Switzerland by Rail
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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
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.

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.

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 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 substations 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. 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.

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### Comparison of European railways (2007) [1]

<table>
<thead>
<tr>
<th>Country</th>
<th>Total km of rail</th>
<th>Number of train journeys per resident</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switzerland</td>
<td>3,158</td>
<td>40</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>275</td>
<td>33</td>
</tr>
<tr>
<td>Denmark</td>
<td>2,133</td>
<td>29</td>
</tr>
<tr>
<td>Austria</td>
<td>5,702</td>
<td>24</td>
</tr>
<tr>
<td>Germany</td>
<td>33,890</td>
<td>22</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>2,776</td>
<td>20</td>
</tr>
<tr>
<td>Belgium</td>
<td>3,374</td>
<td>19</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>9,460</td>
<td>17</td>
</tr>
<tr>
<td>France</td>
<td>28,918</td>
<td>16</td>
</tr>
<tr>
<td>Spain</td>
<td>13,368</td>
<td>11</td>
</tr>
<tr>
<td>Italy</td>
<td>16,335</td>
<td>9</td>
</tr>
</tbody>
</table>

In 2008, 40 million metric tons of freight were transported through Switzerland, more than half of which were transported by train.
ing 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.

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, multi-stage 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.

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.

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 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.

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

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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.

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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.

References
ABB’s substation installations for the rail industry provide reliable power to the line and the vehicle, to keep main line trains, metros and mass transit networks on track. Optimized railway electrification solutions ensure availability and dependability of AC and DC power supply to enable high performance and efficiency. Our domain knowledge and global experience enables us to provide turnkey solutions and a worldwide presence ensures customer support throughout the lifecycle of the substation. ABB is the world’s leading supplier of air- and gas-insulated substations covering a range of voltage levels up to 1,100 kV, with a vast global base of installations. www.abb.com/substations