacturer.

As a result, DB Systemtechnik, bogies department, was entrusted by DB Regio to identify possible new suppliers and to develop together with them new air spring systems. After a number of talks, one company emerged who in due course developed and now manufactures a new system on base of the Deutsche Bahn specifications. The prototype of this was ex-

tensively tested in Minden by the test department running technology, with removal torque and lateral pressure testing taking place on two trials vehicles.

In the further course of events, five trials vehicles in the region Berlin-Brandenburg carried out a field test over one year. When all trials were finished, all documents were examined and evaluated so that the components could be approved for procurement and subsequent use. This is how DB Systemtechnik qualified an alternative supplier, which then resulted in a significant reduction of the item costs.

ESG: The technical competence team in Great Britain

ESG as a fully owned subsidiary of DB Systemtechnik is a highly innovatory service provider in the railway sector in Great Britain. They employ over 80 highly experienced railway engineers who together have a quite multifaceted experience in all areas of railway, in operation and in vehicle technology, especially as concerns locomotives, passenger coaches and electric and diesel multiple units.

During the last five years, this has concerned especially the conduct of many projects for design, development and operational introduction of around 300 new locomotives and 2600 other assorted new vehicles. At the same time, also, the experts in Derby advised and managed around 1000 vehicle conversions.

Photo credit: ESG



Service portfolio of ESG

Engineering & Projects	Consultancy	Technical advisory for all vehicle systems and types / series, malfunction investigation, product improvement, conversion
	Design	Digital modelling 3-D-CAD for design, manufacture, conversion, refurbishment 2-D drawings and cable diagrams as a support to purchasing, manufacturing and installation
	Projects	System knowledge in the introduction of progressive solutions, project management, engineering, design, installation, purchase/sourcing in the case of vehicle conversions and - improvement
Railway Approvals	Approval	Licensing management and certification for all types and series of vehicles. Designated body and notified body for the purpose of national and European rules and regulations
	Auditing	Acknowledged RISAS body for all types Manufacturer- and product-audits. Worldwide service
Re-Franchising		Fleet management strategy made possible by extensive vehicle knowledge Large experience in vehicle conversion programmes



Roll-up sun visors **within the driver's cab**

This sun shade solution was introduced as a complement of existing systems or as a new equipment for vehicles that did not hitherto have such a device. The aim of this is to avoid direct sunlight into the eyes of the driver of a multiple unit, which could result in an inability to recognise signals. Many of the so far existing systems could not be flexibly adjusted by the driver into the desired position. Some other sunshade systems were liable to damage and malfunction.

The new ESG solution enables users to adjust the sunshade using a guider rail system and mechanism and to bring it to the desired position. This new solution is sturdy so that it can withstand years of use without damage. This new solution has been developed to increase reliability and availability around the topic sun protection, but it also assists in questions of obsolescence management.

TSI PRM modification **of class 156**

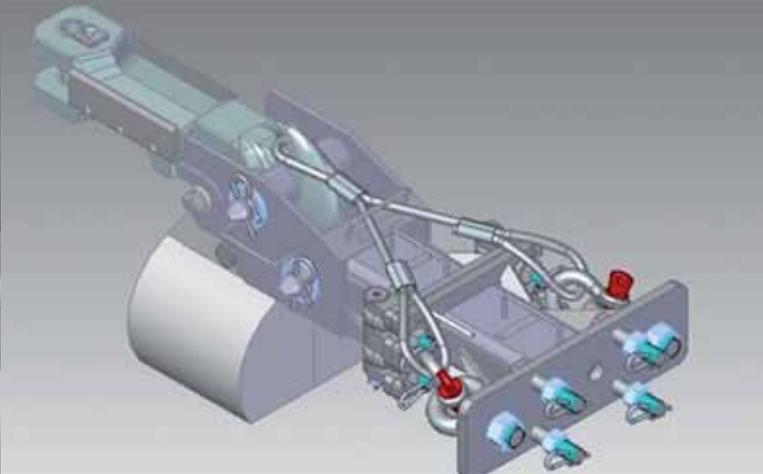
Rail For London Limited contracted the operation of an open jaw connection through London from Maidenhead in the West to Shenfield and Abbey Wood in the East to the operator Crossrail. As a result, Crossrail tendered for a fleet of new modern electric multiple units which will in due course replace the older fleet of Classes 315 and 360 and take on operation on the continuous line. According to plan, this shall happen in stages from May 2017 up until December 2019.

As one of four possible suppliers of vehicles and maintenance, the Japanese vehicle manufacturer Hitachi also participated in this tender. In order to suitably take into account the complex and lengthy procedure of commissioning, including licensing and type testing as well as a commissioning in phases, Hitachi queried ESG for support. In the final result, Hitachi, ESG and the driving technology experts of DB Systemtechnik have made a testing plan that corresponds to the needs of the operator. In this exercise, the experience of national licensing and testing that ESG has was complemented with the specific expert knowledge about type testing and vehicle inspections of DB Systemtechnik, and all this came together to enable an optimised test planning.

Then, from 2015 onwards, in case Hitachi is the winner in the competition for delivery of 55 multiple units of ten wagons each, the following tests shall be executed in close co-operation between Hitachi, ESG and DB Systemtechnik:

- Type testing on the factory premises of Hitachi in Japan
- Vehicle tests on specific trials and sections of lines (especially inside tunnels) of the future Crossrail network.

Photo credits: ESG



New **couplings**

ESG received the task to develop a suitable coupling for the English, Welsh and Scottish Railway (EWSR), so that two locomotives of class 67 could be connected in the scope of strategic rescue services.

After an analysis, in the scope of the design process, drawings were made using AutoCAD where the expected tension was visualised using Mathcad software. The choice of the right material played a most important role in the process. Finally, a high-end aluminium alloy was selected. Even though the coupling had successfully passed all criteria of the first series of trials, it was decided to further reinforce the components by the use of robust extension hoses, and so to improve design stability.

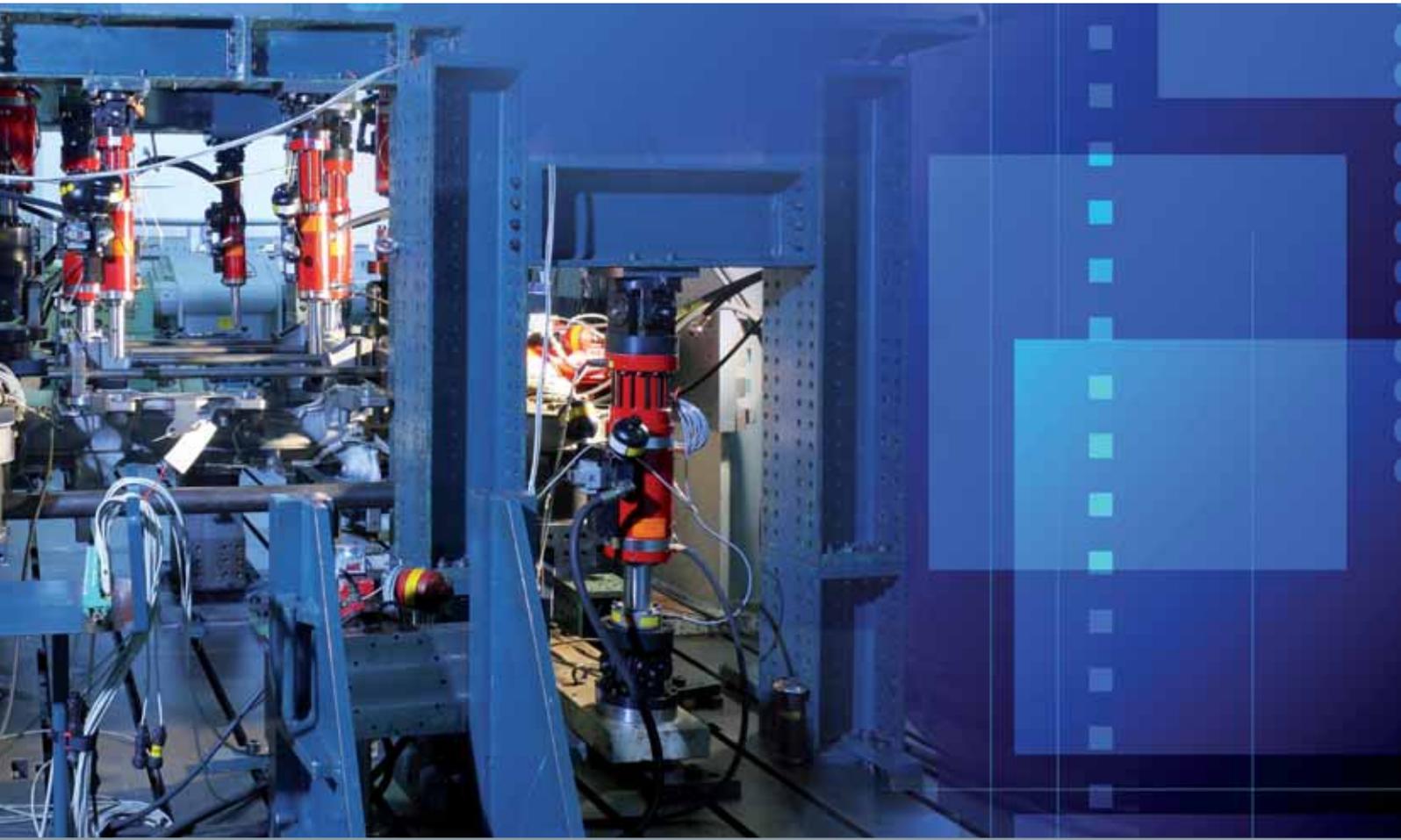
Subsequently, the concluding trials were conducted, the adapters certified and delivered. ESG oversees the manufacture of more than 20 such adapter couplings, identifies and applies all requisite safety markings, so that a complete product can be handed over to the customer. ESG also manufactures an adapter coupling for the South West Trains, which that client needs for the sorting operations of class 455 vehicles. These are carried out in the Bournemouth depot with a class 73 locomotive.

WSPER braking evaluation facility

The ESG WSPER anti-skid test bed is a "hardware-in-the-loop" simulation device which significantly reduces the cost for an anti-skid simulation, reduces time requirements for testing and generates an objective and independent method for testing of the performance of anti-skid systems under less than good traction conditions.

The WSPER anti-skid test bed has been used already by manufacturers and operators alike, including London Underground, Bombardier Transportation, Siemens Transportation, Knorr-Bremse AG, KBRS (UK), Faiveley Transport and KES GmbH, to evaluate the behaviour of brake systems under conditions of low traction values. Add-on systems to improve traction have also been tested on this equipment.

By the use of traction profiles, tested under real-life operating conditions, the WSPER anti-skid test bed has been recognised throughout in Great Britain and abroad alike for its capability to depict the traction conditions that really occur in railway operation. A train simulation and also the simulation of the sanding device function have been validated with results from driving trials with a real train. ESG currently is on the way to being accredited according to EN 17025.



Test rigs & Laboratories



Wheel/rail linear test rig A

The roller rig A can be converted into a linear test rig within a few hours. In this configuration, wear and rolling contact fatigue of rail components can be tested.

Mission: Wear and roll contact fatigue testing on rails, core pieces, pairs of switches, on welded joints, deposit welding and insulated butt joints, interaction between wheel and rail

- Contact force up to 200 kN
- Lateral force up to 20 kN, skew
- Cycles: 1000 cycles under load/h; approx. 1 MLt/d

Brake test rig

Mission: Testing of wheels, brake discs, shoes and pads, simulation of real-life line profiles

Testing conditions:

- 2200 U/Min (350 km/h)
- Press-on forces (65 kN disc /100 kN shoe)
- Water up to 40 l/h



Wheel/rail roller rig A

Roller rig to test complete sets of powered and trailing wheelsets at high speeds

Mission: Wear and rolling contact fatigue testing on wheels; rolling trials with lubrication, brake slipping, squeaky noise in turns, rolling noise and wheel noise absorbers, vibration analysis and tests with diagnostic systems

- Axle load up to 340 kN
- Lateral force 30 kN, skew angle of incidence
- Speeds up to 300 km/h

Anti-skid test rig

Mission: Examination, optimising and testing of anti-skid systems in friction brakes; examination and testing of individual components (rotary encoder, anti-skid valves)

Testing conditions:

- Hardware-in-the-loop (real rotary encoders with driven terminal wheels; anti-skid valves with real pneumatics)
- Top speed up to 500 km/h (depending on wheel radius)
- Wheelset decelerations/accelerations up to 60 m/s²
- Simulation of a vehicle with freely defined parameters
- Simulation of all desired wheel-rail traction profiles according to customer requirement





Wheel/rail linear test rig B

Linear test bed for the cost-effective testing of smaller rail segments and switch components

Mission: To determine wear on switch core pieces, insulated butt joints, welded joints and deposit joints

- Contact force 200 kN, statically adjustable
- Cycles: 5000 Load cycles/h; approx. 5 MLt/d



Wheel/rail heavy duty rig C

Heavy duty test bed to examine wheels and wheelsets with high contact forces and flex moments

Mission: To determine progression of cracks in wheelsets, roller trials on elastic sprung wheel constructions (such as in tramways), wheelset constructions and wheelsets with variable track width, testing of shaft-hub joints

- Vertical forces up to 320 kN
- Lateral forces up to 80 kN
- Speed up to 160 km/h



Pantograph test rig

Mission: Examine the static, quasi-static or dynamic properties of pantographs, calibration, simulated runs on track, measuring in order to make simulation models for pantographs

- Forces up to 550 N
- Frequency range 0-20 Hz

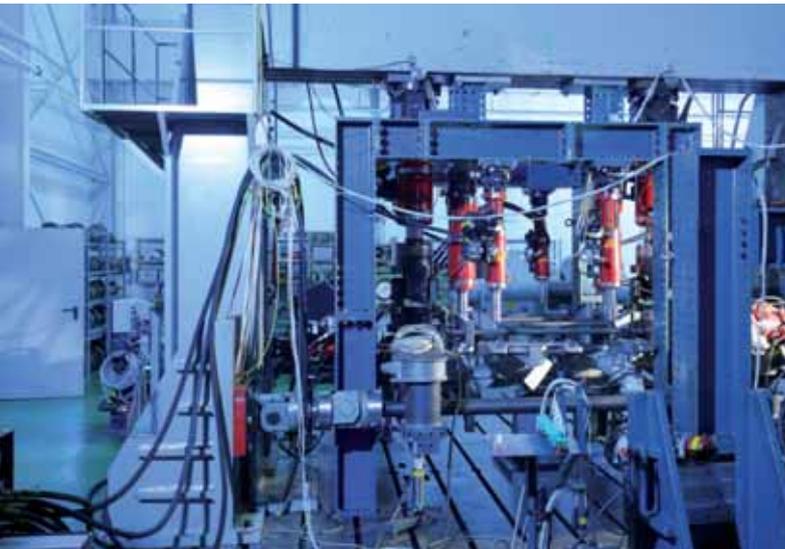


MEiKE climatic chamber

Mission: stationary measuring of components (such as doors, couplings, brakes), optimisation and type testing of air conditioning on rail vehicles, energy consumption examinations, thermographic examinations

- Temperature range: -20 °C to +45 °C
- Moistening of the chamber air, snow and ice generation
- Constancy of temperature in time and in position according to EN 13129-2
- Smoke extraction possible

Photo credits: DB Systemtechnik



Bogie frame test rigs

Mission: To measure static and dynamic loads on bogie frames

Testing conditions according to:

- EN 13749
- Dynamic forces up to 600 kN
- static forces up to 4 MN
- Bogie frame static forces up to 4 MN

Window test rig

Mission: simulates pressure changes in the case of two trains meeting each other and in tunnels, side windows of all types, proof of residual strength in case the outer pane is damaged

Testing conditions:

- UIC 566, NF F 31-314, EBA VwV NEA
- dynamic pressure up to 10,000 Pa
- Frequencies up to 10 Hz
- Sinusoidal and square-wave signal



Axle box test rigs

Mission: To test axle boxes, bearing grease, test bed shafts with Ø 120 mm, Ø 130 mm and Ø 150 mm

Testing conditions:

- EN 12082
- Speed up to 3000 min⁻¹ (500 km/h)
- Axle load up to 27 t
- Headwind at 20 °C

Strength test rigs

Mission: Strength and function testing on components of vehicles and their upper construction, testing arrangements specific to the task

Testing conditions:

- dynamic forces up to 600 kN
- Static forces up to 4 MN



Rotational bending test rig

Mission: Testing fatigue resistance and crack progression on wheels and shafts

Testing conditions:

- EN 13261 und EN 13262
- Rotational bending force (Level and frequency depend on the object to be tested)



Pressure test rig

Mission: Longitudinal forces and vertical forces acting on the body of locomotives, wagons

Testing conditions:

- EN 12663-1 und -2
- static forces up to 2000 kN
- strokes up to 400 mm

Shunting tests

Mission: Dynamic loads caused by head-on impact on rail vehicles and load tie-downs in marshalling procedures and sequencing of wagons

Test conditions:

- EN 12663-1 und -2
- Collision speed up to 15 km/h



Photo credits: DB Systemtechnik



Fairs and activities



Photo credits: DB Systemtechnik, WCRR

1st Customer day of DB Systemtechnik in Munich

Under the slogan "Functioning rail traffic is a common interest", on 22 May 2014 the 1st Customer forum of DB Systemtechnik was held in Munich - Freimann, and over 100 experts participated. There were presentations by DB Systemtechnik as well as guest lectures which all offered customers from the whole railway sector technical background information as well as an opportunity to exchange views and to discuss. A trade show was organised on the side where visitors could see for themselves the range of services that DB Systemtechnik has to offer. In addition, the testing laboratories of the Munich site presented themselves to interested guests.





World Congress on Railway Research 2013 in Sydney

The 10th World Congress on Railway Research (WCRR) was held from 24th to 28th November 2013 in Sydney. Together with the Cooperative Research Centre (CRC) for Rail Innovation the Australasian Railway Association (ARA), UIC, SNCF, Trenitalia, RTRI (Japan), TTCI (USA) und RSSB (GB) as well as DB organised this congress in Australia. This event was carried out simultaneously with the Plus-AusRAIL 2013, the biggest rail fair in Australia, in order to generate even more interest for railway technology on the 5th continent. All in all over 550 participants from 31 different countries participated in WCRR 2013.

Within the organisation committee, DB is represented by Hans Peter Lang and Alfred Hechenberger. Employees of DB Systemtechnik evaluated their work results in expert presentations, chaired some of the conferences, but they also evaluated already in the preparatory phase of the congress the more than 600 topic suggestions that had been submitted.

The concluding selection of topics for the over 150 presentations held in Sydney was done in the so-called marathon meeting of the executive committee, which was held ten months prior to the congress in Tokyo.





Maintenance and repair shop Bremen-Sebaldsbrück celebrate their 100 years

On Saturday 16 June 2014 the 100 years anniversary of these works were celebrated with an open-house day. As guests of honour on this day, shop manager Reinhold Batke welcomed Rüdiger Grube, CEO of DB and the mayor of Bremen Jens Böhrnsen.

Several thousand citizens of Bremen and many railway fans, some of whom had come a long way, could, on this day, take a look behind the scenes of the shop. DB Systemtechnik is solidly implanted on the site Bremen-Sebaldsbrück with a permanent design team. At the assembly stations of the new tunnel rescue locomotives BR 714, employees of both DB Heavy maintenance and DB Systemtechnik together informed about their

task and the technology of these locomotives. The design of these locomotives originated in the CAD computers of DB Systemtechnik engineering department; as the assembly leader, Bodo Ehrlich supported DB Heavy Maintenance in Bremen in the assembly of these first three locomotives.



Photo credits: DB Systemtechnik

Information day wheels and axles

A two-day information event was conducted in Kirchmöser on 06 and 07 March 2013 concerning the now current state of technology as concerns wheels and axles (with design and maintenance, non-destructive testing, questions of materials, measuring technological aspects and a tour of the whole establishment).

The departments maintenance systems and running technology informed about the state of technology in all matters concerning wheels and axles. Some of the topics that were discussed during those two days:

- Design and maintenance of wheelsets
- Condition analysis of axles
- In which intervals to conduct ultrasound testing
- Bench tests to determine in an experiment the residual life expectancy of axles in order to determine intervals for ultrasound testing
- In which way does non-destructive testing develop

- Optimisation of mechanised ultrasound inspection and development of ultrasound inspections on massive axles in built-in state
- New wheel and shaft test rigs in the works
- Wheelset measuring in built-in state
- Wheelset maintenance and -machining in field maintenance
- Continuing development of manufacture in heavy maintenance
- Recent development in materials technology
- Inductive surface hardening
- Wheelset coatings
- Measuring technological aspects in wheelset maintenance

To conclude this event, a technical tour of the installation was organised around the wheel / rail test rigs, at the centre for non-destructive testing on wheelsets and other trials and testing equipment that Kirchmöser had to offer.

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