Railway Gazette
INTERNATIONAL

On track to modal shift

5L wagons lead the way to digital rail freight

Having run a demonstrator train using innovative 5L wagons for the past two years, SBB Cargo is now pushing on with a programme of '5L Next' initiatives to optimise wagon design and wrap its freight activity into a wider digital railway agenda. Reinhard Christeller reports.

Reflecting Swiss national transport policies that are strongly environmentally oriented and favour rail freight, SBB Cargo operates a network of wagonload services over distances averaging just 100 km (RG 4.19 p44), as well as running domestic and transit intermodal and block trains. Yet despite Switzerland's status as one of the most rail freight-friendly countries in Europe, policymakers are keen to see an even more competitive sector develop.

A particular challenge surrounds the cost and complexity of less-than-trainload operations. While wagonload has endured, the part-privatised SBB Cargo faces many of the same challenges that have caused the decline of this type of operation across Europe. To improve its competitiveness and make the best use of the scarce capacity available on the heavily used Swiss network, SBB Cargo needed a holistic and forward-thinking strategy. As a result, it decided to integrate its freight operations into the wider Smartrail 4.0 advanced train control and traffic management programme that majority-owner SBB Group is developing (RG 3.19 p30).

As part of this rethink, SBB Cargo is urgently looking to make a definitive break with many of the traditional manual and analogue operating practices that are still common in rail freight. The cornerstone of this initiative is the 5L programme to develop modern, flexible and digitally networked wagons, where work has been underway for a number of years (RG 9.13 p60). The operator says it remains fully committed to delivering all the aspects of this multi-disciplinary approach, which covers five key objectives for wagon design:

- low noise;
- light weight;
- long lifespan;
- logistics-capable;
- life-cycle cost-oriented.

However, SBB Cargo's aspirations go beyond wagon innovation to cover a wider transformation of Swiss rail freight operations, integrating them fully into a digital railway framework. Automation is intended to reduce operating costs substantially and deliver to a much higher overall transport speed.

A variety of technical measures are being developed to contribute to these objectives and their full impact will only be felt once all have been implemented. SBB Cargo describes this approach as '5L Next'.

Designing a 5L wagon

For more than two years, SBB Cargo has been running a demonstrator train that showcases some of the innovations of the 5L wagon design.

The 5L demonstrator train is already in commercial service in Switzerland.

Photo: Reinhard Christeller

operators and wagon leasing companies, as well as several academic institutions, to trial four types of digital automatic couplers on behalf of BMVI. Various scenarios for their gradual implementation have been outlined, and the couplers will be produced in partnership with suppliers CAF, Dellner, Voith and Wabtec.

The objective of the DAC trials is to ensure that a new generation of autocoupler not only replaces the drawgear and buffers, but complements their mechanical and pneumatic functions with the transmission of electric power and digital data. This would allow the interchange of control and condition monitoring data along the train, which would be interlinked with the railway signalling and traffic management systems. Reflecting 5L's objective of lightweight design, the DAC should not be heavier than the existing buffer and drawgear components.

An advanced digital coupler would also shorten the spacing between wagons, potentially increasing payloads for a given train length by around 4% compared to current wagon designs. Several levels of automation and functionality have been proposed for the DAC programme (Table I); SBB Cargo has chosen level four for its future fleet of 5L wagons with an option to upgrade to level five in the future.

Carbody design

SBB Cargo has sought to reduce the weight of the 5L wagon by 20% compared to a conventional 9 tonne vehicle, reducing tare weight from 18 tonnes to 15 tonnes for the whole vehicle with a 3% increase in payload. The main challenge here lies in designing the underframe to comply with EN12663 structural requirements. For the demonstrator project, Hörmann Vehicle Engineering produced a lightweight truss frame made from modular riveted steel components usually used for lorry chassis production.

Four different designs of low-noise bogies have been developed by ELH, WBN, Tatra and Greenbrier. These are

A 5L wagon needs to be focused on the needs of modern logistics companies, and able to handle a highly diverse array of consignments, including refrigerated and deep-frozen products as well as liquids and bulk commodities. SBB Cargo has identified a need for highly specialised and in many cases custom-designed logistics containers. These do not form part of the wagon structure and will essentially be carried using spigot fixings in the same way as conventional intermodal containers; a similar approach has been adopted for Rail Cargo Austria's InnoWaggon concept (RG 9.14 p86).

Customers would be offered, or could specify, highly customised logistics units that match the needs of their shipments and despatching methods. These containers could be loaded and unloaded without the wagon itself being present. This should allow for the large-scale production of a few wagon types, while the life-cycle of the wagon could be different from that of the container. Such an approach would allow rail operators to respond rapidly and flexibly to the changing requirements of the market.

> 'We are pressing ahead to get the innovative 5L wagon ready for the future of rail freight'
>
> *Jens-Erik Galdiks, Head of Rolling Stock Technology, SBB Cargo*

Pan-European coupler trials

Automatic coupling is another core focus of 5L. While autocouplers are widespread on passenger trainsets and have been universal for freight wagons in North America for many years, many abortive attempts to introduce them in Europe have been made over the past century and a half.

With the intention of finally achieving a co-ordinated European standard, SBB Cargo is participating in the latest efforts backed by the German transport ministry BMVI and the Fr8rail project within Shift2Rail's Innovation Programme 5, as well as TSI and CEN/Cenelec working groups (p18). It has joined forces with a number of other European freight

Photo: SBB Cargo

Models of the 5L logistics concept on display at the Transport Logistic trade show in München in June 2019.

20%

reduction in weight of the 5L wagon compared to a conventional 9 tonne vehicle

Table I. Grades of automation and functionality in automatic couplers

Type	Level of integration
1	Mechanical coupling
2	Type 1 + automatic coupling of air pipe
3	Type 2 + automatic coupling of power and data bus line
4	Type 3 + automatic decoupling, manually actuated at wagon
5	Type 3 + automatic decoupling controlled remotely

Source: Shift2Rail / FR8

Photo: Reinhard Christeller

The middle part of the lightweight underframe has a steel truss structure composed of standard lorry chassis components and connected to the welded end underframes by lockbolts.

Photo: Reinhard Christeller

A Level 4 Wabtec coupler with electro-pneumatic connections and data bus on show at Transport Logistic last year; this design is now in commercial service with SBB Cargo.

all equipped with two large disc brakes per axle and radially steered wheelsets to minimise wear and noise and should also reduce the traction energy demand when operating on sinuous lines. Tests have shown that these designs can reduce noise levels to below 75 dBA, 10 dBA lower than freight trains equipped with K or LL tread brakes. The partners hope that the bogies, including the wheelsets, will be able to operate for 2 million km or 20 years before a major overhaul is needed.

However, some challenges have still to be resolved. One current area of focus is the axlebox bearing grease, where more development is needed to ensure the bearings can work without maintenance over their lifetime. Brake suppliers Knorr-Bremse, Faiveley and Dako are investigating whether the two discs per axle currently fitted could be replaced by a single disc to reduce both the capital cost and weight.

The brakes would be controlled using electro-pneumatic equipment with wheel slide protection to reduce the train's braking distance and the brake release time. This should help to harmonise path allocation for freight trains on mixed-traffic routes, freeing up some network capacity.

Testing of these components is now underway; SBB Cargo says the initial results are encouraging but the final data to quantify the benefits are unlikely to be ready until the first half of 2021.

Faster shunting

Remarshalling individual wagons en route between separate origins and destinations is often the most time-consuming part of the wagonload freight business, and a major contributory factor to these delays is the manual brake test and train preparation process. Its duration depends on the train length and external factors, such as weather. A technical inspector or 'wheeltapper' must walk along the whole train length up to six times, to register and couple the wagons, and manually check the status and condition of each brake on every vehicle. Depending on train length, this can typically take between 1 h and 3 h.

Unsurprisingly, an urgent priority for SBB Cargo has been digitalisation of the brake test, so that this can be performed almost as rapidly as it is for passenger multiple-units. An automatic brake test taking 10 min has been developed and is expected to receive regulatory and safety approval from the Federal Office for Transport later this year. There are also plans to develop a self-testing function for wagon brakes; under a future development this automated condition monitoring tool would inform the driver about the weight, length and braking performance parameters of the train using the in-cab DMI.

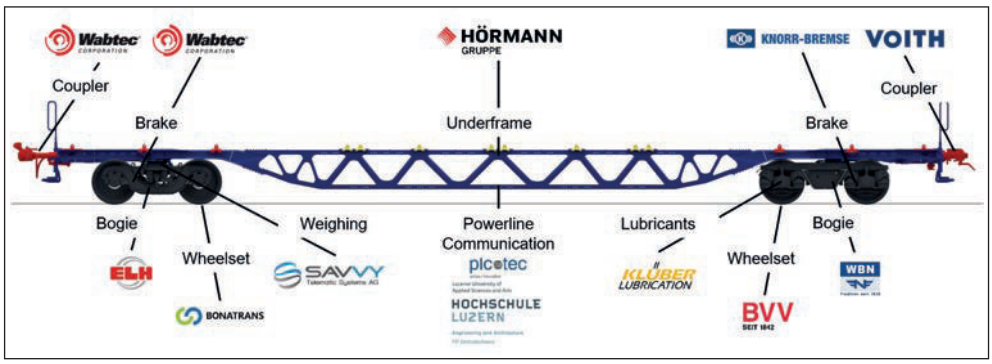
SBB Cargo is already in the process of automating the visual checking of wagons at key yards. A camera system has been installed at the Limmattal marshalling yard near Zürich to detect defects on passing wagons; these could include worn or missing brake pads and bent corner steps. But several further condition states must be 'learned' by the visual recognition tool before the complex pre-departure check process could be truly automated.

Towards a 5L fleet

SBB Cargo is aiming to migrate its entire wagon fleet to 5L standards by the end of the decade. This is in line with European plans to gradually equip close to half a million wagons with DAC, data processing and telematics tools.

So far, SBB Cargo has procured 12 demonstrator 5L wagons, which are operated on two commercial services together with four conventional wagons for comparison purposes. Since June 2018 these vehicles have completed more than 150 000 km of largely trouble-free operation in Switzerland, and SBB Cargo is now expecting to receive the necessary approvals to test the wagons on trains running over longer distances into Germany and Italy.

Anticipating further implementation of 5L principles, SBB Cargo has equipped a first batch of 100 conventional container flat wagons and 25 domestic locomotives with Level 2 autocouplers from Voith. More than 1 000 wagons are on order for its express wagonload service; these will come with autocouplers fitted, marking the start of the projected migration of its entire wagonload operation. Given that the single wagon fleet in Switzerland currently totals more than 10 000 vehicles, this is still likely to be the final element of the freight business to shift to a higher degree of automation.



The 5L demonstrator train has served as a testbed for components from various industrial partners.