

BR 96 – Bavarian Giant Specializing in Helper Service

Articulated locomotives were once a relatively common sight on American railroads, especially west of the Mississippi. Often called Mallets not all articulated locomotives were Mallets. While also used in some part of Europe, they were certainly far and few between and nowhere near the size of the almost gargantuan American articulateds that plied the rails of the Union Pacific, Duluth, Massabi and Iron Range and the Norfolk & Western Railroads. Since finding its way into the hearts of many Märklin modelers, that firm's model of the Bavarian Gt 2x4/4, also known as the BR 96, has made European railroad enthusiasts more aware of this somewhat unconventional locomotive configuration. A word about the designation – G = Güterzug or freight; t = tank locomotive; 2 = two sets of drivers and 4/4 = each axle of the two 4-axle sets of drivers is powered. While certainly capable of hauling many freight cars, the BR 96's service was a specialized, if lonely, service.

The concept of an articulated locomotive is nearly 100 years old. At that time the Swiss engineer Anatole Mallet (1837 – 1919) developed the articulated locomotive as a solution for negotiating tight radius turns. Fundamentally, an articulated Lok has two separate sets of drivers, one of which is fixed to the engine frame and one which is pivoted. There are four cylinders – two high pressure and two low pressure. The high pressure cylinders are generally part of the fixed set of drivers (closest to the cab) and low pressure cylinders are on the pivoted set of drivers.

In the first decade of the 20th century, with passenger and freight trains becoming ever more heavy, the problem of crossing mountains in Bavaria became increasingly difficult. Specifically, three lines were affected.

- Schiefe Ebene between the stations of Neuenmarkt and Marktschorgast. The line measured 4.21 miles with a grade of 1:40.
- Spessartrampe between the stations of Laufach and Heigenbrücken. The line measured 3.22 miles with a grade of 1:50
- The Frankenwaldbahn connecting the stations of Rothenkirchen and Probstzella presented two grades; Rothenkirchen to Steinbach am Wald of 7.62 miles and Probstzella to Steinbach for 8.25 miles. The grade was mainly 1:40.

Helper engines then in use had become almost totally inadequate. The Königlich Bayerische Staatsbahn; Bavarian State Railways (K.Bay.Sts.B.) (*From here on I will use the abbreviation to save valuable space, author.*) thought a tank engine with five driven axles (5/5), an E-Kuppler (E-coupler) in German with 16-ton axle loading would be the solution. But, it was not enough. The next idea was to make this a six-axle tank engine with 16 ton axle loading. Again, a lack of experience with this type of locomotive and the anticipated abrasion of wheels and rails led to discarding this approach.

J.A. Maffei's director of engineering Anton Hammel suggested a 2x3/3 or 2x4/4 Mallet, a suggestion acceptable to the K.Bay.Sts.B. Little time was lost in starting to design the much needed helper engine. Anton Hammel had some very specific suggestions for the dimensions of the cylinders, firebox, wheel size, etc. It was to be a 2x4/4 design.

By September 1913 the prototype, shop number 3414, was delivered to the K.Bay.Sts.B. with road number 5751 ready for initial testing at Maffei's Munich facilities. While tests in the Munich region could not duplicate the conditions prevailing in the three regions outlined, the results, nevertheless, proved very encouraging.

With completion of the new machine's breaking in period and the railroad personnel's familiarization with the engine, official testing began on April 9, 1914. The K.Bay.Sts.B. ordered a total of 15 of the new Mallet designated Gt 2x4/4 (D'D h4v) - D' = four axles in a pivoting frame; D= four axles in a fixed frame; h = superheated steam; 4 = the number of cylinders and h = compound locomotive) from Maffei in Munich and all were delivered in 1913 and 1914. Their shop (factory) numbers ran sequentially from 3414 to 3428 and the railroad numbered them 5751 to 5765. When the Deutsche Reichsbahn was formed in the 1920s, the engines became BR 96s and were numbered 96 001 to 96 015. The first 10 engines were assigned to Rothenkirchen and the remainder to Aschaffenburg.

Here's what the trade press had to say about the new Bavarian Mallet. From *Die Lokomotive* in 1914..."Now this largest and most powerful European steam locomotive being put into service by the Bavarian State Railways is a clear indication of Maffei's expertise in developing the Mallet articulated locomotive. It is far superior to the various helper locomotives it replaces."

From the British magazine *The Locomotive*, also in 1914..."Some new banking (helper) locomotives put into service by the Bavarian State Railways are the heaviest and most powerful tank engines in Europe." The editor went on to point out that while American adoption of the Mallet design resulted in larger machines, the original Mallet is very much an "Old World" invention.

Using a train of 1,000 tons over the Lichtenfels to Rothenkirchen line (23 miles), the previous running time of 103 minutes was reduced to 68 minutes. The next grade from Rothenkirchen to Steinbach was done with a 410 ton train using only a single Gt 2x4/4 in a record 29 minutes compared with the previous time of 58 minutes. Other similar tests were equally successful. Extrapolating these and other savings, the railroad anticipated annual cost savings of DM 100,000, (roughly \$25,000) a not inconsequential amount in those days.

Similarly satisfying results were realized on grades in Northern Bavaria. The 3.2 mile 1:20 grade between Laufach and Hergenbrücken had a great deal of passenger and freight traffic. Despite the advantages gained by using the new locomotive, some of the gains were negated by the machine's complexity. Maintenance costs were definitely higher.

Still, this engine, the largest and heaviest articulated locomotive in Europe, had proven itself to the point where the K.Bay.Sts.B. ordered an additional ten from Maffei in 1922. They were not completely identical to the first lot. They were shop numbers 5336 to 5345; KBStB 5766 to 5775 and then DR 96 016 to 96 025.

Vigorous daily use revealed the need for some modifications and the newer machines, those delivered in 1922/1923, were actually modified first. The 1913/1914 engines were updated between 1929 and 1932.

SERVICE

Use of the Gt 2x4/4 was confined to relatively few locations. The first and second lot were split up between Rothenkirchen for the Steinbach-am-Wald 1:40 grade and

Aschaffenburg for the Schwarzkopf Tunnel near Heigenbrücken 1:50 grade. Assignment to the Schiefe Ebene, the third steep grade, did not take place until 1935 in conjunction with building of the Munich-Berlin Autobahn. Here the massive Mallet helped move heavy freight trains hauling thousands of tons of earth and rocks resulting from the Autobahn construction.

Some Gt 2 x 4/4s were pressed into helper service in Belgium during World War 1. Some were assigned to work as helpers as well as in conventional service in Brügge, Westphalia from 1929 to 1933. Others were scattered throughout regions of Germany that required some helper service or the use of a heavy freight locomotive. They were also tried on the famous Geislinger Steige but not put into service there because the BR 95 (Prussian T20) proved equal to the task. Also, there simply were not sufficient Mallets available in the 1930s and 40s. The rugged Mallets could also be seen in Landshut, Regensburg, Hof and Munich Main Station in the 30s and 40s. They survived the second World War in generally good order but by 1947 the last of the 96s were taken out of service in West Germany. The very last ones to be placed into service were two in 1944 on the Halberstadt – Blankenburger Eisenbahn in Germany's Harz region. They then served in East Germany Deutsche Reichsbahn until 1949. Then for another five years they were used as steam generators.

A measure of the engine's well thought out design was that the second order (1922/23) was, for all practical purposes, configured identically to the first lot. With the formation of the Deutsche Reichsbahn Gesellschaft (DRG) came an increased emphasis on better maintainability and less complexity as seen in the Gt 2x4/4. The ascendancy of the BR 95 (Prussian T20) made that abundantly clear.

By October 1954, the last of the BR 96s (96 002 and 024) were scrapped. There had been some hope that 96 006 might survive and be installed in a museum but, alas, that was not to be. Alas, there are no survivors. There are, however, two magnificent models of the BR 96. A 1:10 scale model of engine 96 016 was built in 1939 by machinists in training at the RAW Ingolstadt shops. This model is now in the Deutsche Museum in Munich. Earlier, in 1935, the same shop built a 1:10 replica of 96 025, which is now in the Nürnberg Transportation Museum.

ORIGINAL AND MODIFIED MACHINES

The Gt 2x4/4 (D'D h4v) was a four cylinder 0-8-8-0 standard gauge articulated locomotive designed primarily for helper service in the Bavarian region of Germany. Unquestionably, it was a very complex locomotive for its time and the engineering staff at Maffei had all it could do to solve the many problems inherent with designing and manufacturing the many steam and water lines with the necessary flexible couplings needed for a Mallet design. The smallest radius curve it could negotiate was 590 ft. Maximum speed was 31 mph. The locomotive had two sets of four-axle drivers. The high pressure cylinder serves the rear (nearest to the cab) drivers and the large, canted low pressure cylinder powers the front set of drivers. The diameter of the high pressure cylinders measured 20.4 in. which was increased to 23.6 in. during modification. The low pressure cylinders were 31.5 in. in diameter, a measurement that remained unchanged when the engines were modified. Heusinger valve gear was used.

Both frames of the engine were welded 1.2 in. rolled plate steel. A hinge pin of 5.9 in. diameter couples both frames. Each four-axle section has a wheelbase of 14.76 ft, or 4.92 ft between axles. The total wheelbase is 40 ft. Empty weight for the first 15 locomotives was 99.4 tons, which remained at that figure upon completion of

the modification program. On the other hand, the second series started out at 101.7 tons and gained during modification to weigh in at 105.4 tons.

The boiler is the largest one ever manufactured by Maffei for the K.Bay.Sts.B. It is mounted on the rear frame of the articulated frame. The inside diameter of the boiler is 5.8 ft of material that is just short of $\frac{3}{4}$ in. in thickness. The highest point on the boiler is 9.67 ft above the top of the rails. Sand domes supplied traction sand to the fronts and rears of each of the drivers. The pipes leading from the sand dome supplying the front set of drives use flexible couplings to accommodate the movement of the boiler in relation to the drivers.

The coal and water capacities for this rather large locomotive were actually rather small. Of course, these relatively low capacities were entirely sufficient since the BR 96 was used almost exclusively in helper service. The first series of engines' coal capacity was 4.0 tons and upon modification, this was increased to 4.5 tons. Water capacity was not changed and was 388 ft³. Initial coal capacity of second series was 4.5 tons which became 5.0 tons during modification. Water capacity remained unchanged at 434 ft³.

Since the Gt 2x4/4 spent as much time traveling reversed and going forward, the engine featured a fully enclosed cab for greater crew comfort. Additional specifications are provided in the attached table.

Updating of all BR 96s was carried out in two stages. The second series (96 016 to 96 025) was the first to be modified. The process lasted from 1925 to 1927. When the BR 95 (Prussian T20) entered service in 1923 to begin tests and evaluation with what turned out to be very favorable results, it became apparent that the complex Gt 2x4/4, with its high maintenance requirements, needed some serious rethinking.

Personnel assigned to the Mallet pointed to the difficulty of effectively applying all of its power to the track. The design had an inherent tendency to go into sideways oscillations about its frame pivot point. This resulted from the difference in the volumes of the high and low pressure cylinders. It required a very skillful locomotive driver to prevent these potentially dangerous oscillations from even starting. The net result was that it was never really possible to utilize all of the steam that the machine's huge boiler provided. To find a solution to the problem Maffei engineers set about checking and redoing some of their cylinder calculations in 1925. Using engine 5773 (96 023) as a test bed, they installed larger high pressure cylinders. This lowered the pressure differential between the high and low pressure cylinders from 1:2.37 to 1:1.78. There was every indication that this was the answer to the oscillation problem. In the Bavaria vs. Prussian contest, i.e., Gt 2x4/4 vs. T20, the former clearly emerged as the winner. The DRG reacted quickly and requested that Maffei carry out the same modifications on the remaining Mallets of the second lot. The cost per engine came to DM 59,100 or approximately \$15,000.

The modifications to the cylinders were not the only ones. There is not enough space in this article to enumerate all the changes in detail. Updates included boilers, fire gratings, ash containers, the feedwater pump and preheating system, sand domes and frames.

Modifications of the locomotives of the original 1913/1914 series (96 001 to 96 015) were started on 96 003 and 005 in August 1929 at RAW (Reichsbahn Ausbesserungserk; modification center) Ingolstadt near Munich. Not modified in numerical sequence,

96 012 was the last machine to be serviced thus. The date was December 2, 1932. Modifications and updates included new boilers and a new retardation braking systems which were removed by the end of the 1930s. The complex Riggerbach retardation brake was a waste of time according to Josef Eich, an engine driver. He said, "by the time everything was adjusted and set, we were back on level track."

According to a comment made by Maffei executive Baron Ludwig von Welser, "The success of the modification program met all expectations and, as a result, the performance of the Gt 2x4/4 is such that it does not have to fear competition from the Prussian T16 and T20."

Specifications

Axle configuration	D'D' h4vt
Service class	Gt 88.15/16
Boiler diameter, inside	69.3 in. (1,760 mm)
Boiler material thickness	0.75 in. (19 mm)
Highest boiler point above the top of rails	116.14 in. (2,950 mm)
Boiler pressure	220.5 psi (15.2 bar)
Heating surface	158.7 ft ² (14.7 m ²)
Superheating surface	598 ft ² (55.3 m ²) for 96 001 - 015
	621 ft ² (57.7 m ²) for
	96 016 - 025
Grating area	45.7 ft ² (4.24 m ²)
High pressure cylinder diameter	2 x 20.5 in. (2 x 520 mm)
Low pressure cylinder diameter	2 x 31.5 in. (2 x 800 mm)
Piston stroke	25.2 in. (640 mm)
Wheel diameter	47.9 in. (1,216 mm)
Wheelbase	480.3 in. (12,200 mm)
Smallest negotiable radius	590 ft (180 m)
Overall length	57.4 ft (17,500 mm)
Fully laden weight	123.2 tons 96-001 - 015, 127.6 tons 96-016 - 025
Maximum axle loading	15.4 tons 96-001 - 015; 16.2 tons 96--16 - 025
Top speed	31 mph (50 km/h)
Maximum pulling power	24 tons

Editor's note – Without Clinton Ross' generous loan of the book "Die Baureihe 96 – Malletrise für den Schiebedienst" this article would not have been possible. It is also not possible to impart all of what is contained in this 275 page volume. This article should be considered a brief introduction to what is a very fascinating locomotive.

Sources

"Die Baureihe 96 – Malletrise für den Schiebedienst," Steffen Lüdecke, EK Verlag, ISBN 3-88255-831-8, 1991.

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Königlich Bayerische Staatsbahn (K.Bay.Sts.B.); Bavarian State Railways

Disposition of BR 96 Locomotives

Editor's note: there is far more information on the disposition of these machines than can possibly be included in this article. Readers fortunate enough to have access to "Die Baureihe 96 – Malletrieme für den Schiebedienst," by Steffen Lüdecke can find more information there.

96 001 - Left Bavaria in 1929 for Sauerland where it helped on the 4 mile (6.4 km) Brügge – Lüdenscheid line with its 28% grade. The engine was removed from service in 1933 and phased out in 1936.

96 002 - Together with 96-024 assigned to Halberstadt-Blankenburger Eisenbahn (HBE) in 1944 to help move heavy limestone trains on the 19 mile (30.5 km) Rübelandbahn in the East Hartz region. Almost deliberately scuttled on April 17, '45 in an attempt to halt the U.S. troops' advance in the Hartz region of Germany. Ended its career doing heavy switching in Stendal. Mustered out in 1954.

96 003 - Left Bavaria in 1929 for Sauerland where it helped on the 4 mile (6.4 km) Brügge – Lüdenscheid with its 2.8% grade. The engine was removed from service in 1933 and phased out in 1936.

96-004 -

96-005 - Left Bavaria in 1929 for Sauerland where it helped on the 4 mile (6.4 km) Brügge – Lüdenscheid line with its 28% grade. The engine was removed from service in 1933 and phased out in 1936.

96-006 - Until 1952 reserved for Nürnberg Museum but scrapped before installation. Indirectly

96-007 - Ended its career as a heater engine.

96-015 - destroyed in World War 2.

96-016 - First engine of 2nd order.

96-024 - Together with 96-002 assigned to Halberstadt-Blankenburger Eisenbahn (HBE) in 1944 to help move heavy limestone trains on the 19 mile (30.5 km) Rübelandbahn in the East Harz region. Ended its career doing heavy switching in Stendal. Mustered out in 1954.

96-025 – Last BR 96

SIDEBAR

My Märklin BR 96 – 96 018 (Gt 2x4/4 Nr. 5768

When I retired in July my company did not give me the traditional golden watch (besides, I much prefer my stainless steel Omega Speedmaster) or any of the usual retirement presents but rather they surprised me with a very generous gift certificate to my favorite train shop – Matschke in Wuppertal. While I was not able to go there in person to invest in Märklin goodies, I had a grand time browsing through catalogs to come up with my Christmas in summer shopping list. One of the Loks I selected was the Bavarian Mallet on page 57 of the 1999/2000 Märklin catalog. BR 96 number 5768. Here's the story behind my Mallet mammoth.

It was built in 1923 and delivered on January 31, 1923 and accepted by the Deutsche Reichsbahn Gesellschaft on February 22 of the same year and assigned to Betriebswerke Rothenkirchen and Aschaffenburg. It performed its duties and in late December 1926 was returned to J. A. Maffei for modifications to the buffers and the braking system. The machine soldiered on into the 1930s, suffered a broken frame in 1931 which was repaired and the Lok returned to service.

The author of "Die Baureihe 96 – Malletriebe für den Schiebedienst" found that the history of 96 018 (5768) becomes unclear in 1944. There is a message from Rbd Nürnberg dated July 26 of that year that the engine was mustered out at Bw Aschaffenburg and stricken from the record. On the other hand, the inventory kept at Rbd Munich and dated December 17, 1945 shows that the machine was still existed but was not in use because it was damaged. Other documents showed it to be stationed at RAW Ingolstadt, again as a damaged engine. Still other sources have 96 018 (5768) returned from Munich to Nürnberg in 1946. There is sufficient evidence that the engine was definitely located in Ingolstadt-North and dismantled in Desching (near Ingolstadt) some time in 1949.

One very interesting aspect of the BR 96 is its relatively short service life compared to other steam locomotives. First put into service in 1913, some of the machines were already withdrawn by the late 1920s. Admittedly, some of them did survive beyond World War 2.