



A mine of efficiency

ABB is helping extend the life of the massive Aitik copper mine by making it more efficient

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– Some 1,000 km north of Stockholm, Sweden, past the Arctic Circle, lies an impressive open-pit copper mine, known as Aitik. Although the proportion of metal found at the Aitik copper mine is low – less than 0.3 percent – it is a highly profitable mine because it is run so efficiently. In fact, operations have recently become even more efficient – a \$790 million modernization of the entire mining operation has enabled the mine operator Boliden to double its production capacity and extending the life of the mine to 2030. ABB has contributed to this success by supplying a range of products and systems to power and operate the entire site.



ABB delivered the world's first gearless mill drive to Lafarge cement company in France in 1969, and the 6.4 MW machine is still operating today.

Located near Gällivare, in the arctic Lapland region of Sweden, the copper deposit at Aitik was discovered in the 1930s. However, mining there began only in 1968 when technology was sufficiently advanced to profitably extract the metal. Although the ore grading is low – 0.25 percent copper, 0.1 g gold per ton ore, and 2 g silver per ton ore – these metals are nevertheless worth digging for. In 2006, Boliden made its largest investment decision to increase output at the mine in the form of a three-year, \$790 million upgrade.

Among the products and systems supplied by ABB are 650 motors, 230 drives and variable-speed drives, two 22.5 MW gearless mill drives, two 2 x 5 MW dual-pinion drive systems, four 1.4 MW permanent-magnet motors, 23 distribution transformers, gas-insulated switchgear, a harmonic filter system, the Extended Automation System 800xA process control system and of course a comprehensive service contract → 1.

Mining at ABB

ABB has a long history in mining solutions. The company delivered the first drives and controls for a mine hoist at the Kolningsberget iron mine in Norberg, Sweden, in 1891 – 120 years ago! It has also delivered more than 600 new hoists and modernized hundreds of existing plants. A mine hoist delivered around 1930 by ASEA, a predecessor company of ABB, to the Zinkgruvan zinc mine in Sweden is still in operation today. ABB has several other firsts in mining history – a predecessor company, VEM, delivered the first bucket chain excavator and conveyor bridge in 1949 as well as the first conveyor belt in 1960.

ABB has also pioneered the development of gearless mill drive (GMD) systems – giant motor and drive systems that power ore mills.¹ They are more reliable and energy efficient than traditional mill drive systems, and increase mill productivity. ABB delivered the world's first gearless mill drive to Lafarge cement company in France in 1969,

and the 6.4 MW machine is still operating today.

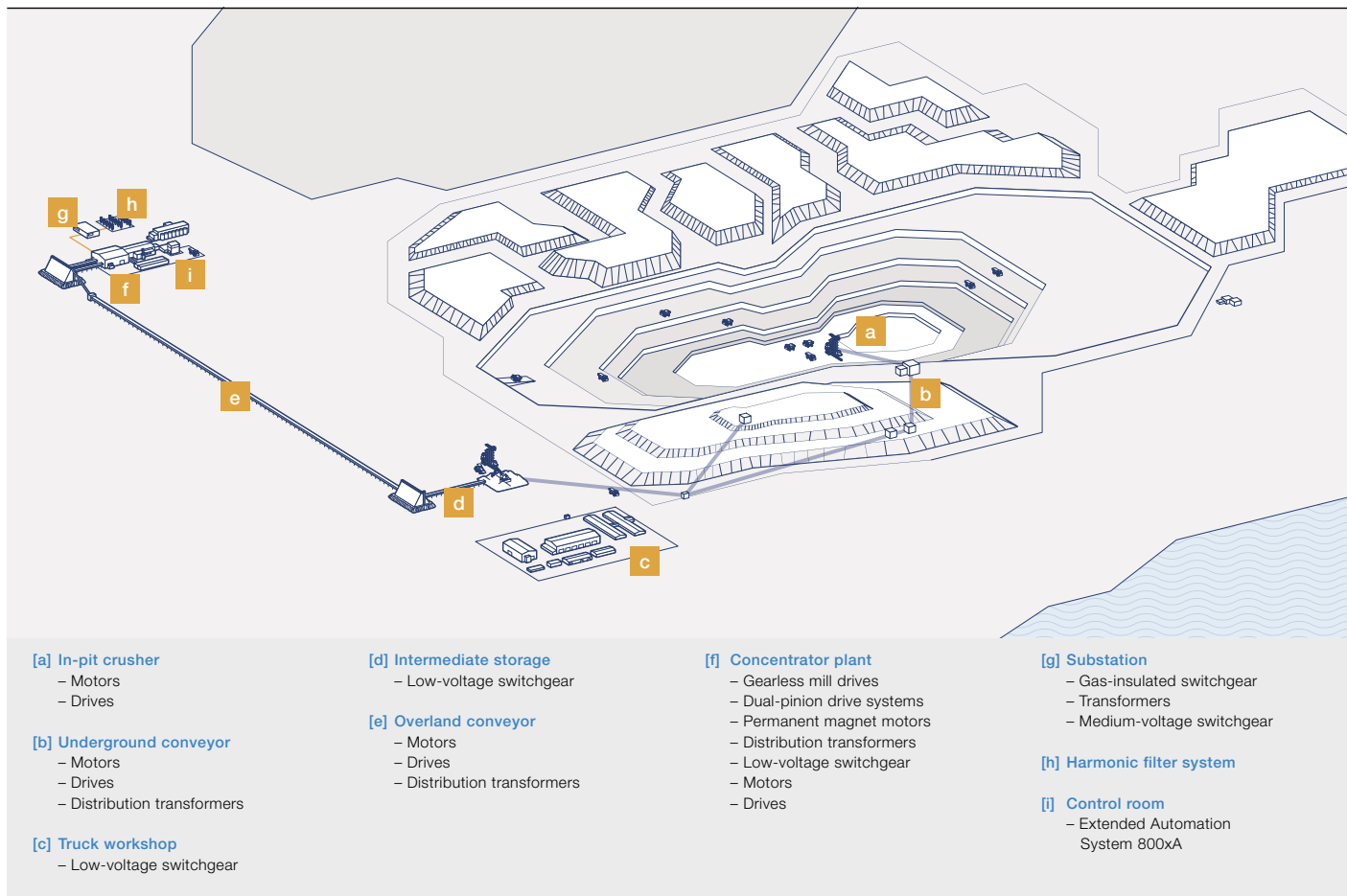
The first ABB GMD system for mineral processing was for a copper concentrator at the Bourgainville mine in Papua New Guinea in 1985. Since 1969, ABB has delivered or has on order more than 100 GMD systems around the world. Over the years, the systems have become larger and more powerful; in 2010, ABB delivered one 28 MW GMD for a 12.2 m semi-autogenous grinding (SAG) mill and two 22 MW GMDs for the 8.5 m ball mills, for the world's largest and highest altitude GMD systems, which were to operate at 4,600 m above sea

Title picture

Aerial view of the Aitik copper mine in Gällivare, Sweden. The open-pit mine is 3 km long and 405 m deep. Photo copyright Boliden/Lars Devall.

Footnote

1 See also "Driving value" in *ABB Review* 1/2011 and "Smooth operation" on page 74 of this issue of *ABB Review*.



level in the copper concentrator at Minera Chinalco's Toromocho mine in Peru. In 2010, ABB received an order to supply a 28MW GMD for the world's first 12.8m diameter SAG mill. But the most powerful GMD systems currently in operation – 22.5MW – are those used in Boliden's concentrator plant in Sweden; they drive the huge 11.6m autogenous (AG) mills. In terms of volume, the Aitik mills are the largest in the world with their astonishing length of 13.7 m.

Ensuring reliable and stable power through the delivery of electrical infrastructure and related equipment is also a

cornerstone of ABB's contribution to mining. Automation has been a key component as well, providing the means to precisely control processes and equipment, optimize production throughput, improve worker safety, and operate with the most efficient use of materials and energy resources. Since 1883, ABB's predecessor company ASEA has been delivering electrical power and control systems to major mining operations throughout the world. Some of ABB's high-profile projects are highlighted in → 2.

Operations at the Aitik mine

A weekly blast at the Aitik mine produces enough ore for Boliden to process 106,000 tons each day. This is enough to keep the massive, 100 ton trucks – with wheels 3.4 m high – filled, hour after

hour → 3. Each of the trucks delivers about 200 tons of ore to a crusher located inside the 405m deep pit, where it is reduced to 30 cm boulders and transported

via underground conveyors to an above-ground storage area. At a speed of 4 m/s, another conveyor carries the ore to the concentrator plant. ABB motors and drives power the conveyors, which

2 Some of ABB's high-profile mining projects

- Supply of two bauxite transport and storage plants to the Bauxiven Los Pijigao bauxite mine in Venezuela in 1992. The installation included the entire electrical infrastructure and electrical equipment such as switchgear, transformers, motor control centers, variable-speed drives and an ABB Master control system.
- Modernization of Cajamarquilla's zinc smelter in Peru in 1998. ABB's delivery included transformer rectifiers, an induction furnace and a process control system, which helped double the plant's capacity.
- Construction of Vale's new Moatize coal plant in Mozambique beginning in 2009. The delivery includes ABB's Extended Automation System 800xA, all medium- and low-voltage power distribution systems, drives, motors and other auxiliary equipment.

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3 Massive, 100 ton trucks with wheels 3.4 m high are used to carry 200 ton loads to the crusher inside the pit at Aitik. Photo by Peter Tubaas.



4 ABB drives are installed in the 7 km of conveyors that transport the ore to the concentrator plant at Aitik.



total 7 km in length. At the concentrator plant, two 22.5 MW gearless mill drives – the most powerful in operation today – grind the ore down to sand, crushing a total of 4,400 tons of ore per hour. The sand is put into flotation tanks filled with reagents, foaming agents, compressed air and chalk, and some 500,000 liters of water are added each hour. This chemical treatment allows the metal to float to the top for easy separation. The resulting concentrate, chalcopryrite, containing 25 percent copper, is transported by rail to Boliden's smelter in Rönskäär, some 400 km southeast of Gällivare.

ABB technologies throughout the mine

Efficiency is truly the key to productivity at the Aitik mine. And ABB has provided the technologies that are making it possible for Boliden to double its production capacity to 36 million tons of ore per year.

Conveyor drives

An impressive 7 km of conveyors transport the large chunks of ore to the concentrator plant where they are ground further → 4. The use of such long conveyors means that there are more demands placed on the mechanical devices and power supply. Controlled soft starting, and controlled operation and protection of the equipment, are thus important. Consequently, choosing the optimal drive solution for the conveyor is critical.

ABB has developed technology specifically to meet overland conveyor requirements. ABB's overland conveyor (OLC) drive solutions, used throughout Aitik,

provide OLC-specific functionality such as load sharing, soft start under all load conditions, various braking and stop functions, and more. These solutions take into account performance, efficiency, capital costs, flexibility and optimization of operation, reliability and aging of the conveyor equipment, the number of parts subject to wear and tear, compactness of the motor, and a motor design that allows easy and rapid change of pulleys and pulley bearings.

Motor and drive systems

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from 4 kW to 5 MW and are used at almost every stage of the mining process. They drive the crushers in the mining pit, the conveyors carrying the crushed rock to the concentrator, the grinding mills, the pumps supplying water to the mills and removing the muddy waste left after the concentration process, as well as the fans regulating air quality.

Many of the motors used at Aitik must operate 24 hours a day, 365 days a year – like the mine itself – and often in very dusty conditions. What's more, any outdoor equipment at the site must be able to withstand temperatures that can drop as low as –45 °C in the winter. These factors make reliability one of the most important requirements of the motors and drive systems.

Substation and harmonic filter

Mining is an energy-intensive activity, and the Aitik expansion project has required the construction of two additional power lines to the site. A new, higher-capacity substation was also required to manage the additional incoming power.

ABB has delivered a 170 kV substation based on gas-insulated switchgear technology, which has reduced the size of the installation by 80 percent → 5. The substation has two incoming power lines from the utility, ensuring delivery of electricity even if one line fails. Three 80 MVA transformers lower the voltage of the incoming power for use in the mine. These transformers can handle the same amount of power required by a city of 100,000 people.

Electricity is distributed throughout the mine via 24 kV switchgear from ABB's UniGear family of equipment. The substation and the two power lines are monitored and protected by ABB's Relion® relay protection. The power equipment ensures the highest possible reliability of the power supply, keeping the mine running night and day.

5 ABB's 170 kV gas-insulated switchgear distributes electric power to the mine.



6 ABB's gearless mill drives power two massive grinding mills, which are the world's largest at 13.7 m long and 11.6 m in diameter.



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ABB has also supplied a harmonic filter system, which enables Boliden to avoid damage to its own equipment as well as disturbance to the local power supply, which could lead to fines from the utility. The harmonic distortions in the grid are kept below the limits given by the IEC (International Electrotechnical Commission) and local standards, and the installed filter and power-factor correction system ensure the power factor is equal to or higher than 0.99.

Gearless mill drives

Mill drives are a critical component in ore and mineral processing. They combine huge capacity and brute strength with energy-efficient operation to grind ore into smaller pieces for further processing. Gearless mill drives (GMDs) are the largest variety, and the absence of a gearbox and other mechanical components increases their efficiency while reducing the need for maintenance.

The main component of a GMD is a colossal motor integrated into a drum-like mill in which the ore is ground. The motor is equipped with a drive, which starts the mill smoothly without any mechanical stress. The GMDs at Aitik have a rating of 22.5 MW, making them the world's most powerful in operation today → 6. The mills they power are 13.7 m long and 11.6 m in diameter – the world's largest by volume – and each has a grinding capacity of 2,200 tons of ore per hour. ABB gearless mill drives provide the huge capacity needed while keeping energy consumption low, and without reducing power quality.

Energy consumed in grinding can be 50 to 70 percent of the total energy used to recover ore. Drives are an energy-efficient way to match mill speed to the needs of the grinding process. With no moving parts between the motor and the drum, a gearless mill is also extremely strong and can reliably process vast quantities of ore.

Control system

The entire mining process at Aitik – including the concentrator plant, conveyor systems, pumping stations and even the mine's own sewage plant – is controlled by ABB's Extended Automation System 800xA → 7. System 800xA integrates a diverse assortment of equipment, systems and applications to provide a common visual interface.

At Aitik, the mine's IBM Maximo maintenance system is integrated with System 800xA, enabling creation of fault reports directly in the operator interface. This integrated solution makes it easier for the operators to report problems to the maintenance department. Now the operators simply click on the object they want to report, choose "create fault report", input the problem and submit the report, which then becomes available in Maximo. Since integrating the maintenance system, there has been a five-fold increase in fault reports, which are attributed to a reduction in unplanned downtime and process disturbances.



ABB's Extended Automation System 800xA controls the entire plant and each piece of equipment throughout the mine.

Aitik is the world's first installation to integrate not only the maintenance system but also the document management system with System 800xA. This gives operators fast and easy access to correct instructions, drawings, etc., and enables quick and accurate decisions and actions. In March 2011, Aitik also began using System 800xA asset monitors as a means to achieve predictive maintenance, focusing on three critical parts of

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the operation that are essential for availability and profitability at the mine. One of these is the gearbox for the large mills. Asset monitors signal the need for maintenance and help proactively detect equipment anomalies and take corrective actions before operations are affected. Boliden plans to implement the ABB Asset Optimization solution at all of its mines when upgrading their System 800xA control systems.

Another first achieved at Aitik is the ability to run the complete System 800xA for the concentrator plant on HTC smartphones → 8. This enables immense flexibility in supervising and controlling the plant.

Aitik is also one of the first industrial sites in the world to use the new international standard, IEC 61850, that defines communication within and between electrical components. This means that System 800xA provides a single environment by which to control and supervise process automation equipment, power automation equipment, as well as protection, switchgear, transmission and distribution equipment. The integration of the electrical control system with the process control system at the plant increases productivity and reduces stoppages by permitting a single strategy in the areas of engineering, maintenance and operations. Furthermore, the adoption of a global standard based on the latest technology enables lower installation and operational costs, as well as enhanced visibility of power usage and consumption.

A reliable and dependable energy supply is vital for the functioning of any industry. Managing and controlling this supply is thus as important as managing and controlling any other significant process parameter. At Aitik this means that the incoming power is visible in System 800xA. The operators have a complete overview of the entire plant and can immediately make adjustments if there are disturbances to the incoming power.



Soon, engineers, operators, supervisors and the like will each have their own HTC smartphones to supervise and control the plant.

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