New track maintenance vehicles for the Munich underground railway

Considerations regarding vehicle procurement from the perspective of Stadtwerke München as the operating company

Fig. 1: MVG mainly uses heavy-duty small wagons for infrastructure maintenance on the underground *Source: Robel*

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Stadtwerke München (SWM) is responsible for the new vehicle procurement division of Münchner Verkehrsgesellschaft (MVG). One of its topics are auxiliary railway vehicles for Munich's underground and tram networks. Auxiliary railway vehicles comprise several types of specialized vehicles that are used for internal transport, but primarily for infrastructure maintenance. Passengers are largely unaware of the dimensions of these vehicles, as they rarely if ever see them. They include, in particular, various types of locomotives and wagons (usually referred to here as trailers), rail treatment vehicles and, above all, track maintenance vehicles (TMVs), also known as heavy-duty small wagons (Fig. 1).

Fleet modernization: one vehicle for every task

The existing fleet of auxiliary railway vehicles is getting on in years and is therefore being modernized and adapted to the requirements of modern underground operations. The increasing focus on reducing CO_2 emissions, but also reducing emissions for employees in a largely underground network (in accordance with the technical regulations for hazardous substances TRGS 554 [1] and 900 [2]) led to the procurement of new electric locomotives with additional battery equipment some time ago (Fig. 2). There were already two locomotives with this drive technology at SWM and they had proved their worth; all-electric vehicles were out of the question, as the conductor rail is often shut off during construction work and some track is not electrified.

After these locomotives failed to meet MVG's requirements, the vehicle strategy was also changed in view of increased transport requirements. While logistics and maintenance have previously operated independently with largely separate vehicle fleets, in the future all requirements are to be covered by track maintenance vehicles (Fig. 3). However, as this also includes transferring underground trains via the siding of the branch line, the machine capabilities had to be adjusted in terms of nominal capacity. At the same time, however, further requirements were placed on the loading and unloading of welded strings. This requires two TMVs, with several trailers in the formation between them. Two-axle, conventional TMVs would have had to be changed/rotated in their orientation in order to position the crane on the trailer side. A higher vehicle requirement would have been the uneconomical consequence. This made the procurement of classic, two-axle TMVs obsolete, and the decision was made in favour of the new vehicle concept with loading cranes on both sides and a central cab (Fig. 4).

Fig. 2: To reduce CO_2 emissions, electric locomotives with additional battery equipment are used for traction tasks, among other things
Source: Wikimedia Commons, Underground Depot North, shunting 20.02.24

Hybrid drive as a logi(sti)cal solution

When evaluating a suitable drive concept, it was necessary to combine various tasks. A diesel-only vehicle was ruled out in advance. SWM also did not want to create the infrastructural prerequisites for hydrogen propulsion, especially as there were still some uncertainties surrounding this technology. Therefore, the solution of choice was a hybrid one. However, there were concerns that the diesel engine would be used again for a longer period of time when the battery power was exhausted underground. This meant the time had come to think about innovative solutions. As part of the market exploration discussions with various vehicle manufacturers, there were discussions as to whether the vehicles could also be operated using pantographs via the conductor rail.

This had the following advantages from the operating company's point of view:

- Journeys to logistics transports, such as escalators, can be made electrically.
- Journeys to and from various construction sites can be made, or maintenance work can also be done electrically.
- A battery that is empty due to work or connected track construction equipment can be recharged during transfer travel.
- Even without an external connection, a parked vehicle can be charged via the conductor rail.

As a result, a discharged battery with the conductor rail switched off (due to construction work and occupational safety) was identified as the worst-case scenario. For these cases, the diesel engine therefore had to meet the highest requirements of occupational safety and environmental protection, which, in addition to the highest possible normative classifications, also included appropriate filter technology.

Maintenance specificities of the Munich underground railway

The operating conditions in Munich, such as banking, posed additional challenges to the rail vehicle manufacturer. In such cases, a limited number of trailers can be pushed in front of the traction vehicle; the prerequisite for this is a clear view of all units and effective train protection on the leading vehicle. Train protection (magnetic train stop, Siemens CTS-M 104 system) must be deactivated on the traction vehicle.

In order to be able to transport larger gross hauled tonnage of a train on an uphill gradient of 40‰, operation was also required in double heading, both in the constellation of TMV + TMV, as well as TMV + trailer number x + TMV.

Fig. 3: From one to two cranes: the existing fleet of track maintenance vehicles will be supplemented by ten three-axle hybrid track maintenance vehicles as of 2024
Source: SWM, Robel

Fig. 4: As the Munich underground network does not have any facilities for turning, all units are designed for bi-directional working, with a crane on both vehicle ends and loading platforms at station level on both sides. *Source: Robel*

Data is transmitted via the electrical connection of the automatic central buffer coupler, the Scharfenberg system by Voith. In order to enable temporary operation with third-party vehicles in the latter constellation, a „radio double heading" data transmission system also had to be implemented.

Another special requirement is an additional shunting coupler for heavy rail vehicles, which requires the Scharfenberg coupler to be lowered, because the shunting coupler and the central buffer coupler would touch and obstruct each other when the vehicle is ready for operation. The reason for this considerable design effort is the recurring need to use heavy-rail wagons in the SWM network. For this purpose, the company also has some of its own ballast and flat wagons, but also hires suitable vehicles for large construction sites.

Similar coupler designs with a wide variety of solutions have existed in the locomotive sector at SWM for a very long time: the technical complexity of this design unites all individual solutions.

Tendering and procurement

Based on these requirements, the last step before the tendering process was to determine the number of vehicles, which was a result of the needs assessment and the replacement of old vehicles. Initially, six TMVs were put out to tender, and the contract was awarded to Robel, based in Freilassing.

New construction projects to come (extending the U5 to Pasing and the U6 to Martinsried, building the new U9), replacing the existing train protection systems, and taking into account of the longer downtime of some existing vehicles due to a lack of spare-part availability ultimately led to another tender for four TMVs. The contract for this was once again awarded to Robel. This means that ten identical TMVs will be available after delivery and authorization, with corresponding synergies in maintenance, spare parts stocking, and staff training. The logistics and maintenance of the rail network is ensured in the long term, with modern working conditions for employees. The decommissioning of almost all existing vehicles associated with the new procurement thus means a complete departure from the previous locomotive concept of SWM and MVG.

This procurement strategy and the TMV with its innovative technology will be part of their joint presentation at Innotrans 2024.

More about MVG

MVG was founded as a wholly-owned subsidiary of SWM and has been responsible for underground, bus, and tram services since 2002.

The underground transport services are provided on behalf of MVG by its parent company SWM. Approx. 230 km of permanent way, 511 turnouts, and 100 stations provide the infrastructure for eight lines, with an average loading of 38,000 t/d, on sections with maximum loading even 68,000 t/d.

Over 4,500 employees (Mobility and MVG department) ensure that operations run smoothly or create the conditions for this, including around 2,300 drivers.

The underground network is connected to the rail network by a branch line. New underground trains are delivered here by rail in an environmentally friendly way. The fleet of underground trains is constantly being modernized; MVG will receive additional C2 vehicles by 2024.

The longest underground line is the U6, at 27.4 km on the route Klinikum Großhadern – Garching Campus. This line is also home to the „Technical Base", the workshop base of the Munich underground railway.

Planning is currently underway for the construction of another depot.

REFERENCES
1. TRGS 554, Technical Rules for Hazardous Substances, Exhaust Gases from Diesel Engines (2019)
2. TRGS 900, Technical Rules for Hazardous Substances, Occupational Exposure Limits (2024)

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