

Case story | VACON® NXP

Excavating tunnels through the Alps

Reliable and effective ventilation is of the essence when excavating the world's longest railway tunnels through the Alps in Switzerland. In the Ceneri Base Tunnel (CBT), which is a logical continuation of the Gotthard Base Tunnel, ventilation of the explosion areas is handled by a system designed by Systemair* and controlled by the VACON® NXP range of AC drives.

The Gotthard rail link, which is one of the two major sections in the massive AlpTransit project**, consists of the Zimmerberg Base Tunnel, the Gotthard Base Tunnel and the Ceneri Base Tunnel. Constructed several

hundred metres below the level of the current tunnels, the new Gotthard rail link means a continuous flat rail link through the Alps with a maximum elevation of just 550 metres above sea level. This brings significant benefits in terms of logistics and economy, since it allows longer trains with double the weight to travel at twice the current speed.

Unique, redundant ventilation system at CBT

With excavation scheduled for completion in 2016, and opening at the end of 2019, the Ceneri Base Tunnel will be an important feeder in

the south of Europe for the Gotthard Base Tunnel – the world's longest railway tunnel with a length of 57 kilometres (35.4 miles). The Ceneri Base Tunnel will also shorten travel times, for example between the cities of Locarno and Lugano in the canton of Ticino, Switzerland, from the current 50 minutes to 22 minutes. The construction contract for the Ceneri Base Tunnel was awarded in 2009 to Consorzio Condotte-Cossi, with whom Systemair is collaborating to design the ventilation used during excavation. In planning the ventilation system, Systemair has focused on safety, control and energy savings.





The Ceneri Base Tunnel, consisting of two single-track bores each with a designed length of 15.4 kilometres (9.6 miles), has an installation cavern in the centre of the excavation area in the heart of Monte Ceneri. The installation cavern plays an extremely important role in the base tunnel construction logistics, since the excavation work and the four rail tracks advance from here to the north and the south. The cavern is accessed through two previously constructed tunnels: the exploratory tunnel (CPS¹) and the access tunnel (FIS²). These two tunnels form the core of Systemair's unique solution for providing fresh air for the four lines.

Fresh air is taken in through the exploratory tunnel into the installation cavern and then into the West Tube with the help of primary fans. In the West Tube, which is kept pressurized, secondary fans blow fresh air into the excavation areas, and these fans are constantly being moved forward as the work of excavating the tunnel advances.

¹ CPS, *Cunicolo di prospezione Sigirino*

² FIS, *Finestra intermedia di Sigirino*

The exhaust air from the excavation area is conveyed by another group of fans into the East Tube, and then to the access tunnel. To prevent the exhaust air from returning into the installation cavern, the pressure in the cavern is kept at a comparatively high level at all times. This is achieved by controlling the speed of the fans with the help of the VACON® AC drives.

One of the most important features of the system is its redundancy: all the fan installations are equipped with a combination of a redundant motor and a Vacon drive controlling it to ensure the ventilation system continues to function even in the case of a breakdown. A redundant ventilation system is also a must for securing the safety of the excavation workers underground. Since conventional blasting methods that generate smoke, gases and dust are used in excavating the Ceneri Base Tunnel, reliable, effective ventilation is essential at all times.

Safety, control and energy savings important in ventilation

The ventilation system in the Ceneri Base Tunnel is equipped with air-cooled VACON® NXP AC drives in the range 55 kW - 250 kW (400 V), with a total installed power of some 2.5 MW in a stand-alone enclosure (IP54). This solution gives significant energy savings but also offers many other benefits as well.

The control system, which is based on the Profinet communications protocol, allows centralized control, monitoring and adjustment of the functions of each individual AC drive. The control logic enables the optimization of all the AC drives, so the air flow in and out of the underground space can be balanced. It is possible, when necessary, to by-pass the centralized control system and to control locally the VACON® AC drive parameters of each fan.

Effective ventilation of the explosion area is essential for removing the blast dust and gases as quickly as possible. Groups of fans fitted with VACON® AC drives enable fast ventilation with maximum power and make the explosion area accessible again in only 15 minutes. This reduces the idle time on the site, which is an important factor in the overall economy of the tunnel excavation.

Maximum energy efficiency is ensured by controlling the speed of the fans with the help of the AC drives to match the required air flow.

A further benefit is that controlled acceleration and deceleration of all the fans means the tunnel is filled gently with air, thus avoiding abrupt changes in the quality of the air.

“The reliability and robust structure of the AC drive, coupled with the technical assistance provided by Vacon Italy throughout the project, ensure that the customer does not need to worry,” states Roberto Redondi, tunnel construction ventilation manager at Systemair Italy, MRT division.

After 64 per cent of Swiss voters accepted the AlpTransit project in a 1992 referendum, construction of the Gotthard Base Tunnel began in 1996 and it is expected to come into use in 2016. With a route length of 57 km (35.4 mi) and a total of 151.84 km (94.3 mi) of tunnels, shafts and passages, the Gotthard Base Tunnel is the world’s longest rail tunnel, surpassing the undersea Seikan Tunnel in Japan and the 50 km Channel Tunnel linking England and France. The Gotthard axis will provide a high speed link through the Alps with a top speed estimated at 250 km/h, reducing travel time between Zurich and Milan from the present 4 hours and 10 minutes to 2 hours and 40 minutes.

Roberto Redondi, Tunnel Construction Ventilation Manager at Systemair, with a 250 kW fan used for fresh air in the exploratory tunnel.



Today, the Systemair Group includes about 60 companies with 2 300 employees in 39 countries in Europe, North America, Middle East, Asia, Africa and Australia. The company had sales of more than SEK 3.47 billion in the 2010/2011 financial year. The MRT (Metro Road and Train) is Systemair’s division focussing on delivering ventilation systems for underground, road and rail tunnels. Their Italian-based personnel have a very broad knowhow in this specific field. Their goal is to be the sole reference for the companies that work in underground projects.



AlpTransit, also known as New Railway Link through the Alps (NRLA), is a Swiss federal project aimed to build faster north-south rail links across the Swiss Alps by constructing base tunnels several hundred metres below the level of the current tunnels. The AlpTransit project comprises two major sections, the Gotthard axis and the Löttschberg axis. The third largest project is the Ceneri Base Tunnel, which is under construction in the canton of Ticino. It will pass under Monte Ceneri between Camorino in the Magadino Flat and Vezia near Lugano.

Cover photo: Systemair’s fans equipped with Vacon AC drives in the Ceneri Base Tunnel.

Photos courtesy of Systemair



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