# The Ae6/6 - a technical overview

*Above:* No. 11520 at Langenbrück.

*Above Right:* An unknown Ae6/6 on a log train near Lotzwil.


*Right: No.* 11464 on a local freight at Mülenen.

# The Ae6/6 – a Technical Overview

## Paul Russenberger

The post-war rise in traffic over the Gotthard demonstrated that the use of locomotives with four driven axles was becoming inadequate. The Ae4/6 was limited to a load of 375t without assistance; if this could be increased to 600t, then 95% of all trains over the Gotthard could be handled by a single locomotive.

Accordingly, the SBB issued this specification in 1949 for two prototypes at a cost of up to CHF3.25m:

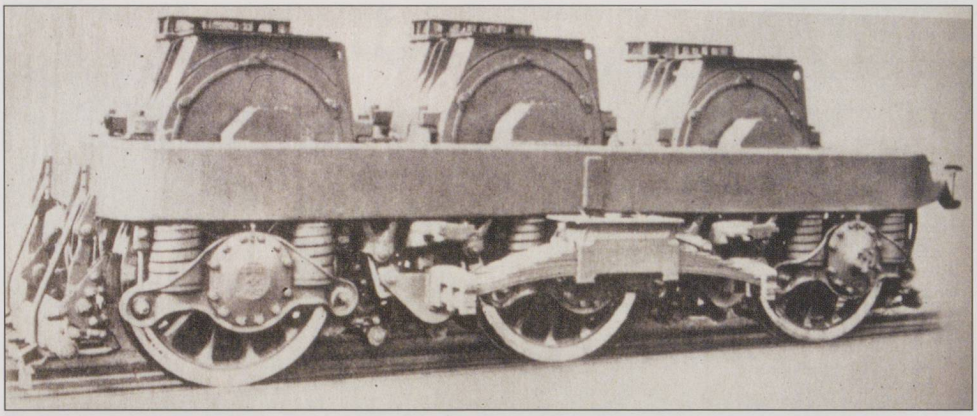
**1.** A 6-axle locomotive with no carrying axles and a maximum axle load of 20t and weight in working order of 120t, subject to a tolerance of 2%.

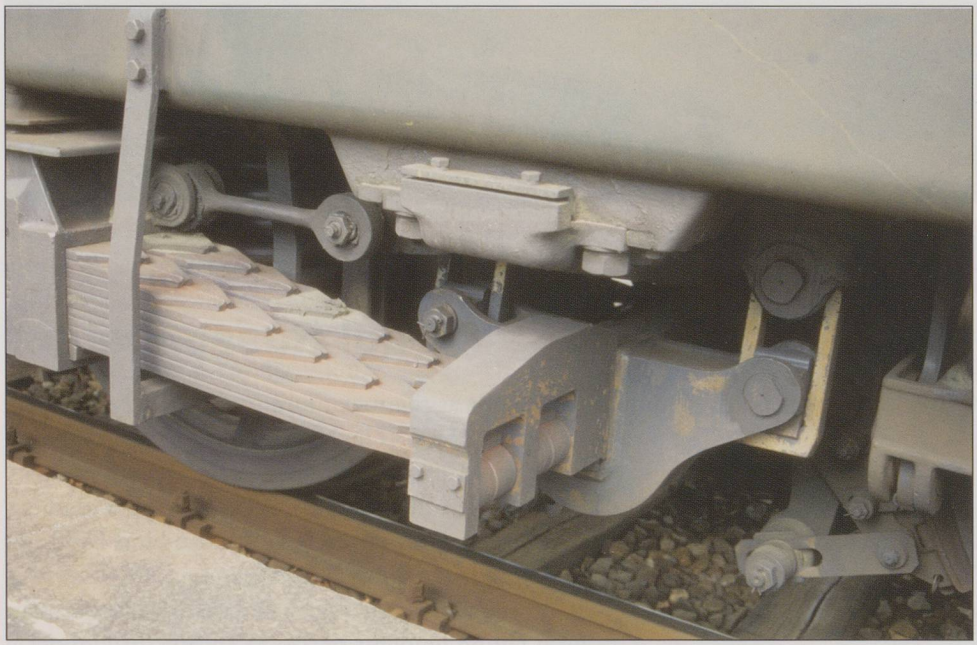
**2.** An hourly rating of 6000 hp at 74 kph and a continuous rating of 5400 hp at 78.5 kph, with a tractive effort of at least 8t at the maximum speed of 125 kph with power supplied at 15kV. The hourly rating to be capable of being exceeded by 10% for 15 minutes.

**3.** To be capable of hauling a load of 600t up a gradient of 2.6% (1 in 38.5), 750t up 2.1% (1 in 47.6) and 1450t up 10% (1 in 100) at a speed of 75 km/hr.

**4.** Using regenerative braking to be able to control a train of 300t on a falling gradient of 2% (1 in 50) throughout a speed range of 35-75 kph continuously and to exceed this by 20% for 5 minutes.

A consortium of SLM (mechanical construction), Brown Boveri (electrical equipment), MFO (brakes) and SAAS (switchgear) responded with a unit price of CHF1.62m.



*Top:* No. 11450 at Chur in August 1992.

*Middle:* Ae6/6 bogie showing the springs supporting the body and the spoked wheels.

*Bottom:* Inverted leaf spring secondary suspension directly supporting the body.

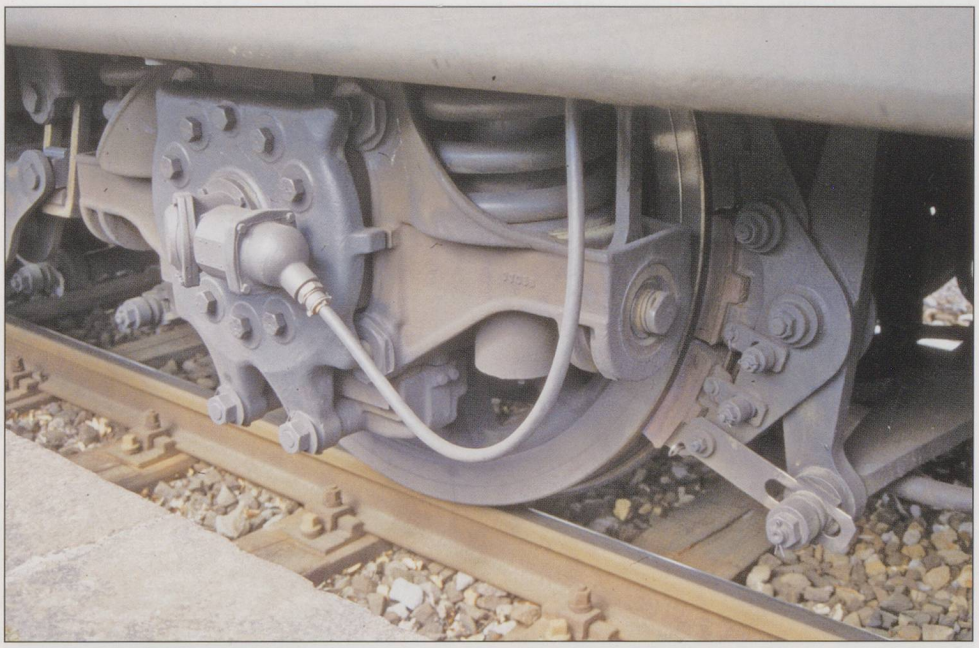
The first locomotive was delivered on 4th September 1952, with the second following on 31st January 1953.

After commissioning tests, both went into timetabled service between Luzern and Chiasso running between 800 and 990km daily. This exacting regime revealed problems with the traction motors, a tendency to rough riding on poor quality track, and undue flange wear. Some motor failures led to them temporarily running between Bern and Luzern with up to two motors removed and replaced by ballast.

The body was of electrically welded integral construction, with stiffening pillars at the corners and in the centre of the ends to provide additional protection to the crew. Fenders were fitted below the buffer beams to keep ice and snow out of the bogies. The body rested on four inverted leaf springs, forming the secondary suspension, placed outside the centre of each bogie and could slide on the spring buckle to allow the bogie to rotate. The ends of each spring were connected to the one on the other side by transoms running through the bogie resting on hanger brackets attached to the bogie frame. Traction forces were transmitted from the bogie to the body by two pivots located in transverse girders between the outer and middle traction motors; these pivots could slide in an oil

filled V-shaped channel in the girder at the same level as the top of the outside inverted leaf springs. The channels were curved so that the pivots moved about a virtual pivot point in the centre of the bogie.

The bogies, welded from steel castings and rolled sections, were identical to those used on the SNCF CC 6051 built by SLM in 1950. Primary suspension was provided by pairs of coil springs on each roller-bearing axle box, those on the middle axle being softer. Rubber inserts allowed limited horizontal movement between both outer axles of each bogie and the bogie frame. Flange lubrication was fitted to the outer axles of the locomotive. The motors were fully suspended, power being transmitted through BBC spring drives, which had been introduced on earlier Triebwagen and used both on the Re4/4 and internationally. The motor pinion engages with a toothed wheel. On the inside of the wheel a series of springs, orientated circumferentially, connect it to a number of radial arms attached to the rail wheels. This arrangement allows vertical and horizontal movement between the motor and the driven axle. Ten arms were used to enable greater power transmission than through the eight on the Re4/4. The teeth were angled slightly to improve continuity of contact; the gear ratio was 1:2.56. Despite the motors being fully suspended, the bogies exerted severe forces on the track causing the maximum speed in service to be limited to 110 kph.



*Above:* Axle box with speedometer drive, showing the coil springs between axle box and bogie. The lower two of the three brake blocks can be seen.

*All photos: Paul Russenberger*

To comply with legislation both automatic and straight air brakes were fitted, controlled through a single driver's brake valve. A 'rapid action' brake enabled a total brake force of 150% of the locomotive weight to be applied at the brake block/wheel interface at speeds above 60 kph. The driver could activate an electro-pneumatic anti-slip control, through a push button. In traction this applied limited air pressure to the brake cylinders. Sand could also be applied to the outer axles of the locomotive.

The high-tension electrical circuit was fed through an air blast circuit breaker supplied by BBC and capable of interrupting a 200 MVA fault in 0.05 seconds. It was specifically developed for lightweight and ease of maintenance; the type used on the production series became a BBC export product. A high-tension tap changer, fitted integrally with the transformer, was used so that a low current was being switched. This successfully reduced wear, despite there being about 5000 step changes in daily running of 800 to 1000km. The low tension total traction current was typically 3000A. Additional secondary windings provided 220V for auxiliaries and 1000V for train heating. Oil tight MFO induction motors, lubricated by the transformer oil, pumped it through four coolers.

Apart from 11412-14, which had MFO 10-pole motors, BBC 14-pole series commutator motors were fitted. Access to the brushes was from both underneath and within the locomotive, the commutator end of the motor being adjacent to the internal walkway. All six traction motors were arranged in parallel. The carcasses were weld fabricated to reduce the weight to 3800kg, giving the


No. 11518 leaves the shed at Erstfeld to bank a freight up to Goschenen, 1 April 2000.




weight to power ratio of 3.1kg/hourly hp.

To limit brake block and wheel tread wear on the Gotthard route, MFO developed regenerative braking, using No.1 motor to generate current to excite the field windings of the others. With up to 15 steps of braking, 1960kw could be absorbed at the wheel. To prevent overheating of the traction motors, a resistance was inserted in parallel with the field windings above 95 kph. This was not automatic and led to severe changes in braking effort if the driver removed it at a lower speed.

Equipment was cooled by two symmetrical ventilating systems, each of which could deliver 270m$^3$/min. These drew air in through bodyside louvres and passed it through the transformer oil cooler and then the traction motors on the commutator side. The interior of the body was slightly pressurised to keep out brake block dust and snow. An ac induction motor supplied 36V to supply the control circuits and lighting. Miniature circuit breakers, rather than fuses, protected the auxiliary electrical circuits.

Bellinzona works was responsible for heavy maintenance. Repairs took place every 400,000km, the sequence being **R3: R1: R1: R2: R1: R1: R3**. The equipment dealt with at each repair was:

**R1**: Running gear, brakes and tyre re-profiling.

**R2**: R1, and traction motors, control equipment and auxiliaries.

**R3**: Complete overhaul of all components and repaint.

The interval between repairs would normally be around 20 months. Should a locomotive have been in service for 6 years since a repair without achieving 400,000km, an examination of the

*Top:* No. 111408 rests on a Sunday afternoon at Bulach with several others, 27 April 2003.

*Middle & Bottom: No.* 111520 at Fluelen on 13 September 2010, on a freight, now red and bereft of nameplate, but still majestic.

relevant components took place to ensure that it would be able to run the full distance satisfactorily.

Four spare bogies were kept at Bellinzona and the interchangeability of components between locomotives reduced downtime at depots and works. In 1964, 5.1% of the fleet were out of service in works. This was made up of planned maintenance 1.7%, technical faults 1.9% and accident repairs 1.5%.

No.11401 was given its first R3 at 1,892,084km to provide early evidence of its condition. This showed a reduction of 3-rappen/kilometre in maintenance costs. Subsequent data showed that the cost of lubricating materials was 0.7-rappen/kilometre with 500t loads; 100,000km running produced 1mm depth of wear on the wheel treads; on lightly graded sections of line the power consumption was 0.04kW-hr per tonne-kilometre.

Following crash damage in 1972, No.11430 was experimentally fitted with automatic couplings at Number 1 end. This eliminated the need for buffers; the air pipes and front fender were also altered, the coupling release and brake pipe cocks being on the right hand side. The locomotive ran just one test journey on a freight train!

In 1996 Nos.11474 & 11475 were used to test the braking of a 1500 m long freight train weighing 4055t between Büren an der Aare and Solothurn. Placed at each end, radio contact simulated multiple working.

By 1960 there were 50 units in service to cover 41 diagrams, requiring 82% availability. While intended for the Gotthard, in 1958 the Ae6/6 fulfilled two diagrams between Vallorbe and Domodossola; these were covered by Erstfeld shed, to which the locomotives returned every two weeks for maintenance. When the last units were delivered all, except Nos.11471-11483 at Lausanne, were allocated to either Erstfeld or Bellinzona. Daily diagrams generally covered 660 km, although four on the Gotthard exceeded 1000 km, and reached as far afield as Basel, Buchs and Romanshorn. Although Zürich gained its first allocation in 1975, the delivery of Re4/4lll and Re6/6 classes began the serious displacement from the Gotthard and by 1980 only Nos.11403-17 were at Erstfeld, Bellinzona's units having moved to Basel. The Ae6/6 was now permitted everywhere except Bäretswil – Bauma, Bischofszell Nord – Hauptwil and Thalheim – Ossingen. They really had become 'universal locomotives'!

On a personal note, I was aware of them on my first three visits to Switzerland in 1958-60 as they were the only standard gauge named Swiss locomotives. In the mind of a schoolboy in shorts they were the 'Canton Class' and I had dreams of getting a Tri-ang EM2, renumbering it and giving it a Ticino emblem. The last time I saw one in service was No.11520 at Flüelen on 13 September 2010; now red and bereft of name and emblem it still had something of the majesty I remembered.

# Exploring by PostAuto

## Martin Fisher seeks your assistance for a future book

Photo: Malcolm Bulpitt

The programme of eight Swiss Travel Guides has been completed this year with the publication of '*Basel and North West Switzerland*'. Emboldened by the success of these Guides, over the next few years the *Swiss Railways Society* will be publishing more books about exploring Switzerland. The first few additional titles are already in the pipeline, but I am writing to seek your assistance with a book that is not scheduled for publication until March 2016. That book will be about Swiss PostAutos and while there is likely to be a bit about the history of the organisation, and a description of the fleet, the main object will be to describe a selection of routes operated by the PTT's ubiquitous yellow vehicles. There are some obvious Alpine candidates for inclusion but I would be very grateful if members could let me have a brief description of routes they have enjoyed over the years, whether in the Alps or in less well known corners of Switzerland. With any submission please add a sentence or two about what made the journey so memorable for you. There have one or two articles describing PostAuto trips that have been published in *Swiss Express* in recent years and with the permission of both the Editor and the authors' I will look at these for possible inclusion. Please email your ideas c/o editor@swissrailsoc.org.uk putting Swiss Express PostAuto in the subject box, or write direct to me at 28 Appletree Lane, Redditch, Worcs., B97 6SE.GB, by the end of September 2014.