

From old to new: retrofits for track maintenance vehicles

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Railway construction companies are short of time. Construction windows are getting smaller and smaller, the required process speed is increasing. For a machine fleet this means more or less round the clock availability. This permanent availability can only be ensured with regular maintenance and overhauls or scheduled overhauls and expansion of the vehicle fleet.

The operating company is facing the challenge to maintain or increase the productive efficiency of its track construction machines and to keep the downtimes required as low as possible at the same time. Successful fleet management has to determine the optimum time and scope of maintenance. In a next step, the company needs to decide for which services it has in-house capacity and at what point it is economically more efficient to outsource the work to a service partner.

This article illustrates the range of services and the benefits of a so-called “retrofit” (complete overhaul) of construction machines, provides information about the required resources, about decision criteria and strategies.

1 Overhaul or new purchase?

After the third revision of a machine at the latest, generally after about 20 years of operation, most operating companies will be faced with the question of how to invest into the machine fleet. Changing legal frameworks will often require new work processes, and the demographic development in cities in particular requires a great amount of flexibility from the infrastructure operators with regard to the availability of their track construction machines: The intervals in local public transport networks are becoming shorter, construction work almost always has to be carried out in ever shorter night-time possessions.

Purchasing a new machine has the advantage that all existing systems will continue working until the new machine has been integrated. In addition, new vehicles will often have an expanded range of uses. Contrast this with drawn-out tender and approvals processes - which can take up to two years for work vehicles - and considerable financial and personnel expense.

Retrofitting existing machines meets the current demands for sustainability but means non-availability of the machine for three to six months, depending on the scope of the work. During this time the vehicle is dismantled into its components, refurbished and upgraded with the latest technology. A complete overhaul will upgrade the machine to customer requirements within the approval restrictions and thus ensure another 20 years of service. The cost of procurement processes, new type approvals and new machine training does not apply, the vehicle is as new and operational without any additional expenditure. (Fig. 1)



Fig. 1: Track vehicle before and after a retrofit

2 Overview of the benefits of a retrofit:

- Calculable investment, as a rule 50% of the purchasing price of a new vehicle
- The approval remains: ready for operation straight away, no additional expenditure
- Doubling of service life has a positive effect on the total cost of ownership (TCO)
- Renewed warranty period of up to 24 months for the whole vehicle
- Up-to-date technology and documentation as well as spare parts availability will reduce any future downtimes to a minimum
- Significantly improved occupational safety, from lighting, fire safety and control technology through to improved views
- Improved ergonomics through up-to-date cabin equipment and climate control
- New components for expanded areas of use and better environmental protection, e.g. particulate filters for work in tunnels or in urban environments
- Lower follow-up costs due to new components, known work procedures and workshop and spare parts store already set up

3 From revision to retrofit: exceeding legal requirements

The aim of preventive maintenance is the continuous trouble-free operation and, above all, the extension of the service life of a machine, which for track vehicles, for example, can easily be 25 years or more if serviced in line with best practice. In Germany, it is a legal requirement for track construction machines to undergo an inspection every six years as per Article 32 of the Railway Construction and Operations Act (EBO). The condition of the vehicle permitting, the law allows the interval between two consecutive inspections to be extended several times by a year, but to no more than 8 years. The scope of the inspection and maintenance measures as per Article 32 EBO is stipulated by law and worked to in check lists.

The first revision, which includes the replacement of wear parts and a check in the form of measurements and visual inspections, only takes a short time. By the third revision, it is only a small step towards a complete overhaul, because after 20 years of service time- and cost-intensive repairs will usually be imminent.

Many fleet operators will use this opportunity to have a retrofit performed at the same time as a revision. The vehicle will be out of operation for a few more weeks but will then be upgraded to the latest technology and to the customer's specific requirements for at least another 20 years of operation. (Fig. 2)



Fig. 2: After a retrofit the visual appearance of the vehicle is almost identical to the original new product

4 The quotation as a decision maker

How does the company decide the scope of a complete overhaul? Which components are to be overhauled or renewed, which adaptations will result in a considerable expansion of the area of use, in an increase in efficiency, in improved occupational safety? Up to which point is a retrofit economical when compared to a new purchase? When answering these questions, the ROBEL service centre will draw on its experience gathered from the worldwide deployment of track maintenance machines over many decades.

An accurate quotation is based on close cooperation with the customer over the whole offer process. As a first step, ROBEL engineers will inspect the vehicle together with the customer. In a joint exercise, requirements are specified, and the added value of potential additional work discussed.

ROBEL will provide a preliminary service of the technical clarification of the requirements: Accurate calculations will be made on the cost of materials, spare parts and delivery times, data relevant to approval etc., parts lists will be drawn up and the working hours calculated up to acceptance. Each item will be discussed with the customer in person before the final offer is submitted. The time this takes, usually about a month, is a good investment: The customer will receive reliable and binding information from which the investment and requirement of resources can be calculated; this provides a reliable basis for decision-making.

5 The manufacturer as a service partner

Once a company has decided to go ahead with a retrofit, the details will be agreed. The service is to be delivered on time, at the agreed scope and with transparent costings. This is based on comprehensive technical expertise, knowledge of standards and schedules, quick analysis and reliable statements on what has to be done as a minimum and what work delivers added value from experience. In many cases, a complete overhaul involves significant interventions. The associated risks can be reduced to a minimum if the service partner is also the manufacturer of the vehicle.

ROBEL pools its service competency into a separate business unit, "Service & Customer Support". Apart from the required technical experts and assembly halls, the Freilassing site also has the measuring equipment and special machines as well as the key European approvals, such as ECM, and HPQ, SNCF (France) and RISAS (UK) for axle production. Spare parts are available at short notice. In addition, the vertical integration of our manufacturing facilities allows us to produce many parts in-house based on original drawings, if required.

The existing design knowledge is applied for dismantling and reassembling the vehicle as well as in decision-making about replacement or new parts and when looking at suggestions for adaptations and improvements. When a ROBEL machine is undergoing a retrofit, the vehicle history and life cycle costs as well as the experience of the service engineers over the whole product service life will be included in the assessment. An important factor is also the familiarity with the

machine fleet: Solutions for other machines will automatically be taken into consideration for the retrofit.

6 Retrofit – (almost) everything is possible

In the course of a complete overhaul the vehicle will be technically upgraded to the latest state-of-the-art to comply with current requirements and legal frameworks. Furthermore, the aim is to make the track maintenance machine safer and more comfortable as a workspace with improved ergonomics. Over the last few years, the subject of environmental protection has become increasingly relevant. Exceeding the CO2 limits in many European big cities has had an impact on rail infrastructure work and the requirements on work vehicles. If the vehicle fleet does not comply with the latest emission standards, its use in urban environments will become difficult.

The possibilities for overhauls in line with the criteria listed above are endless and can vary depending on the vehicle type and country-specific legislation. The customer will decide on the scope of work in cooperation with the service partner.

Reconditioning	Replacement/renewal	Upgrade
<ul style="list-style-type: none"> • Frame measurement and checking of welds • Complete revision of wheelsets and bogies • Engine, gearbox, pumps • Crane, regulating plough, conveyor, sweeper unit (country-specific) • Complete re-painting 	<ul style="list-style-type: none"> • Cabin incl. windows • Retrofit as per fire safety standard: insulating material cabin, cables, hoses • Electric cabling, with wire labelling, if necessary • Hydraulic lines • Installation of up-to-date technology • Spare parts warranty • Updated documentation 	<ul style="list-style-type: none"> • Heating/air conditioning • Sockets, pneumatic and hydraulic connections • Camera system • Connections for winter equipment, e.g. snow blower, plough, brush • Additional generator for work equipment power supply

7 It's all a matter of time

The decision as to if and when a retrofit will be carried out depends on numerous factors. The most important criterion is the availability of the vehicle. Hefty penalties for delays mean even faster intervals with reliably operational vehicles for the maintenance companies. Lengthy servicing work is therefore mostly scheduled in the winter months when there is less maintenance activity. The customer will not only require strict adherence to the deadlines from the service partner, but also a high degree of flexibility. As a manufacturer with considerable human resources and space, ROBEL has sufficient additional potential to absorb seasonal fluctuations and to move to factory floors of other business areas at peak times.

Even so, it is not possible to carry out a retrofit at short notice. After the machine has been inspected by a service engineer together with the customer, it takes about a month until the final quotation is ready. From receipt of order, the time for ordering

materials, for design and generating parts lists as well as the customer arranging the downtime will normally be three to six months. The actual work, including updated documentation, customer acceptance and training, will take about four to six months. After that, ROBEL has to issue test certificates, submit a spare parts offer and commission the machine. Overall, the time from deciding for a retrofit to the machine being operational again will be at least seven but no more than twelve months.

8 From old to new – retrofit in detail

When the machine arrives at the service centre an initial investigation based on the original documentation is carried out. Then the machine will be dismantled completely (Fig. 3). Brake and hydraulic components, controls as well as cranes, buffers and draw hooks will be sent to the original manufacturer for investigation.



Fig. 3: After the initial investigation the track vehicle is fully dismantled

Solid foundations: frame testing

As part of a retrofit, the frame will normally be completely exposed, sand-blasted and all relevant weld seams subjected to magnetic particle testing (Fig. 4). Measurements following the frame test sheet will often show that the vehicle frame exhibits some damage from small accidents or intense use of the vehicle; this will be repaired (Fig. 5). A professional frame inspection and, if necessary, repair and repair log, form an essential part of a complete overhaul and will guarantee the use of the track construction machine for many more decades to come.

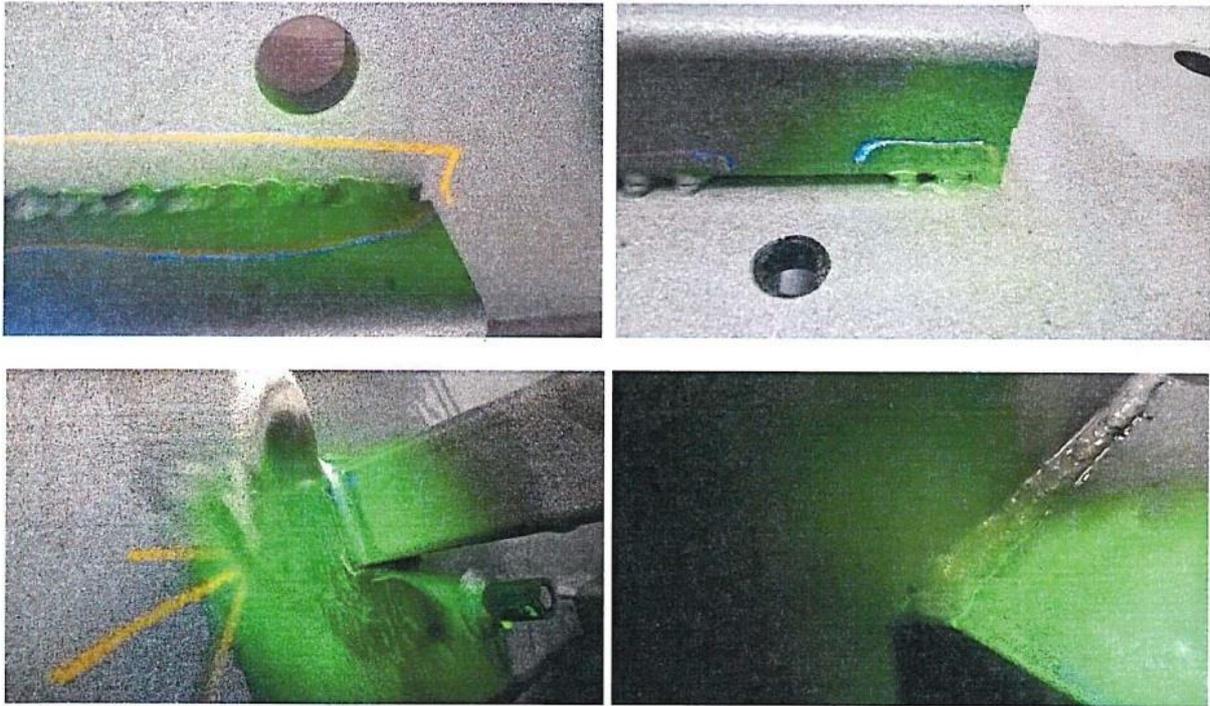


Fig. 4: Full magnetic particle testing of all relevant frame welds

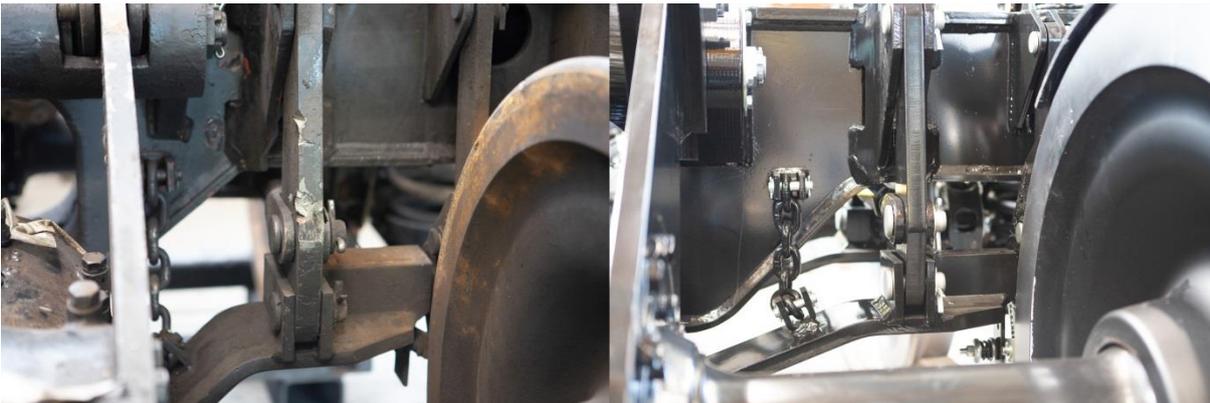


Fig. 5: The defective brake rigging is reconditioned, damaged levers are replaced with new ones and all bolts are checked and lubricated.

Mainstay: wheelset reconditioning

In the course of a retrofit, ROBEL will make use of its in-house axle centre for reconditioning idler and power wheelsets and bogies (Figs. 6 and 7). Our warehouse management is, amongst others, geared towards the availability of wheel discs in all common EU variants. In addition, our manufacturing facilities allow us to produce many parts in-house based on original drawings, if required.

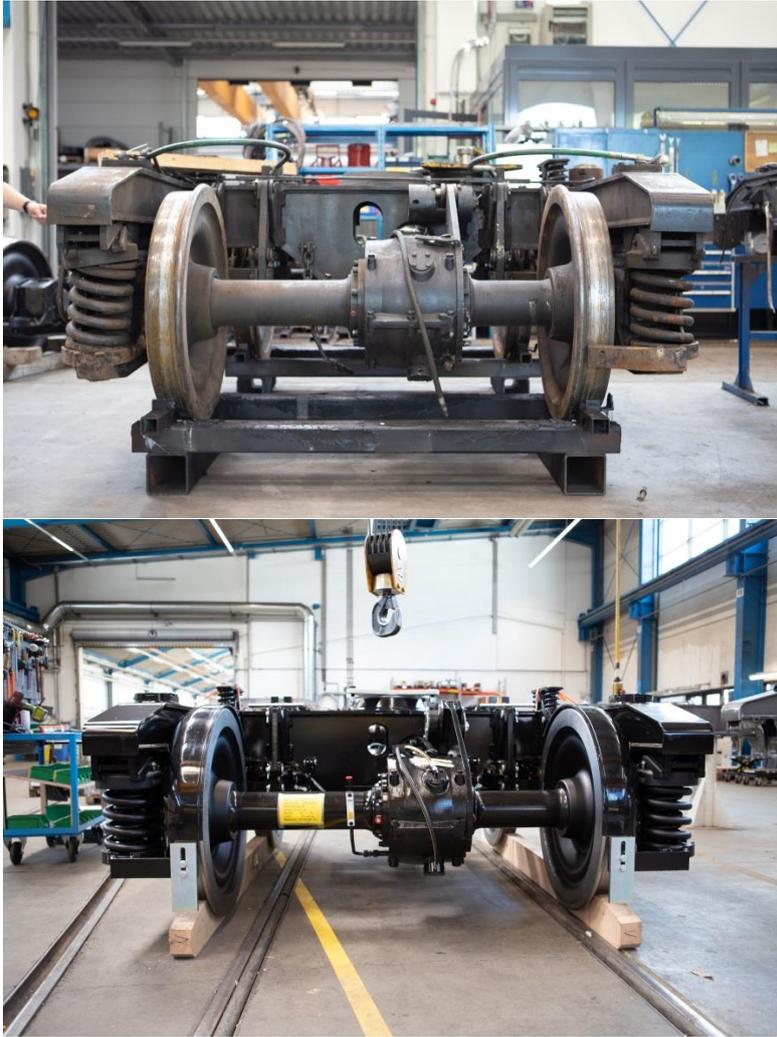


Fig. 6/7: Bogie before and after reconditioning

During a complete overhaul, all wheel sets are removed, dismantled and all assemblies, such as axle shaft, gearbox, housing, cleaned and tested with ultrasound or magnetic particle testing. A double-cylinder axle press (Fig. 8) is used for press-fitting and removing the wheels and brake discs, laser measuring, displaying and recording the press-fitted axles according to standards. (Fig. 9).



Fig. 8: Double-cylinder axle press for automatic press-fitting and removal of wheels and brake discs with digital monitoring and recording

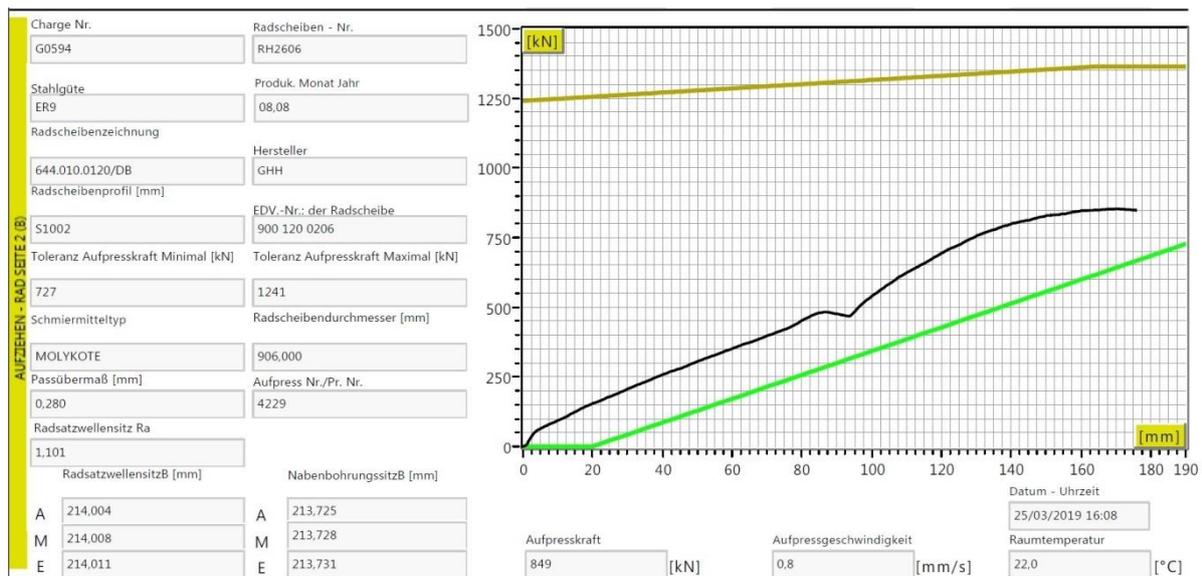


Fig. 9: The extract of the test certificate from the wheelset press shows the force progression that requires verification when press-fitting the wheelset in accordance with DIN EN 13260.

In the fully automatic cleaning plant complete wheelsets, axle shafts and individual components are cleaned and paint-stripped. Apart from the huge time savings - manual cleaning of a complete wheelset would previously take more than a whole day - and the considerably reduced exposure of staff to pollution levels, the major benefit is the full compliance with the standards prescribed for European approvals. Cleaning axle shafts, for example by grinding (France) or sand-blasting them (UK) is no longer permitted (Fig. 10).

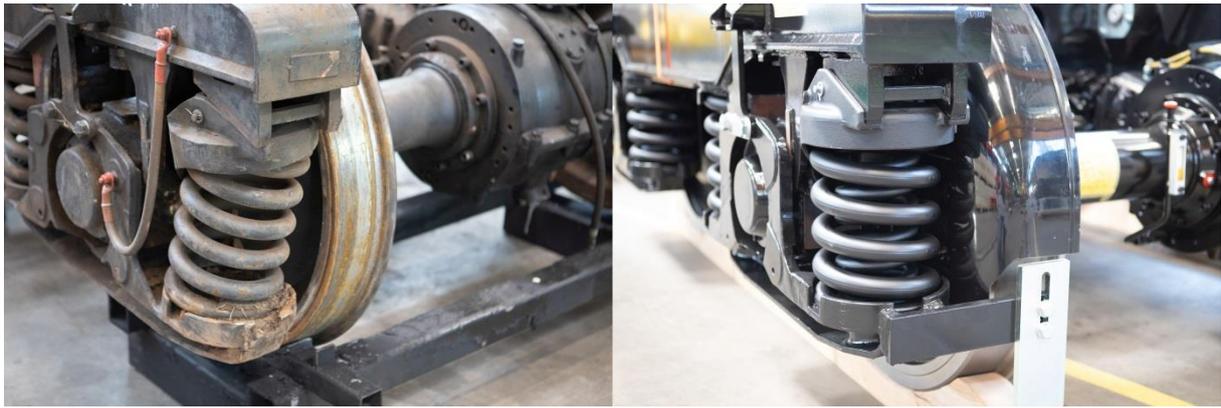


Fig. 10: The primary suspension is repaired to the relevant standards, the worn wheel disc is replaced with a new one.

Where automation and the use of machine-controlled testing make sense, measurements are no longer taken manually but digitally. The measuring equipment and test rigs used at ROBEL, such as the geometry test rig, roughness measuring device or the passometer micrometer have been adapted to the specifics of the track and are subject to strict requirements for maintenance and calibration. Measurement results are fully recorded and documented. A spring testing rig is used for testing the primary and secondary coil spring suspension. The spring length, force and any deviations are measured electronically, documented and recorded in a certifiable test protocol for the prescribed documentation in line with DIN EN 13298/27204-4.

Safety in and around the vehicle: renewal of cabin and work units

Depending on its condition and on the customer's requirements, the existing cabin will be refurbished, or a new cabin installed (Fig. 11). The existing floor structure, insulation material as well as the driver's and pilotman's seats will be replaced with fire-resistant material in line with the current fire safety standard EN 45545. Installing new windscreens brings several advantages: Instead of bonding, as was previously common, the screens are now clamped or screwed, which makes it easier and more cost-efficient for the customer to replace them. It is no longer necessary to outsource work to workshops with a bonding room. Additional cabin windows will provide a better view and thus improve the safety and result of the work on the track.



Fig. 11: A complete refurbishment or replacement of the cabin allows for the installation of additional windows with modern fixing methods.

Frequently used units on track construction vehicles, such as cranes, regulating ploughs, conveyors, sweeper units, etc., may show considerable wear after 15 to 20 years. Depending on its condition, the respective module will either be repaired or, if not relevant for approval, replaced with an updated version.

Improved performance and environmental protection: engine replacement

In line with country-specific requirements, either a replacement engine of the same design or a new engine will be fitted; it will meet the current emission standards, e.g. have an SCR system (Selective Catalytic Reduction) with urea injection for the reduction of nitrogen oxides (Fig. 12). This will ensure the vehicle is within the applicable emission limits - a significant additional benefit for the operating company.

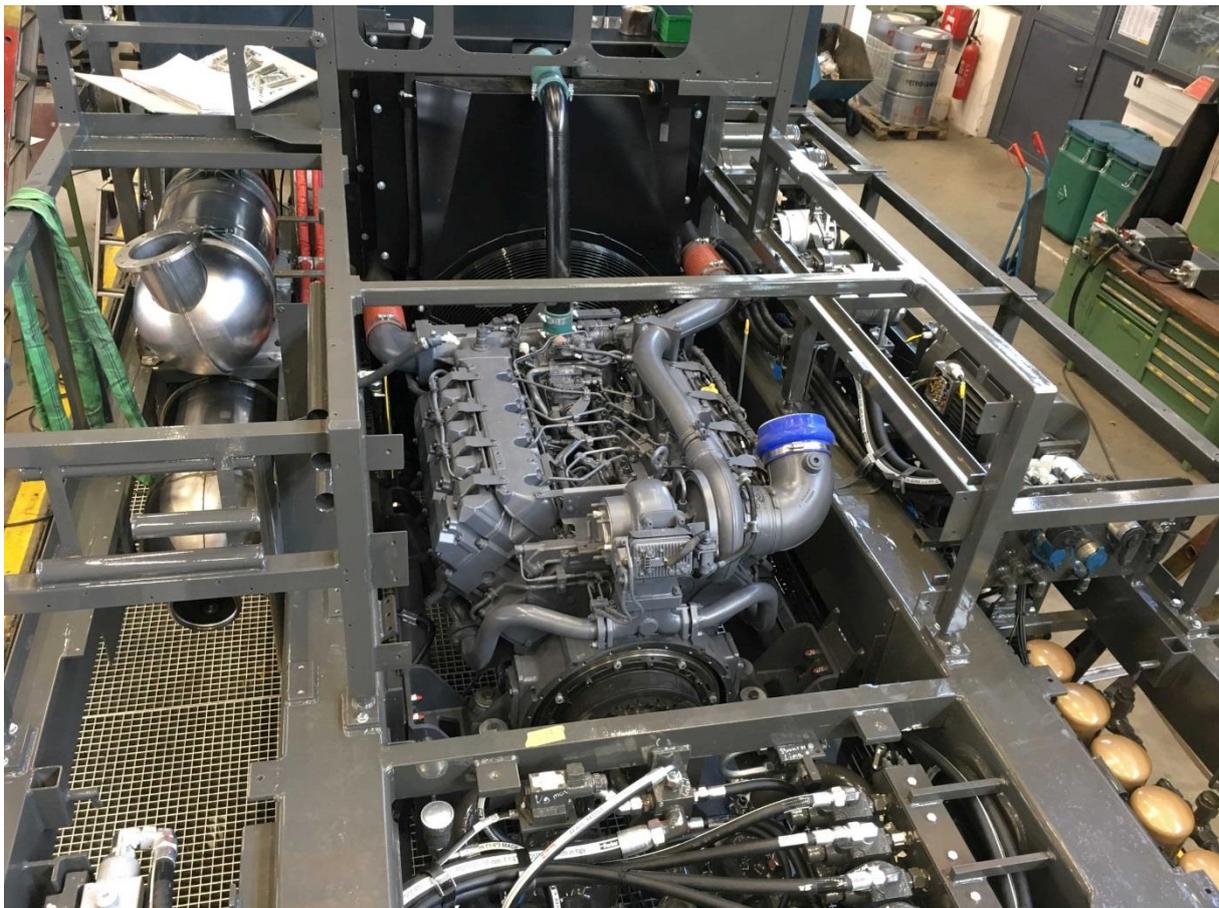


Fig. 12: Thanks to the installation of a new engine with SCR system the vehicle will work within the latest emission limits after the retrofit.

The Norwegian transport company Sporveien Oslo AS, for instance, decided to have new engines with SCR system fitted to its whole fleet of ROBEL track vehicles during their retrofits to meet the current emission standard. Now equipped with the latest emission technology, these vehicles comply with the strict requirements for the use of track construction vehicles in Oslo, Europe's green capital 2019.

When using an identical replacement engine that meets the emission standard valid at the time of approval, the vehicle can be upgraded with diesel particulate filters, e.g. to keep the permission to work in tunnels. This extends the scope of use of existing vehicles significantly at a comparatively low investment.

Increasing occupational safety and comfort: electrics, hydraulics, pneumatics

An essential part of a complete overhaul is a full check, reconditioning and upgrade of the pneumatic, hydraulic, electric and electronic components. In general, this will include an upgrade of the signal, working, trackside and access lighting to LED technology as well as the installation of a new or additional heating or air conditioning system. Additional sockets, hydraulic connections, e.g. for winter equipment, and pneumatic connections for external tools will be installed and the cabling and hydraulic lines upgraded to meet current fire safety standards (Fig. 13). Additional generators can also be fitted. Using the manufacturer's design drawings, small design changes can be made to accommodate a new air dryer unit. The braking system undergoes a complete overhaul, all relevant components are checked, logged and renewed, if necessary.

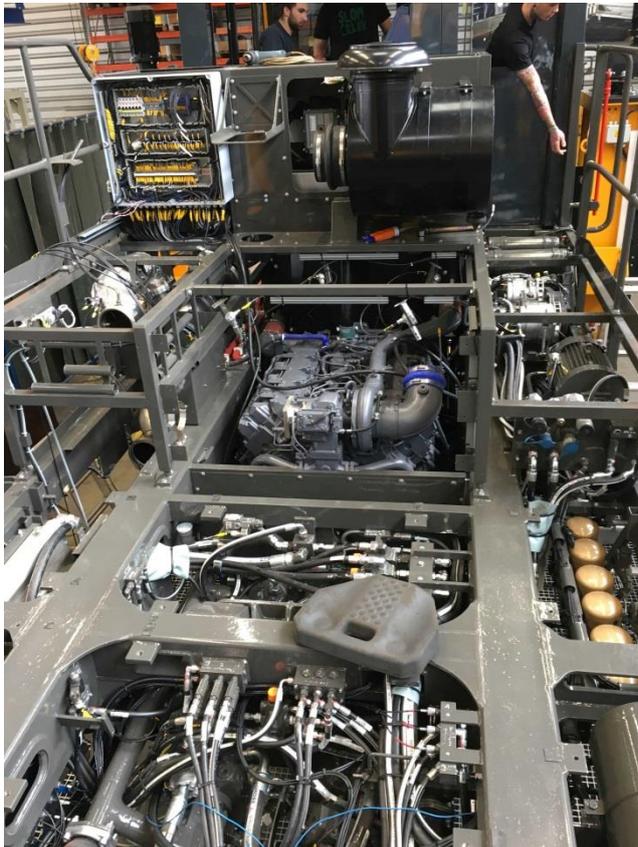


Fig. 13: An essential part of a complete overhaul is the replacement of the cabling and hydraulic lines in accordance with the latest fire safety standards to increase occupational safety.

The vehicle control system is tested comprehensively and checked and repaired by the original manufacturer. If this is no longer possible or spare parts are no longer available, it is possible to retrofit a later version of the control system after consultation with the customer.

New build of proven assets: installation processes

The installation process within a retrofit essentially corresponds to a new build. Here, too, the manufacturer's knowledge ensures quality in each step of the process. Cabin, engine and components are first fitted as produced (Fig. 14), then the vehicle is dismantled again for painting the frame and cabin. During the final assembly, the cabin, engine, hydraulic and other components as well as work units are fitted, and the electrics and cabling installed (Fig. 15). The result is a machine that visually hardly differs from the original new product.



Fig. 14: Manufacturer know-how flows into the assembly processes of a retrofit; here the body shell before painting.

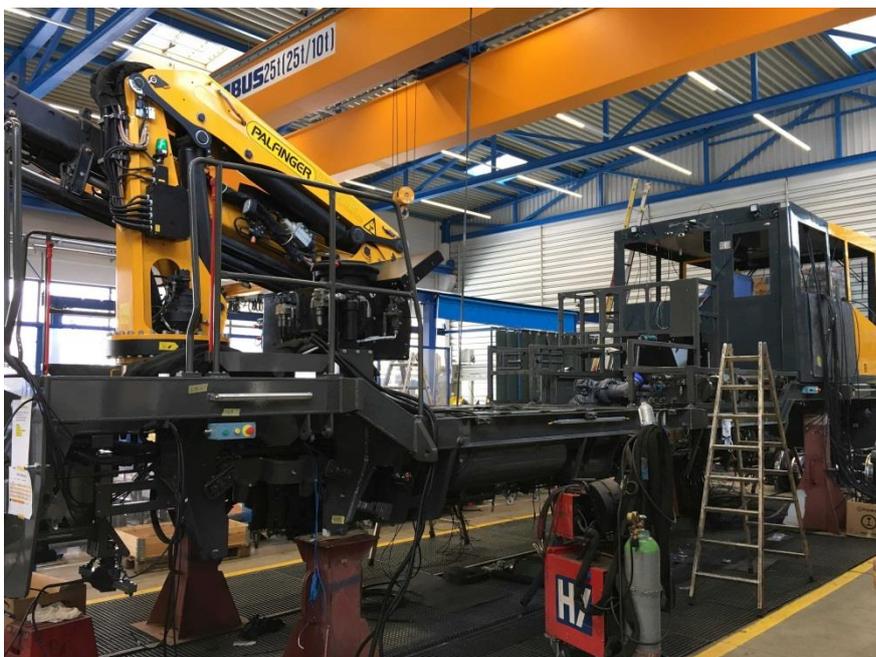


Fig. 15: Once the frame and cabin are painted, the final assembly of cabin, engine and components is carried out, and the electrical installations and cabling are fitted, just like with a new vehicle.

Full operational readiness: commissioning and documentation

Once all components have been assembled, upgrades made and the machine is operational again, it is extensively tested and commissioned, with a functional test included. In-house track systems allow us to carry out most of the checks on site in Freilassing. The final stage of recommissioning consists of test runs on DB track, just next to our company premises; these can include brake tests, travelling gear adjustments or runs under load conditions. The machine is weighed on in-house calibrated weigh bridges.

Since ROBEL has the required EBA certificates and approvals for acceptance, the customer will receive the completely overhauled machine, which is now ready to use, together with updated documentation (operating manual, maintenance manual, spare parts catalogue, electrical/hydraulic/pneumatic drawings). Training will usually take no longer than half a day since the operators are largely familiar with the processes and only need to be trained in using new equipment. A last load test and final commissioning are carried out at the customer's site with the support of ROBEL service engineers.

9 Pushing the limits

As the scope of work detailed above demonstrates, the possibilities of a vehicle retrofit as part of a complete overhaul are boundless. A retrofit will only reach its limit if modifications are no longer economically viable or are so significant that a new approval will be required.

Depending on country-specific regulations, this can include:

- fitting a new type of engine
- fitting a more powerful engine
- replacing the crane with a bigger model
- replacing or extending the control system
- increasing the maximum driving and working speed
- measures resulting in a considerable increase in dead weight
- measures resulting in a considerable increase in dimensions

10 Summary

A retrofit will upgrade proven track construction machines to the latest technology and occupational safety standards. At a calculable investment and quick amortisation, the vehicle will not only deliver full performance for the next 20 years but also comply with the latest requirements on occupational safety, ergonomics and environmental protection. The operating company together with its service partner, who in an ideal scenario is also the manufacturer, will make the decision if/when a complete overhaul is economically viable or if the requirements make a new purchase necessary. ROBEL's long-standing experience in design, operation and maintenance of vehicles ensures planning certainty, profitability and reliable availability of their customers' vehicle fleet.

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