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Switzerland by rail

Supplying traction power for the country's major railway initiatives

RENÉ JENNI, REMIGIUS STOFFEL, MELANIE NYFELER – Switzerland is generally considered a pioneer when it comes to public transport. In no other part of the world are trains, trams and buses used as often as they are in this small Alpine country. In fact, so beloved is the public transportation system in Switzerland that its people have repeatedly voted in favor of extending the already comprehensive rail network even further. The country's aim is to carry more travelers on public transport and transfer more freight from road to rail. ABB is participating in this effort, supplying the power for the two new base tunnels through the Alps – the Lötschberg and the Gotthard – as well as DC traction substations for public transport in the conurbations around the cities of Zurich, Bern and Luzern.

Studies repeatedly show that the Swiss are world champions when it comes to traveling by train. On average, each of the country's residents travels 40 times each year on Swiss trains, amounting to about 900,000 people on the Swiss railroad system every single day [1,2] → 1. Not surprisingly Switzerland has the highest frequency of train services in the world.

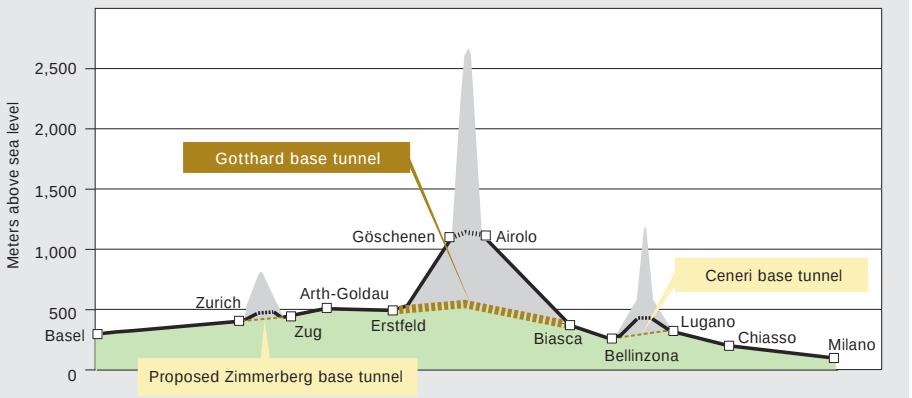
Thanks to the strategic transportation policy of the Swiss government, Switzerland has a very well developed rail network, which ensures that rural areas can be reached and offers rail connections between cities that operate every hour or even every half hour. To meet the growing demand, Swiss Federal Railways (Schweizerische Bundesbahnen, or SBB) has not only increased the frequency of its timetable, it also continually upgrades its rolling stock.

When it comes to rail transport in an international context, the Alpine country also sets milestones and pursues an active policy of transporting goods by train rather than truck, where possible. Today Switzerland is the most important transit country for goods crossing the Alps by rail. In 2008, 40 million tons of freight were transported through Switzerland, more than half of which – around 25 million metric tons – were transported by train [3]. Many referenda have also demonstrated the Swiss' support for transport of goods by rail. An important step in enabling such rail transport is the construction of the New Railway Link through the Alps (NRLA), which integrates Swit-

1 Comparison of European railways (2007) [1]

Country	Total km of rail	Number of train journeys per resident
Switzerland	3,158	40
Luxembourg	275	33
Denmark	2,133	29
Austria	5,702	24
Germany	33,890	22
The Netherlands	2,776	20
Belgium	3,374	19
Czech Republic	9,460	17
France	29,918	16
Spain	13,368	11
Italy	16,335	9

2 Alpine base tunnels (©AlpTransit Gotthard Ltd.). Train route from Basel, Switzerland to Milano, Italy via the 57 km long Gotthard base tunnel



zerland into the growing European high-speed network. Thanks to the two NRLA axes – Gotthard and Lötschberg – the annual capacity of goods transported by rail will more than double from 20 million metric tons in 2003 to around 50 million metric tons once the two routes have been completed in 2017.

Traction power for Lötschberg

The Lötschberg base tunnel was opened in December 2007 after a construction and planning period of about 10 years. This new rail tunnel considerably reduces travel time from the north to the Valais region of Switzerland in the south. Every day around 40 passenger and 110 goods trains pass through the Alps at an altitude of about 800 m – about double the numbers that pass through the much higher link between Goppenstein and Kandersteg, which has been used to date also as a car shuttle.

This once-in-a-century achievement, with numerous cross-galleries and huge excavations for the technical systems, also provided a tremendous challenge for ABB. The company was responsible for the design, supply, installation and commissioning of the 16.7 Hz traction power supply system and the 50 Hz energy distribution system.

The supplied medium-voltage system provides the power to the infrastructure for the lighting, signaling, communications, ventilation and air conditioning systems, as well as the safety doors in the entire tunnel. The medium-voltage distribution system includes 21 transformer stations with UniGear ZS1 air-insulated medium-voltage switchgear, 30 distribution transformers and two 5 MVA coupling transformers for connecting the two networks of the local energy suppliers.

The second part of the order involved the 16.7 Hz traction power supply system. To connect Switzerland to the high-speed European network, the contact lines in the tunnel were specially designed for train speeds of up to 250 km/h. The traction power supply system is designed in such a way that several train configurations with up to six locomotives and freight trains of up to 1.5 km in length can be supplied with power simultaneously. Consequently, the switching and protection equipment must be able to handle short-circuit currents of over 40 kA.

ABB installed air-insulated single-phase UniGear R36 switching panels, which offer maximum security to personnel and systems. The traction power supply assemblies, including its highly sophisticated substation automation and protection system, are installed in containers. The containers are then placed in different operating centers housing all systems required to safely operate the railway system. Two local control centers near the northern and southern tunnel portals contain the workstations from which the power supply systems are controlled and monitored.

The world's longest rail tunnel

To the east of Lötschberg and nearly in the center of the country, the work on Switzerland's second cross-Alpine link is powering ahead. The base tunnel of the Gotthard is the heart of the NRLA and is expected to make a marked improvement in travel and freight options in central Europe. When it goes into operation in 2017, the Gotthard base tunnel will, at about 57 km, be the longest tunnel in the world → 2. The building project is both immense and pioneering. Creating the twin tubes with connecting crossways means removing – in sections – a total stretch of 152 km of rock. This work will be completed in autumn 2010. Installation of the electrical equipment is already underway in some parts of the tunnel.

Here too, ABB is supplying the power engineering equipment. The company is to supply gas-insulated medium-voltage switching panels and protection equipment for the 50 Hz tunnel infrastructure. The 875 medium-voltage units will provide a reliable supply of power and, at the same time, must withstand harsher than usual climatic conditions while requiring a minimal amount of maintenance.

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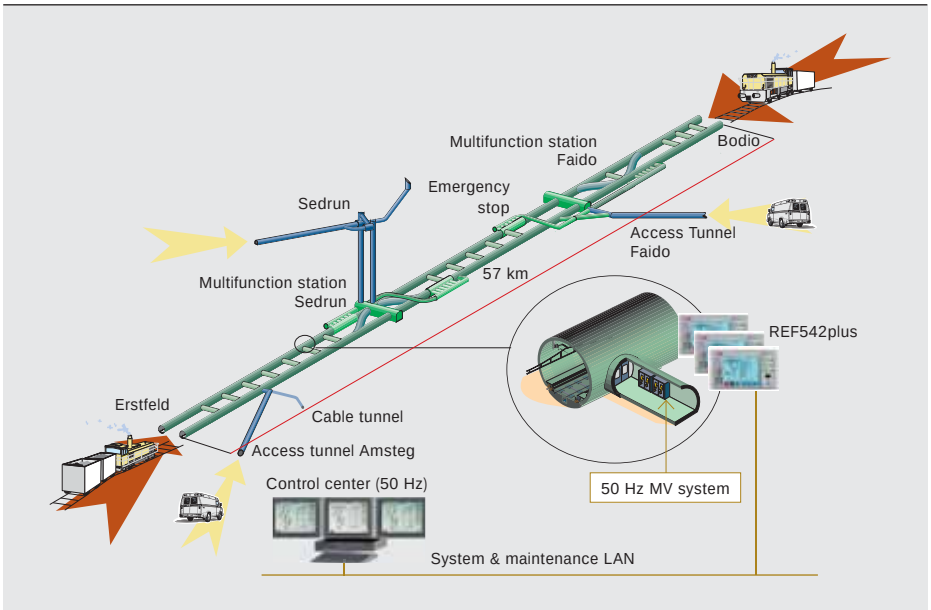
The two parallel, single-track tunnel tubes are connected to each other every 325 m by a 40 m long crossway. The systems for supplying electricity to the tun-

3 AlpTransit Gotthard tunnel overview (© AlpTransit Gotthard Ltd. Adapted by ABB)



4 REF542plus is providing fault protection in the Gotthard tunnel.

nel infrastructure are installed in these cross-galleries, which serve as escape routes between the two tunnel tubes ➔ 3. Because conditions in the tunnel are harsher than usual – factors such as salt deposits, brake dust, soot particles and abraded material from the rails and contact wires come in to play – ZX0-type gas-insulated switchgear is used. An important feature of this switchgear is that it is extremely compact, with a field width of only 400 mm. By combining up to six fields to form a fully functioning switchgear block, it is possible to exchange complete switchgear units within a very short time in the event of a fault. This functionality is critical for the operation of the Gotthard base tunnel, because rail traffic will have to be interrupted when access to the crossway is needed.

Exposure to the elements

Because the environmental conditions are so hostile, the relevant control cabinet must be designed to comply with protective class IP65. In addition, a standard feature of the medium-voltage part of the switchgear is that it is gastight. These design elements eliminate the risk of any ingress of environmental elements – ie, dust or water.

The intense fluctuations in pressure in the crossways place high demands on the materials. Because the trains pass the crossways at speeds of up to 250 km/h, variations in pressure of ±10 kPa are produced. Thus, pressure resistance of the ZX0 switchgear, including the control cabinet, has been ensured. The reliability and availability of these systems is essential for safety in the tunnel. This task is primarily handled by the REF542plus multifunction protection and control unit, which has been on the market for more than 10 years ➔ 4.

Over 500 units of this type have been installed at different points throughout the length of the tunnel. Here, the REF542plus performs its most important task using the newly developed, multistage distance protection. In order to provide optimum selectivity in a network, while at the same time provide a stable and reliable supply, fast identification of the fault type and the location of the fault is important, so that just the faulty parts of the network can be switched off. Information on both these points is transferred immediately to the tunnel control system.

REF542plus also enables remote service. Not only is it possible to access stored programs and protective data remotely via Ethernet LAN, but the data can also be changed and replaced. To date, REF542plus is the only protective equipment that offers this unique feature. Installation of the rail equipment has already begun and the 50 Hz supply is scheduled to start in 2011. The switchgear will then operate for decades, helping to safely transport millions of passengers through this unique tunnel system.

Urban transport system in Zurich

ABB is not only providing the power required to cross the Alps by rail – the company's power supply systems have also been used successfully for light rail and urban transport. In the Zurich region, a new light rail system is being built, which will link the adjacent Glattal residential and business area with the dynamic center of the country's largest city. The 150,000 inhabitants and 120,000

ABB is supplying the 50 Hz tunnel infrastructure with 875 gas-insulated medium-voltage switching panels and protection equipment for the Gotthard tunnel.

employees in its catchment area will benefit from the modern 12.7 km long tram line, which is being completed in stages and will be finished by the end of 2010 ➔ 5.

As the main contractor, ABB is working with the local construction companies Implenia Ltd. and Walo Bertschinger to provide the entire energy supply system.

5 Glattalbahn on the Balsberg viaduct (Photo: Daniel Boschung)

By 2012 ABB will deliver five rectifier substations, which will supply the city of Bern's tram lines with 600 V DC and also provide appropriate protection for the contact line system.

ABB is responsible for the design, supply, installation and commissioning of the rectifier substations providing the necessary traction power. The energy supply system includes eight rectifier substations, which supply the contact line with 600 V DC. The rectifier transformers are rated at 900 and 1,400 kVA, depending on the location.

ABB is also responsible for the low-voltage main distribution system, which is supplying all 22 stops on the Glattal light rail line with the required power (230 V) so that ticket vending machines, information boards and track switches all operate seamlessly. ABB has also installed the lighting, ventilation and fire alarm systems in the rectifier stations.

Development of urban transport

As is the case in Zurich, suburbs are booming – in and around Bern, Switzerland's capital city, the volume of traffic is also increasing. The city has opted for the tram as a means of public transport. In contrast to the trolleybuses used to date, the two new tram lines create direct links between the west, town center and east of Bern.

By 2012 ABB will deliver five rectifier substations, which will supply the tram lines with 600 V DC and also provide appropriate protection for the contact line system. The RTU560D remote system will connect the rectifier substations to the higher-level control system operated by the local utility.

ABB is also carrying out other contracts, including one for the municipal transport authorities in Lucerne to renew rectifier substations for their trolleybus lines.

Switzerland as a role model

Thanks to its well-developed public transport network, Switzerland is considered to be a positive role model and has influenced the trend toward the "ecological fast track." Its government wants to protect the Alps and the people living in the most densely populated areas of the country from the negative consequences of transit traffic. According to the director of the Swiss Federal Office of Transport [4], there are also economic reasons why they must succeed in shifting traffic – and above all, the expected growth in such traffic – to the railway. ABB is playing a key role in this shift with its innovative railway technology.

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