Dedicated service

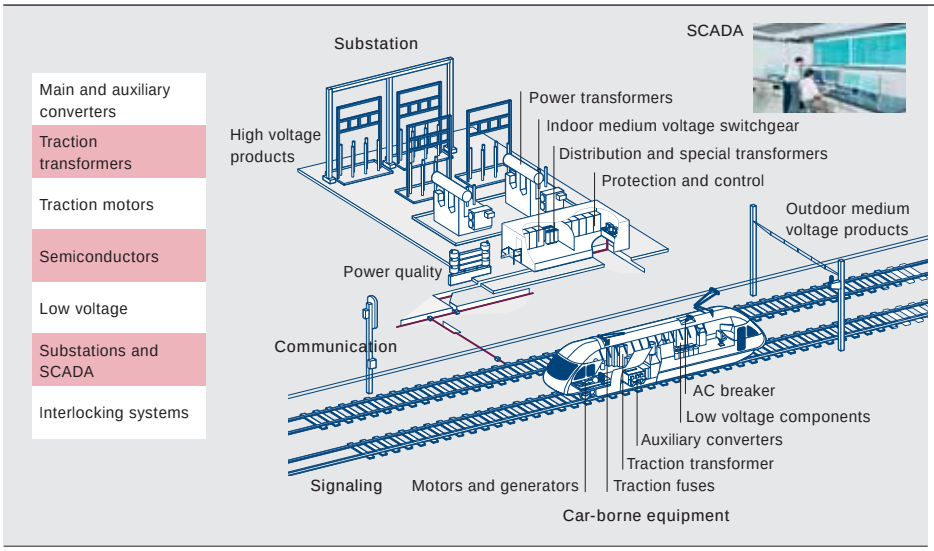
ABB offers a broad service palette for rail customers

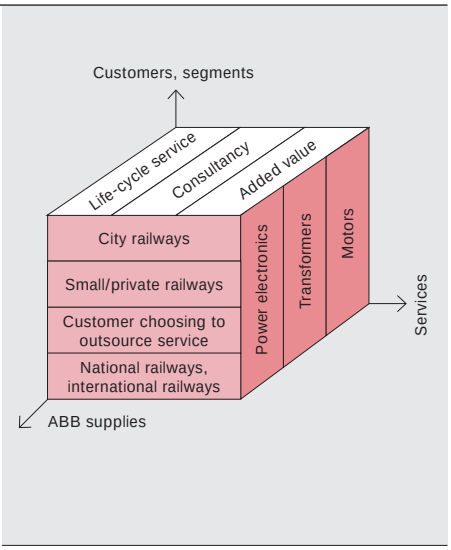
VINCENT MOINE, HARALD HEPP, SANDRO MACIOCIA – The majority of articles published in *ABB Review* focus on the latest technologies and products. Whereas the newsworthiness of a technology often correlates with it being state-of-the-art, ABB is aware that in their day to day operations, many customers are dealing with far more than just the company's latest products. A typical customer's installed base may have been built up and developed over a period of 40 years or more, and will reflect the different technological paradigms of that period. ABB has hence developed a service portfolio to help customers face this challenge. Thanks to its vast knowledge base, the company can provide service for rolling stock regardless of type or age – even extending this service to the equipment of other manufacturers. Work performed can range from routine diagnosis and maintenance to retrofitting, re-engineering and heavy overhauls.

Traditionally, railway companies have performed their maintenance and engineering in-house, and frequently operated large and specialized workshops for this purpose. Recent years have seen a shift in this approach, with railways increasingly entrusting such work to external contractors. One factor that has lead to this change is that many new operators have entered the market in the wake of liberalization. These companies usually wish to concentrate on the operations side of their business, and hence outsource maintenance to specialists. However, not only new operators stand to gain from such arrangements. Developments affecting traditional railway companies include the loss of specialized knowledge through the retirement of an aging workforce, and also the introduction of modern technologies whose maintenance requires different skill sets.

From ABB's perspective as an equipment manufacturer, providing service to railway operators has the additional advantage that the understanding of maintenance needs and of the behavior of equipment throughout its lifetime is fed back within the organization and used to improve future designs. Ultimately, the closing of this feedback loop benefits both manufacturer and customer.

1 ABB manufactures a broad range of components for railway systems, and also provides service for these.





With many railways across the world expected to handle increasing traffic in an increasingly competitive environment, overhauls can often present an economically attractive alternative to replacement.

A look at much of the rolling stock built over recent decades reflects the development of the industry during that period. Until about 20 years ago, most manufacturers were local and many countries presented semi-closed markets in which suppliers enjoyed almost symbiotic relationships with their customers. The subsequent opening of these markets has led to a rapid concentration of manufacturing into larger international or even global companies, and permitted a greater standardization of platforms and components. However, the longevity of equipment means that trains manufactured prior to these developments will continue to see intensive use for many years. Today's service and maintenance providers are thus required to understand a broad range of designs and technologies.

The range of railway components which ABB manufactures, and also supplies service for, is shown in ➔ 1. At one end of the scale of its service offerings, ABB can support customers with spare parts and maintenance planning. At the other end, major retrofits can upgrade products permitting them to operate more efficiently and economically. Retrofit can sometimes present an interesting alternative to replacement. ABB's service offerings thus protect the customer's investment by reducing lifecycle costs, permitting equipment to work harder and longer and increasing reliability and availability.

Service planning

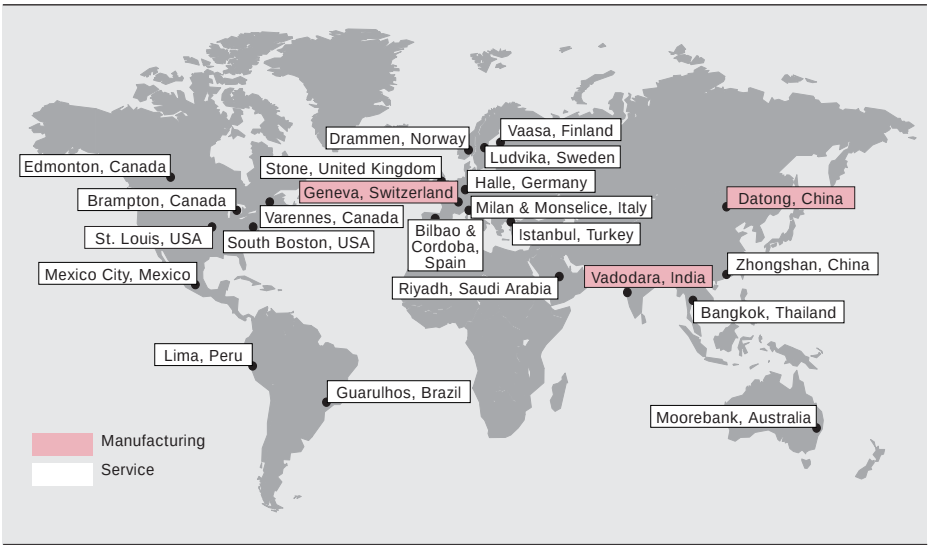
The collection and analysis of condition and diagnostic data throughout the lifecycle of equipment is permitting a shift from time-based to condition-based maintenance, maximizing availability and reliability while also reducing the costs of interventions and the associated downtime.

Besides smaller repairs during its lifetime, rolling stock often sees heavier engineering work at some point in its life. Typically, this takes the form of a so-called mid-life overhaul. The mid life-point splits the operating life of 30 to 40 years into two sections of about 15 to 20 years. The latter period is an optimal interval for heavy overhauls of such components as transformers and motors. Furthermore, the opportunity of such an intervention can be taken to make design modifications, either to suit changed demands or operating conditions, or to include the benefits of technological developments. For example older GTO- or thyristor-based converters can be replaced by modern IGBT-based ones, permitting more economic and efficient operation.

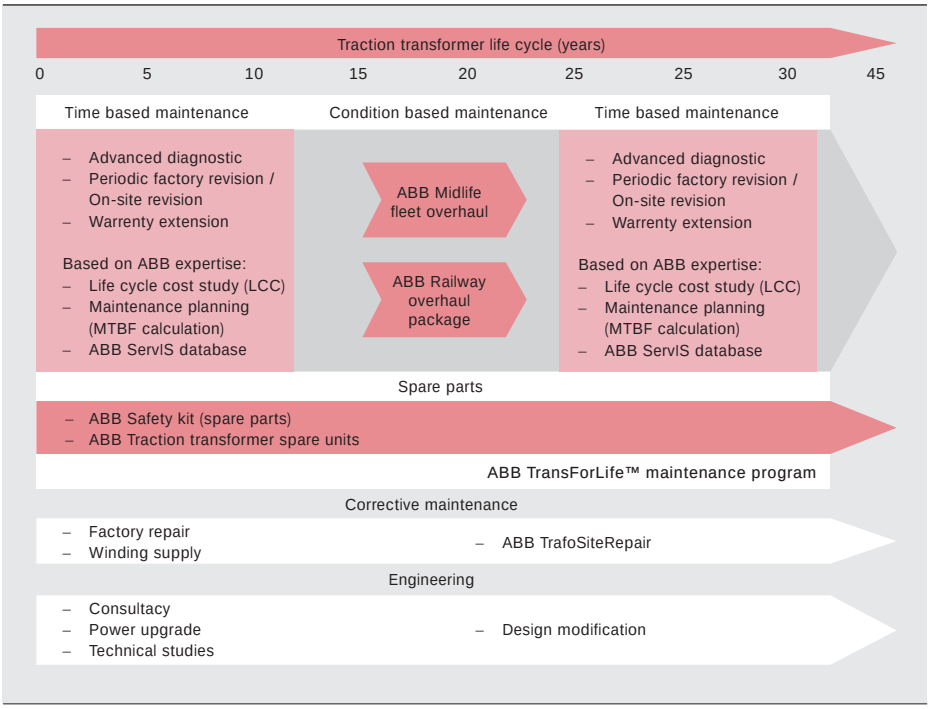
Transformers

Having been involved in AC railway electrification since the earliest days, ABB can look back on a long history of involvement in traction transformers. It is not uncommon to find examples aged 30 to 40 years in daily use today. With access to both experience and documentation from predecessor companies such as ASEA, BBC, SAAS, MFO and TIBB, ABB is well placed to provide service and support for traction transformers. Furthermore, ABB's transformer expertise is far from limited to railway applications:

2 ABB's global transformer expertise features 30 service centers and 1,000 experts



3 ABB TransForLife™ lifecycle service solutions for traction transformers



4 Repair of transformers for SNCF BB36000 locomotives

In 2008/09, ABB performed factory repairs on the transformers of three of SNCF's (French national railways) BB36000 locomotives. The work performed included:

– Inspection, cleaning, diagnostic measurements and expertise.
– Exchange of active part and reactors (windings and core)
– Replacement of all the gaskets and damaged accessories such as low voltage and high voltage bushings, oil level indicator, valves
– Revision of pump and cooling system
– Electrical routine tests according to IEC standards
– Oil Analysis after repair

These transformers were not ABB products, but originally manufactured by a French competitor. ABB's capacity to perform these repairs shows the company's ability to understand and work with third-party products.

Photo above: SNCF

The company can draw on its broader knowledge by extending such offerings as parts of its ABB TransForLife™ solutions package to on-board traction transformers. This covers both on-site and factory repair/revision as well as maintenance contracts and spare parts. Similarly, traction transformers benefit from the company's simulation and diagnostics packages [1].

ABB estimates that some 70,000 of its traction transformers are in use today. Furthermore, the company's scope extends beyond these as was shown by some recent projects involving transformers of other suppliers.

ABB's global presence means that it has 30 centers of transformer expertise across the world, and can draw on the knowledge of some 1,000 experts → 2. These ABB service centers are all able to offer transformer service and to support and to effect repairs. A typical traction transformer lifecycle is shown in → 3. The diagram shows the services that ABB TransForLife™ Solutions can offer during the different phases of the vehicle's lifecycle.

Examples of recent refurbishment projects are presented in → 4 and → 5.

Footnote

1 For more information on traction transformers see also "Transforming suburban transport" on page 55 of this edition of ABB Review.

5 Mid-life fleet overhaul of Euroshuttle locomotives

Eurotunnel operates a fleet of dedicated Bo-Bo-Bo locomotives on its shuttle trains transporting cars, coaches and lorries through the Channel Tunnel between England and France. As the tunnel is more than 100 m below sea level, trains enter it through inclined sections at either end. The locomotives must not only be powerful enough to start the heaviest train on these gradients, but the tunnel's special significance and length have led to stringent demands in terms of fire protection and redundancy which these locomotives must fulfill.

ABB won the order to overhaul the 15 years old traction transformers of 17 of these locomotives in a three-year contract lasting from 2006 to 2008. The scope of this preventive maintenance work included for each of the 17 traction transformers :

- Oil analysis, interpretation and recommendation
- Inspection, cleaning and diagnostic measurement
- Inspection and control of the active part (pressure of the windings, spacers)
- Mechanical optimization of the tank (O-ring gasket)
- Replacement of all gaskets, refilling with fresh oil
- Special tightness test under pressure with warm oil
- Electrical routine tests "as-new"
- Oil analysis after overhaul

Left-hand photo: Eurotunnel

6 Traction motor overhaul for Matterhorn-Gotthardbahn

The Matterhorn-Gotthardbahn (MGB) is a Swiss narrow gauge railway serving, among other destinations, the car-free resort of Zermatt at the foot of the world-famous Matterhorn mountain. Some parts of the MGB's route are rack railways and others are adhesion worked, with the rolling stock being able to work on both systems. During the last two years, ABB received several orders for products and services from MGB:

- Overhaul and repairs
- Supply of capital spares (complete rotors, complete stators)
- Supply of spare parts
- New windings and commutators for DC-Motors

Photo: Matterhorn-Gotthardbahn

Motors

Similarly to its transformer expertise, ABB's experience with traction motors goes back to the early days of railway electrification. ABB's predecessor companies were already making traction motors in the 1890s. ABB has thus inherited a great wealth of knowledge and experience and is now not only able to manufacture state-of-the-art traction motors but also to provide a full range of service, stretching from spare parts to overhauls and repairs, and covering both current and older types of traction motor.

The overhaul of a traction motor involves the comprehensive dismantling, control and exchange of wearing parts such as bearings or brushes in order to guarantee the specified number of kilometers of operation. This work typically involves the washing of parts in a spray booth and drying them in a vacuum oven. Where needed, motors can be rewound and parts replaced. Should replacement parts no longer be available, replica parts can be manufactured. Indeed, the scope of replacement can extend from spare parts, to capital spares (a complete stator or rotor), or even a complete replacement motor. Spare parts can also be supplied directly to customers to support their own inventory and maintenance activities.

At the core of a state-of-the art repair or overhaul is the Vacuum Pressure Impregnation (VPI) of stator windings using the patented Gemodur® (for DC-Motors) or Veridur®-Plus (for AC Motors) technology. These impregnation technologies guarantee strength of the electrical insulation system against both continuous and variation of high temperatures, as well as the mechanical stability of the windings and the iron core in view of vibrations. They also assure durable protection against dust, corrosion and hu-

ABB's global presence means that it has 30 centers of transformer expertise across the world, and can draw on the knowledge of some 1,000 experts.

midity. The repair or overhaul of a traction motor is concluded with the balancing of the motor, re-assembly, final testing, and painting with silicone-based varnish.

Extending beyond these repairs targeted at maintaining designed performance levels, motors can also be modified and improved beyond their original specifications. This may be necessary to cope with a different voltage or other changes in the power supply, or to permit the motor's rated power or speed to be increased [2].

An example of a recent motor refurbishment projects is presented in ➔ 6.

Converters

Converters play a key role in most large refurbishment projects for rail vehicles. When train fleets are renovated, typically after 15–20 years, operators often seek higher power, efficiency and reliability and lower maintenance costs.

Auxiliary converters

The demand for auxiliary power on trains has increased considerably in recent years. Staff and passengers increasingly expect HVAC (heating, ventilation and

Motors can be modified and improved beyond their original specifications, permitting rated power or speed to be increased.

Footnote

2 See also,"Standardizing the traction motor" on page 66 of this edition of *ABB Review*.

7 Auxiliary converters for the Swiss regional train refurbishment project "Domino"

In 2006, Swiss federal railways (SBB) embarked on their largest refurbishment program for regional trains so far. This project, Domino, essentially consists of a general overhaul of the 20-year-old "NPZ"* motor and driving trailer cars and a replacement of the 40-year-old intermediate coaches. The tender to supply the new intermediate coaches was awarded to Bombardier while the general overhaul of the end cars is being executed in SBB's own workshops in Yverdon and Olten. Faiveley won the order for the new HVAC equipment of these cars. New auxiliary converters were needed for both the refurbished coaches (25 kVA) and the new ones (45 kVA). ABB managed to independently win the converter contracts from both Faiveley and Bombardier. This resulted in the advantage of a common auxiliary converter platform and a common stock of spare parts. More than 300 converters have been ordered for this project so far, with further options pending.

ABB's BORDLINE M** static (auxiliary) converters are very compact and rugged but lightweight units that include galvanic insulation, regulated DC- and three-phase AC-outputs, filters and all control electronics (see also "A perfect fit" on pages 60–65 of this issue of *ABB Review*). The scalable BORDLINE M platform for railway coaches with 1000 VAC/16.7 Hz train supply uses air-forced cooling (like most other BORDLINE M series). It features a battery charger with a flat-battery start function.

The delivery schedule for this major refurbishment project was very challenging with a prototype converter of the 45 kVA type to be delivered only two months after the awarding of the contract. Series deliveries started in July 2008 with up to four converters per week. Depending on how the refurbishment continues, converter deliveries will continue at least until the end of 2011.

Footnotes

* NPZ: Neuer Pendelzug

** See also "BORDLINE M: A very high efficiency AC/DC/DC converter architecture for traction auxiliary services", ABB Review 2/2009 pages 35–41.

8 Propulsion converter retrofit solution for ICE1 high-speed trains of Deutsche Bahn (DB)

The ICE1 fleet was the first series production of high-speed trains in Germany. After about 14 years of operation, Deutsche Bahn (DB) launched a refurbishment program in summer 2005. The interior of all coaches was redesigned (for which the DB received the Brunel Award for railway design in 2008). For the power cars, DB launched a tender in 2007 with the goal of replacing older thyristor-equipped traction converters by modern IGBT converters.

Mainly due to high scoring high in terms of energy efficiency and life cycle costs, ABB could win the prototype order in September 2008. Within only 13 months, ABB developed and produced new traction converters for two 4.8 MW ICE1 power cars. Retrofitting a propulsion converter into an older train is in many respects much more demanding than developing a new traction chain from scratch. All major interfaces are fixed and given, in particular the physical and logical interfaces to the vehicle's older control system (which was retained), as well as the terminals and electrical characteristics of motors, transformer, cooling system and all mechanical parameters.

The new converter is based on ABB's three-level topology for power modules, resulting in much lower harmonics on both motor and supply sides. Among other positive effects, this minimizes energy losses and reduces stress on the motors, enhancing their life expectation. Compared to the thyristor converters being replaced, energy consumption was cut by 15 percent. Besides making the train greener, this substantially reduces operating costs (more than 100,000 Euros – ca. $ 140,000 – per year and train). The old thyristor power modules weighed 300 kg and were almost 1.5 m in length. ABB's three-level IGBT modules weight less than 35kg and have dimensions of about 80 × 40 × 20 cm meaning they can be exchanged by one person without any lifting tools. High modularity, increased reliability and sophisticated software for service and diagnosis also contribute to the reduction of maintenance requirements of the ICE1 fleet.

Test runs successfully began in November 2009. Following further thorough testing and re-homologation process, DB will decide whether it will refit a further 36 ICE1 power cars with this new IGBT converter.

Left-hand photo: DB

air-conditioning) systems and other facilities such as passenger information and entertainment systems, power sockets for laptops and vacuum toilets. Such offerings are largely standard on new vehicles [3], and if older vehicles are to remain attractive to passengers, they must offer comparable levels of comfort. Existing auxiliary power systems on trains are often not able to cope with present demands and must be re-designed from scratch. An example of an ongoing retrofit project is presented in ➔ 7.

Traction power

Refurbishment of traction converters typically seeks to increase efficiency and vehicle performance while reducing wear and maintenance costs and sometimes also weight [4].

Whereas components such as motors and transformers are usually refurbished during their mid-life overhaul, it often makes sense to replace traction converters. The reason for this is the higher pace at which technology has developed in this area. Components such as semiconductors, control electronics and software have developed rapidly over the past 15 to 20 years. Today's products are often so much more capable, effective and efficient that seeking to refurbish and retain old arrangements is often neither economical nor attractive. Furthermore, spare parts may be difficult to procure.

It is thus not surprising that ABB, as an independent component supplier, often receives requests from service companies, large workshops, OEMs, railway or mass transit operators concerning the replacement of converters.

ABB's traction converters are based on a modular platform, offering the advantage of short realization times and low development risk. The engineering effort of adapting or tailoring converters to a specific vehicle is thus most attractive when complete fleets or vehicle classes need to be refurbished. ABB recently supplied traction converters for the retrofit of an ICE1 German high-speed train ➔ 8.

Outlook

With many railways across the world expected to handle increasing traffic in an increasingly competitive environment, overhauls can often present an economically attractive alternative to replacement. ABB is well placed to offer services tailed to the customer's demands and the particularities of the equipment.

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Footnotes

3 See also "Performance on track: Electric power products on trains – designed by ABB to make journeys more comfortable", *ABB Review* 2/2008 pages 25–29.

4 For more on traction converters, see also "A perfect fit" on page 60 of this edition of *ABB Review*.