Zeitschrift: Swiss express : the Swiss Railways Society journal

Herausgeber: Swiss Railways Society

Band: - (2005)

Heft: [2]

Artikel: Amsteg-Silenen : hydro-electric generating station

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DOI: https://doi.org/10.5169/seals-854824

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AMSTEG-SILENEN
Hydro-electric Generating Station

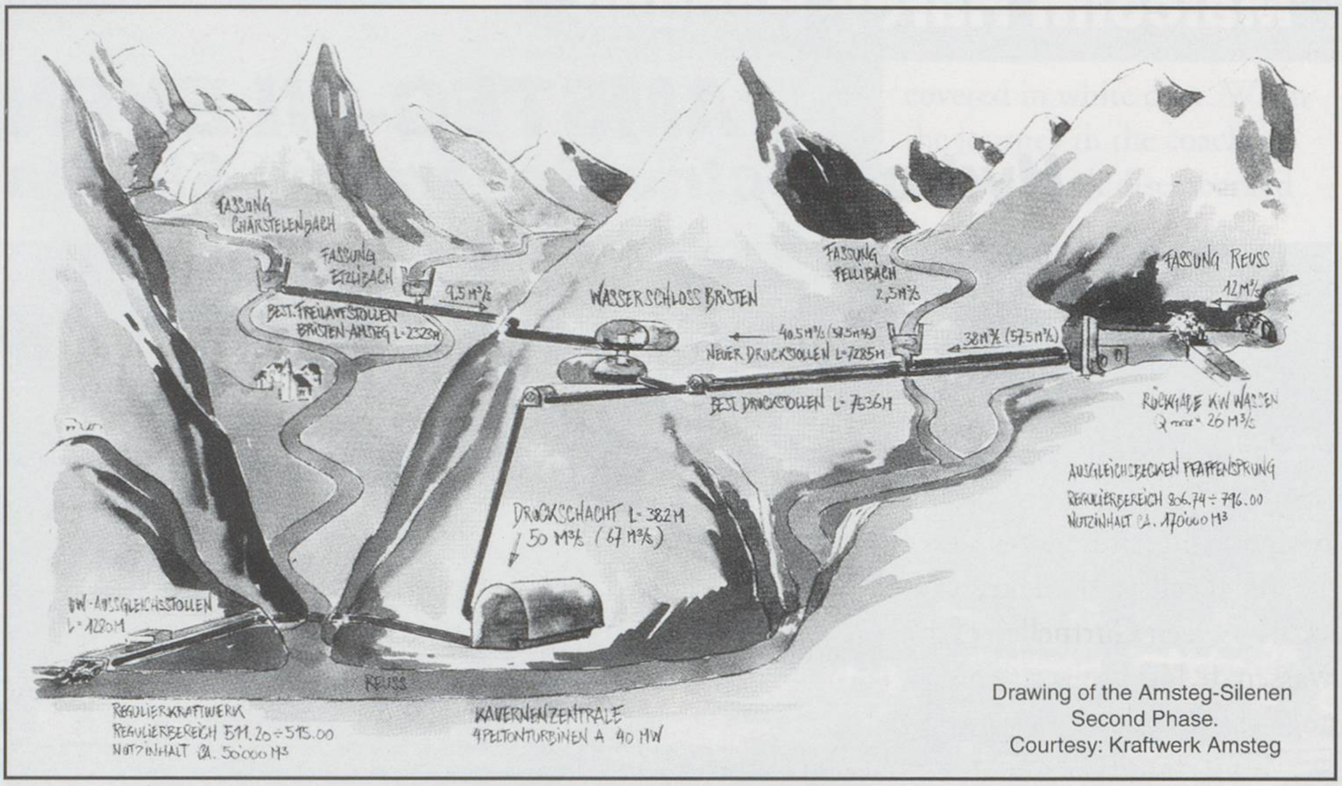
Amsteg. Power station. Photo: Malcolm Hardy-Randall Collection

The SBB Electrification Commission

At the start of the 20th Century and at the insistence of Dr Emil Huber Stockar - a Director of Maschinenfabrik Oerlikon (MFO) - a request was made to the SBB to carry out a trial into the use of high voltage AC traction power for the main routes, in particular the Gotthard line. With the granting of this request a commission was set up to investigate the proposals to electrify the Swiss Railways. The current voltage level for trams and light railways prevailing at this time was 600 - 700 volts DC, which was far too low for main line locomotives so tests with a higher voltage had to be undertaken. Thanks to the research by Huber Stockar's eminent colleague, Hans Behn Eschenburg, Chief Electrical Engineer MFO, in overcoming the problems concerning the use of high voltages in traction motors, tests could take place between Seebach and Affoltern on the 16th January 1905.

The full trial of the MFO system with three locomotives took place between 1907 - 09 at the same time as trials by the Brown Boveri Company were taking place on the main line through the Simplon tunnel. The commission was presented with the results of these trials for the use of electric traction carried out by the privately funded single phase 15 kV 50 [later 15] Hz system designed and built by MFO for the Seebach to Wettingen line and the three phase 3 kV system employed by BBC on the Brig to Iselle di Trasquera line through the Simplon tunnel.

Encouraging results on the use of 15 kV 16.66 Hz catenary supply came from the BLS, who had in 1906, acting upon the advice given by Prof Blattner, decided to use the MFO system. This system, in use since 1911 on the Spiez - Frutigen line, provided ample data to the SBB and also had a profound effect on the final report from the Electrification Commission. In 1912 it announced that the mountain



Drawing of the Amsteg-Silenen Second Phase.
Courtesy: Kraftwerk Amsteg

section of the recently acquired (in 1909) Gotthardbahn should be electrified at 15 kV 16.66 Hz.

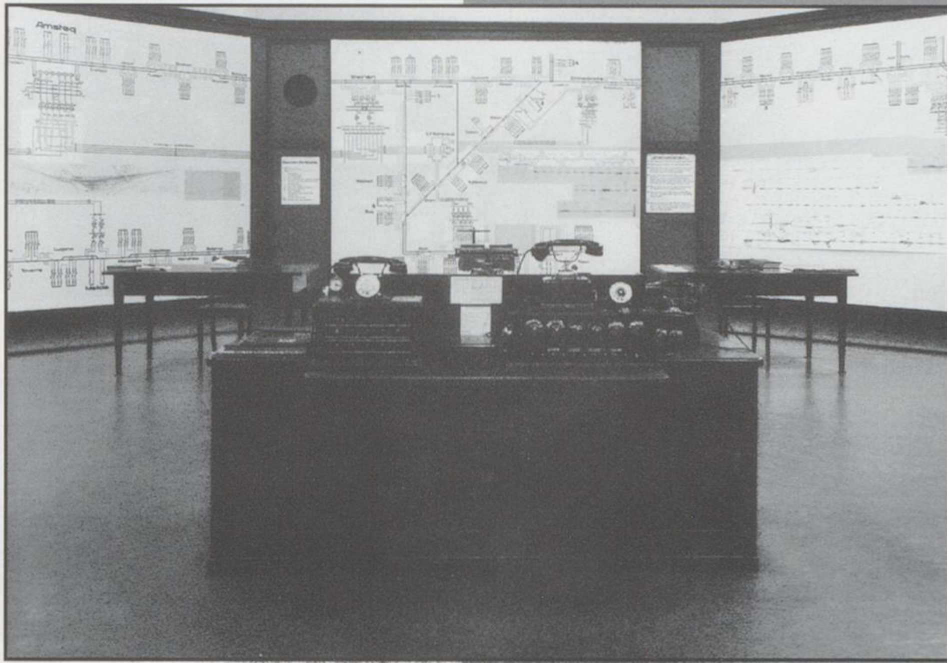
The management of the Gotthardbahn had negotiated with the Uri and Tessin/Ticino governments in 1907 for water extraction rights from the Reuss and Ticino river areas, a right that transferred to the SBB after the takeover of the GB. The General Management of the SBB agreed in August 1913 with the Gotthard electrification proposals. In November 1913 the Board of Directors of the SBB unanimously approved the plans, although there had been a suggestion, from a single member of the board, that a number of locomotives equal to 100% of those in normal use should be held in reserve due to repair requirements! An initial credit of SFr38.5 million was arranged for the work to be started, with catenary installation over the route from Erstfeld to Bellinzona planned to start as soon as possible but because of the outbreak of the First World War in 1914 plans had to be put on hold due to a shortage of materials. However, work started in 1916 on the supply and installation of the catenary and the building of the power generating station at Ritom-Piotta on the South Ramp required to supply the route. The SBB placed a high degree of urgency upon the work as the cost of coal had by this time reached a level of 7 times higher than pre-war prices. It had also become extremely difficult to obtain.

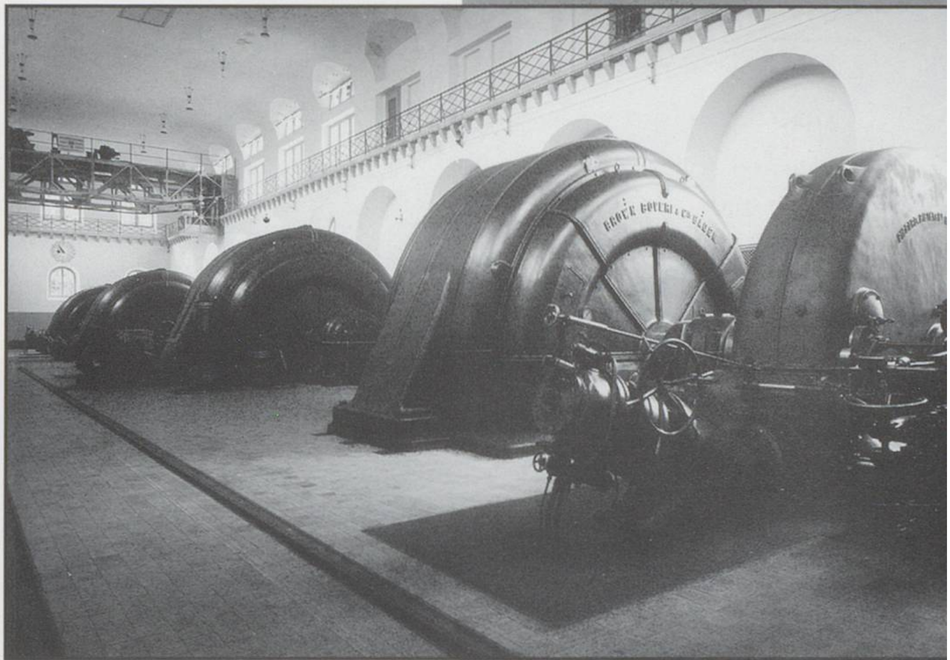
The first hydro-electric station in Amsteg

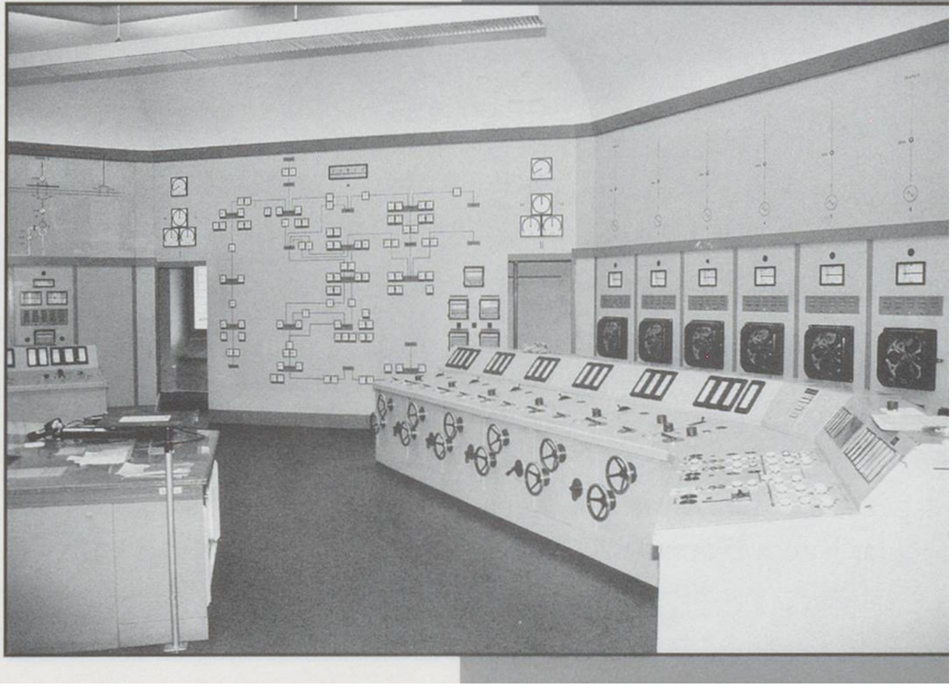
A generating station for the supply of electric traction power had to be planned and built to supply the North Ramp of the Gotthard section of the line and later the area to the north of Erstfeld. Site surveys of the area showed that the best location for the hydro-electric plant was Amsteg-Silenen just south of Erstfeld.

Construction began in 1918 of the station as a running water hydro-electric generating plant using local rivers for supply, as there are no water storage facilities available other than the very small lake at Pfaffensprung. The building work was given to the Zürich engineer Hans Studer with the SBB engineer G. Croce being responsible for the electro-mechanical equipment. All of this being under the watchful eye of SBB Kraftwerkzentrale architect Thomas Nager. Construction was completed in December 1922, at a cost of SFr51 million and was ready for service providing traction power for the section from

TOP RIGHT: Amsteg. Control Room.
CENTRE: Generator Hall. Completed.
BELOW: Amsteg. Old Control Centre.
Photographs:
Malcolm Hardy-Randall collection



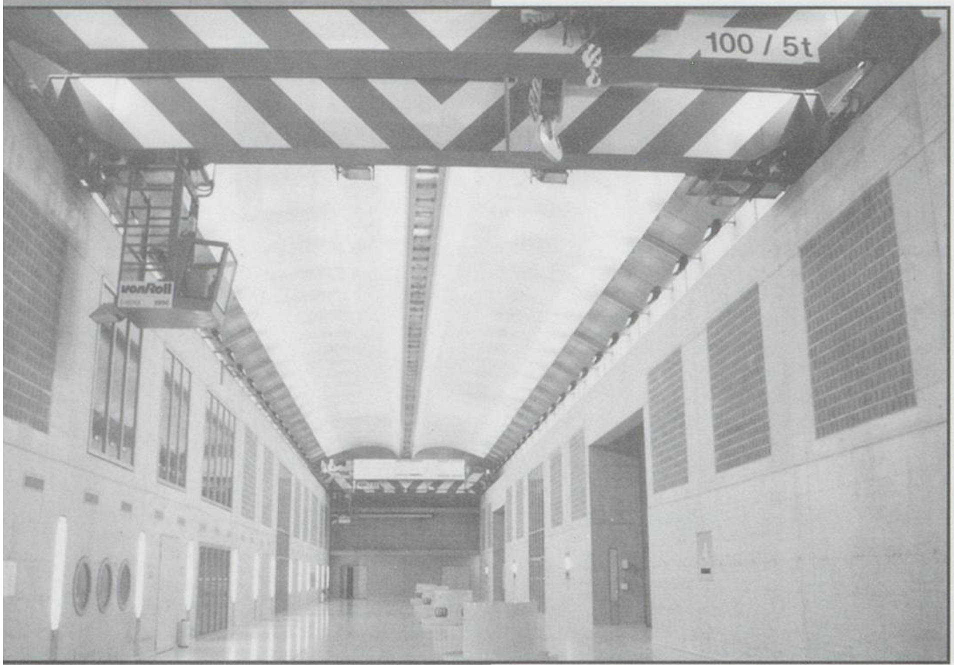


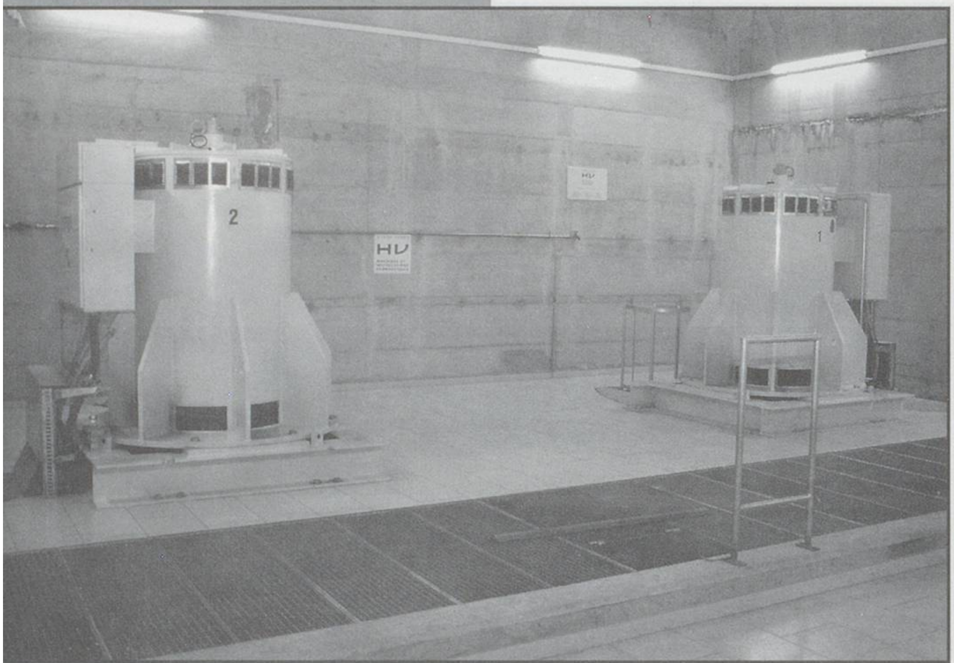


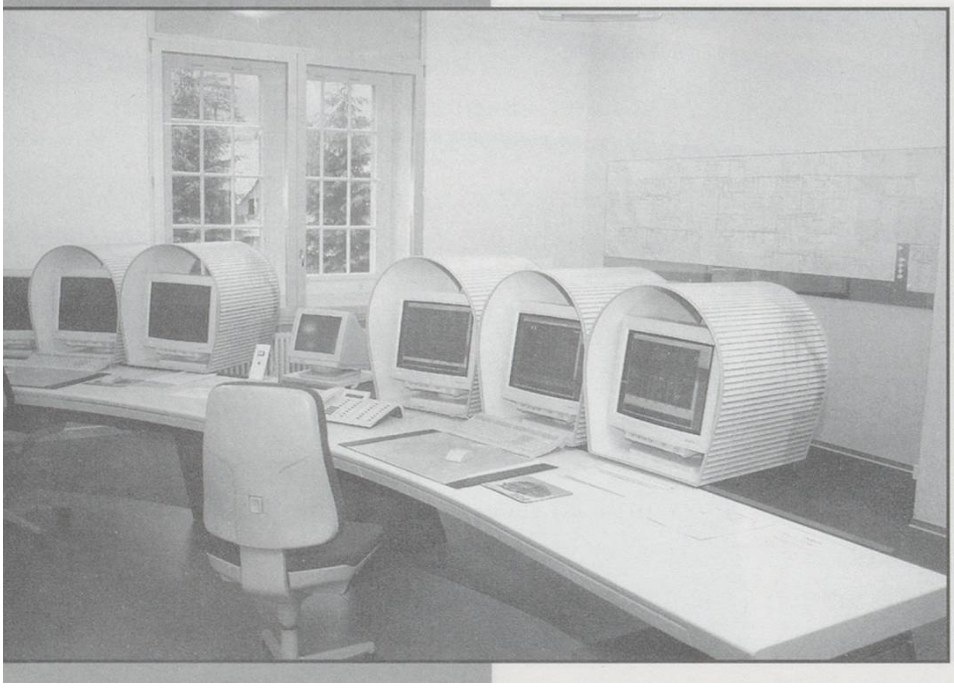
Göschenen to Erstfeld.

In the station were six Pelton wheel turbines driven by water from the Chärstelenbach and Reuss rivers, and from the Pfaffensprung lake located 275 metres higher up the Reuss valley. The lake, lying between Gurtnellen and Wassen, fed its water to Amsteg via a 7.5 km tunnel into two 3.6 metre diameter water pipes down to the generating hall. The MFO-built single phase generator driven by a Piccard - Pictet-built Pelton wheel-water driven turbine rotating at 333 rpm had a maximum rating of 12,700 kVA. The first five generators brought on line in 1922 had a continuous working capacity of 50,000 kVA, later increased to 62,000 kVA. The sixth unit brought into service later was a three phase 50 Hz Generator to supply the public electricity service.

During a later station rebuild the 50 Hz public supply generator ceased operation, and in its place was fitted a 16.6 Hz generating unit to supply more power to the SBB network. The output transformers, each weighing 50 tonnes and supplied by the manufacturer S.A. des Ateliers de Sécheron in Geneva, fed power at 66 kV to the SBB network.







TOP LEFT: Amsteg II. Generator Hall.
CENTRE: Secondary Generating Hall.
BELOW: Amsteg. New Control room.

The Second Generating Station

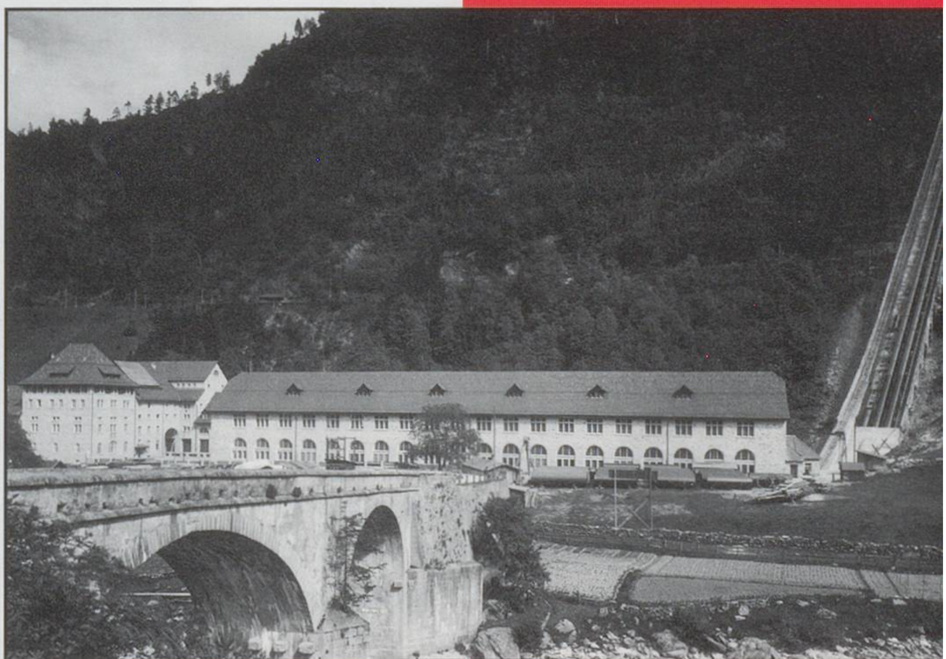
The Reuss must be about the most utilised river in Switzerland for the generation of electric power. The SBB Göschenen and SBB Göscheneralp stations take water from the river and feed it back into the Reuss, which then flows down the mountain. Along with water from tributaries and the water from the generating station at Wassen the river passes into the lake at Pfaffensprung, which forms the main source for the Amsteg station. The Pfaffensprung lake has a storage capacity of approximately 160,000 m^3 which is sufficient to supply the Amsteg complex with enough water for 40 minutes when running at maximum output.

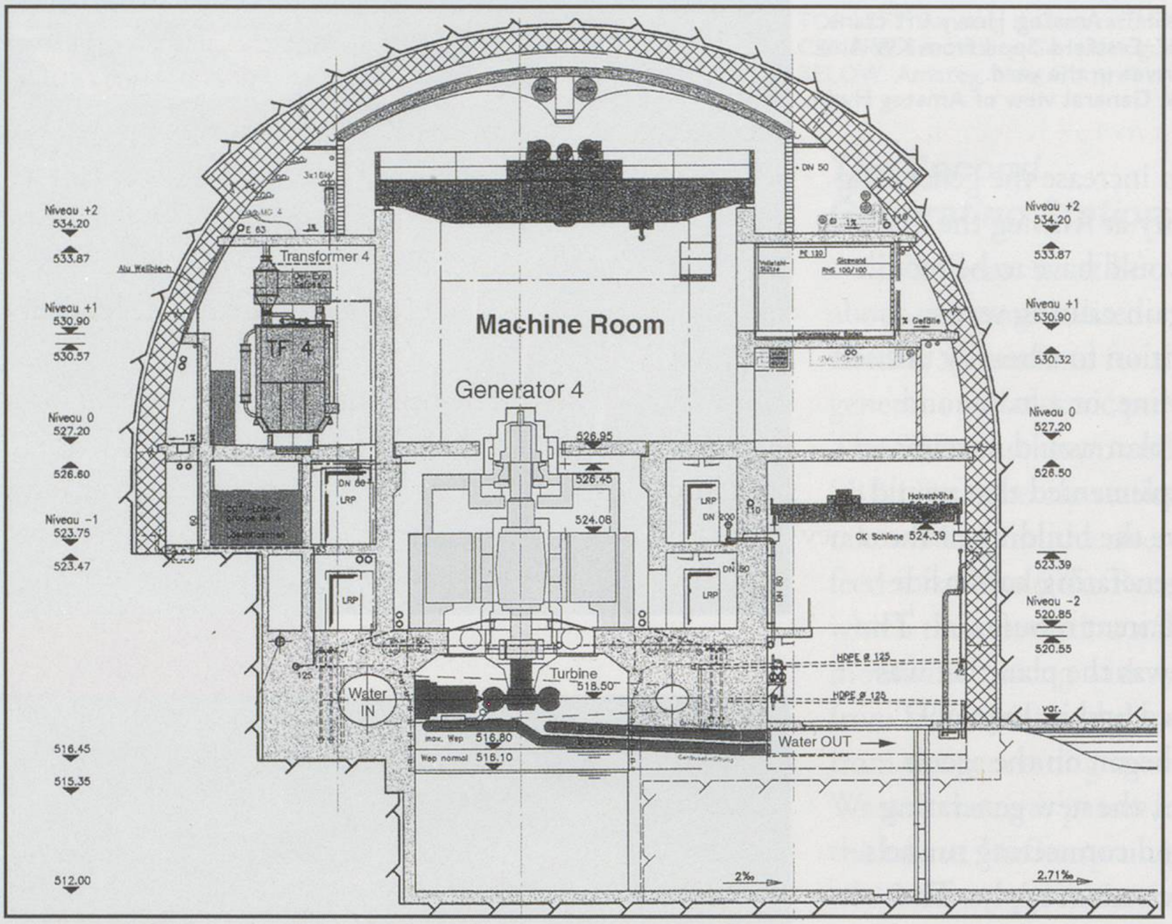
Possibly the largest single project in the hydro-electric generating industry in Switzerland took place at Amsteg. The supply of power had to be increased to meet the ever increasing demand for traction power on the Gotthard. On the south side of the pass the hydro-electric plant at Ritom was undergoing development but on the north side the station at Amsteg was the only site that could be developed further.

TOP RIGHT: Amsteg. Heavy lift crane.
CENTRE: Erstfeld. Spoil from KW Amsteg arrives in the yard.
BELOW: General view of Amsteg Hydro

To increase the generating capacity at Amsteg the main hall would have to be rebuilt yet again causing severe disruption to a heavily utilised main line, or a major and novel plan would have to be implemented that would involve the building of the new generating hall inside the adjacent mountain. The latter was the plan that was adopted and in July 1992 work began on the access tunnel, the new generating hall and connecting tunnels for the water supply. The cost of the subterranean plant was estimated to be SFr 460 million for an annual output of about 460 million KWh. In the summer of 1998 when the station was commissioned the final cost was SFr 474 million.

A tunnel built in the 1920s fed water from the Pfaffensprung lake down to the generating plant at Amsteg-Silenen I, but for the new station this was not suitable so a new tunnel that measures 7 kilometres was constructed to connect the lake and a new junction station where all the water feed tunnels combine along with a new system that brings water from the Chärstelenbach and Etzlibach rivers via two small dams built across the two rivers.





ABOVE: Cross section of the main generating hall.
BELOW: Amsteg. Generator hall. Turbine assembly.
Malcolm Hardy-Randall collection

The water is then fed via a 2.3 kilometre long tunnel into a huge underground control facility.

The control section provides a steady flow of water to the generating plant but also provides a facility that prevents the 'kick back' pulse created on emergency generator shut-down from causing damage to the distribution system. Water from the control section is then fed to the valves, which regulate the flow into a 382 metre long tunnel down into the new generating plants.

The main generating cavern has the capability of housing four turbines, but at present has only three fitted as these are more than able to satisfy the current needs of the SBB. The Pelton impeller fitted with 19 cups of stainless steel has a diameter of 2 metres and weighs 8 tonnes and is connected to the generator rotor by six steel bolts. Rotational speed of the turbine is 333.33 RPM.

The generator fitted with self-excitation is rated at 50 MVA and an output voltage of 11KV 16.66 Hz single phase. The output

supply is fed to individual oil-cooled 50 MVA transformers fitted to each generator for conversion to 132 KV for feeding via the external switching station to the railway grid system. A diesel generator for emergency supplies is fitted within the cavern. Fire protection for the transformers, generators as well as internal cabling and switches is provided by a Halon gas fire extinguishing system.

Water from the output side of the old generating plant was fed straight back into the Reuss river, but from the new plant it is sent via a 1,280 metre long tunnel to a small generating plant built in a cavern lower down the mountain to provide power at 50 Hz for the local public network. The water leaves the public supply generator plant and is finally discharged back into the main river and on into the Vierwaldstättersee near Flüelen. The two turbines fitted in the small cavern are connected to two self-excited generators that have an individual rating of 1,150 kVA at 50 Hz. The output is fed from each of the generators to transformers that step up the voltage from 400 volts to 15,000 volts at 50 Hz. The supply is then fed into the public network for distribution to the local community or can be fed on a parallel system independent of the public supply.

The computerised control room has overall control of all functions from the sluice gates and valves of the water input to the output of the electrical supply. The system provides for full automatic control with full logging of events, to manual override for maintenance of equipment. A full control link is built into the system to connect the station to the Central Control Centre Zollikofen.

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