

MINING & CONSTRUCTION

MECHANIZED ROCK EXCAVATION WITH ATLAS COPCO – NO 1 / 2011



World record for raiseboring

High-tech on the high wire

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Diesel or electric?

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Atlas Copco



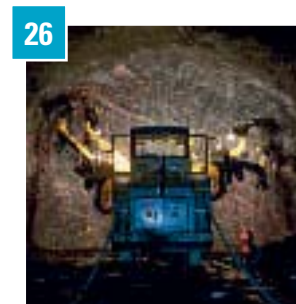
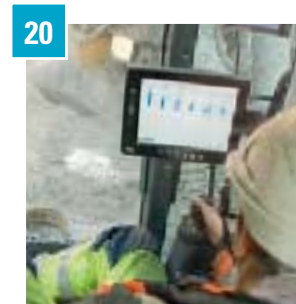
Someone once said “the difficult we do immediately, the impossible takes a little longer”. It was an ironic response to a tough request. But these days, “doing the impossible” is becoming the norm.

Thanks to technological advancement and continuous innovation we can now do some remarkable things in mining and construction that were unthinkable just a decade or so ago. And the demands on us as suppliers continues to grow. Our customers want products with more intelligence, power and reliability – and they want them now. The service intervals for a rock drill is a good example. Just a short while ago, our customers were happy if a rock drill performed for 400 hours before requiring a service, which, by the way, is extremely good. Today, some customers want this to be increased to at least 600 hours.

Innovation and speed is the key to meeting such strong demands. Our Rig Control System (RCS) is a typical case in point – an Atlas Copco innovation that has resulted in a comprehensive and unique platform that is now incorporated into a wide range of products. The big challenge now is to help our customers to co-ordinate and integrate RCS into their processes so that they will get the maximum benefit from this technology.

I know that Atlas Copco will continue to drive innovation and meet new challenges, however demanding or complex these may be. And we will continue to do so the way we always have – in close cooperation with our customers around the world.

KOBUS MALAN
President, Atlas Copco Rocktec Division



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MINING & CONSTRUCTION is published by Atlas Copco. The magazine focuses on the company's know-how, products and methods used for drilling, boring, rock reinforcement and loading worldwide.

PUBLISHED BY Atlas Copco Rock Drills AB, SE-701 91 Örebro, Sweden. www.atlascopco.com
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EDITORIAL PRODUCTION, DESIGN & LAYOUT Greenwood Communications AB, Box 50, SE-121 25 Stockholm, Sweden.
Tel: +46 (0)8 411 85 11. www.greenwood.se

PRINTED BY Alloffset AB, Bandhagen, Sweden 2010. ISSN 0284-8201.

WEBSITE www.miningandconstruction.com

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PEAK

Suspended from a cable car system high in the Swiss Alps, an Atlas Copco drill rig weighing 36 tonnes is gradually hauled to the top of Europe. Welcome to Project Linthal.



PERFORMANCE

» **S**ix hundred meters inside a Swiss mountain, one of the most unique hydropower construction projects in Europe is now well under way. This is Project Linthal 2015, which involves a powerhouse cavern, a new dam, headrace and tailrace and a 5 km maze of tunnels.

With 20 different sites located more than 1 000 m high in the Alps southwest of Zurich, it is a complex and challenging task that requires robust equipment, superior engineering skill and extreme logistics expertise.

Here, in this spectacular but difficult terrain, the only viable method of transportation is a specially constructed cable car which is used for transporting all personnel and equipment – not least entire drill rigs weighing some 36 tonnes.

Atlas Copco has delivered five drill rigs to the project in this way; three two-boom Boomer E2 C rigs equipped with COP 2238 rock drills and featuring the RCS rig control system, a Boomer 281 with COP 1838 rock drills and a two-boom Boomer L2 C with COP 1838 rock drills.

Swiss precision

Although it was the first time that Atlas Copco has used a cable car to transport complete rigs up to an Alpine site, the operation was carried out with typical Swiss precision and without a hitch.

Stephane Moser, the Atlas Copco product manager in Switzerland who supervised the operation, explains: “We have delivered individual components this way before but this was the first time we have lifted a whole rig. There was nothing to worry about. The cable system with its 94 mm thick transport cable is a very strong construction and I was completely confident that everything would go well.

“After we got the first rig in place and adjusted the positioning to get the balance right, it was no problem at all. I must admit that it was an inspiring experience to see those rigs hanging in the air as they made their way up the mountainside.”

The cable car is used daily for various forms of transportation and is in operation almost every half hour. The journey from the base camp to the off-load area takes just 20 minutes – a trip that Moser has now made seven times and reports that the



Boomer rigs are all performing well despite some difficult geological conditions.

“The rock here is a mixture of shale, slate and schist which is typical for this area, and the formations are changing all the time,” he says. “Despite this, we are getting an average penetration rate of 3.5 meters per minute and good life length on the drill bits, so everyone is pretty satisfied.”

Accuracy critical

Marti Tunnelbau, the tunneling contractor, is drilling and blasting a wide variety of cross sections with tunnelers working three shifts per day, seven days a week.

Some 500–700 m³ of rock is removed each day and more than 1.5 km of tunnel have been successfully excavated with a minimum of drill rig downtime.

Accuracy in the blast hole drilling operation is critical to productivity and Rolf Dubach, Site Manager for Marti Tunnelbau, the tunneling contractor, says the rigs are living up to expectations.

The rig control system (RCS) is the heart and brain of the Boomer E2 C rigs (*see*

page 20). For example, its Advanced Boom Control system (ABC) provides accurate blast hole positioning and continuous precision drilling. This results in good rock fragmentation and accurate tunnel contours with a minimum of overbreak which, in turn, reduces the cost of reinforcement, lining and mucking-out.

Using Atlas Copco’s Tunnel Manager software, the optimal drilling pattern is fed into the rig’s control system, and the ABC system automatically guides the booms to the correct drilling position, eliminating the need to mark up the rock face.

Supporting the rock

Primary rock support is carried out with a combination of Atlas Copco Swellex rock bolts, grouted anchors and mesh, and shotcrete.

The Swellex bolts, which are expanded in the hole using high pressure water, are generally used in lengths up to 4 m while the more conventional grouted anchors are used in lengths of 4–12 m, depending on the tunnel or cavern section.

Alpine climbers: An Atlas Copco Boomer E2 C drill rig being hoisted up to the site. Facing page, top: Inside one of the tunnels leading to the powerhouse cavern; below, Rolf Dubach, Site Manager for the contractor Marti Tunnelbau, discusses the layout of the new power plant.




Typical rockbolt diameters range from 16 to 36 mm with bearing loads up to 450 kN. Ground water inflow has so far been limited and overall excavations have proved to be very dry, eliminating the need for grouting, or waterproofing membranes between primary and secondary linings.

Protecting the environment

Swiss construction has to meet strict environmental legislation and Project Linthal is no exception. Water has to be filtered prior to release back into the environment, vibration has to be controlled when blasting and emissions are also carefully monitored, whether from diesel engines or from the blasting process itself.

Marti Tunnelbau started the tunneling work in October 2009 and aims to be finished by 2016. Site Manager Dubach concludes: "After this project is over, any other tunnel project that I work on in the future will seem simple by comparison."

Axpo, the Swiss energy group that will operate the new power plant, expects it to be ready to go on stream by 2015. 

HARNESSING POWER IN THE ALPS

Project Linthal 2015 is the latest addition to the existing Linth-Limmern AG (KLL) hydropower system located some 80 km southwest of Zurich.

It is a pumped storage facility designed to boost the system's capacity from 450 kWh to 1 450 kWh.

The project comprises a new, 1 000 m long, 35 m high gravity dam, a huge powerhouse cavern to house four pump turbines, a secondary cavern for transformers and electrical equipment and 5 km of tunnels including a new headrace and tailrace.

The facility is being built inside a mountain between two lakes – Lake Limmern (at 1 700 m above sea level) and Lake Mutt, located about 600 m higher up.

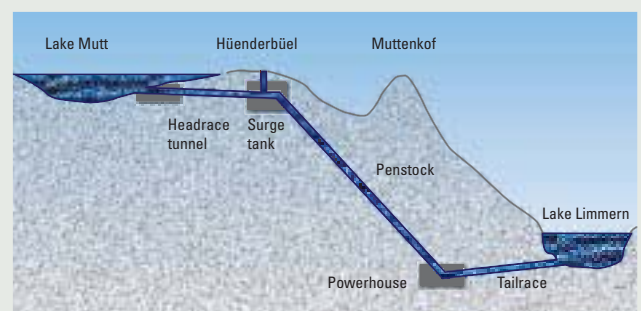
Water will be pumped from Lake Limmern up to Lake Mutt where it will then be channeled through two headrace tunnels to the powerhouse.

The new dam, which will require the removal of 80 000 m² of rock,

will increase Lake Mutt's storage capacity from 9 to 25 million m³ and raise the water level in the lake by 28 m.

Depending on the time of day, and therefore the price of electricity, the pumping turbines will either be pumping water up to Lake Mutt or used to generate electricity when the water flow is reversed.

This so-called load balancing enables low-cost energy to be used to run the pumps during the off-peak period in order to meet high electricity demands during peak periods.





The Atlas Copco Robbins 91RH C raiseborer at Kiruna Mine: A highly advanced machine providing extreme power and torque, pictured here with operators Ulf Lindström and Johan Garp of Bergteam

RAISING THE

Swedish Iron ore giant LKAB is building a new main level at its famous Kiruna Mine in Sweden – and setting the scene for a world record in raiseboring technology.

For the past 10 years, Sweden's Kiruna Mine – the world's largest underground iron ore operation – has been worked from a depth of 1 045 m, supplying high grade pellets to the world's steel mills.

Now a new chapter in the mine's rich history has just begun with a project to build a completely new haulage level 320 m lower down. This will extend the life of the mine by another 20 years beyond 2030.

Construction of the new 1 365 m level is a complex task exploiting all of the modern mining techniques you would expect on such a major development. But above all, it will showcase the technology required for developing shafts and ore passes by hosting the biggest raiseboring project of all time.

The new infrastructure requires the construction of a minimum of 55 000 m of shafts and ore passes – 40 000 m at Kiruna

Mine and a further 15 000 at the nearby Malmberget Mine – all by 2014.

Bergteamet, which is one of Sweden's leading providers of mining and underground services, is in charge of this part of the development work and is using Robbins raiseboring machines from Atlas Copco.

Uniquely powerful

As M&C went to press, two Atlas Copco raiseboring machines were on site, Robbins 73RM-DC and the larger 91RH C, while three more Robbins 91RH C machines were on order. All of the units are tasked with bor-



A prime example of fine raiseboring technology: Perfectly straight and smooth walls, bored at precisely the required diameter.

STAKES

Swedish iron miners stage world's biggest raise boring project

ing raises ranging from 90–360 m long and up to 5 m in diameter.

Weighing in at 33 tonnes, the Robbins 91RHC is an enormously powerful machine. It has a pulling power of 6 800 kN and a continuous torque of 450 kNm.

The rock consists of several different formations including granite with a compressive strength of 220–350 MPa as well as quartz porphyry with a strength of up to 350 MPa.

During upward reaming, the machine is also assisted in these hard rock conditions by the superior cutting capability of

the Secoroc Magnum V cutters that are mounted in the cutterhead. Designed and manufactured by Atlas Copco Secoroc in Texas, USA, they are designed for maximum cutting efficiency in collaboration with these raiseboring rigs' massive rotation and feed forces.

Groups of four

Although the Robbins 91RHC is capable of boring raises up to 1 000 m long, they are being used here to bore a large number of short ore passes in groups of four. These will be installed between the different

levels, ultimately linking up the new level at 1 365 m.

Net penetration when boring pilot holes is 0.95 m per hour and each machine is averaging 10 m per day, depending on the rock formation and shaft length. Each raise will take several months to complete.

Bergteamet's Project Manager at the Kiruna site is Håkan Johansson, one of the raiseboring specialists who last year assisted in the dramatic rescue of the trapped Chilean miners and where raiseboring was one of the methods used to reach them. »



Håkan Johansson, Bergteamet's Project Manager at Kiruna, assisted in the operations to rescue the trapped Chilean miners.

» Johansson explains: "The technology of crushing rock with the aid of a big reamer is well proven and we are using it here on a huge scale in co-operation with Atlas Copco. It represents the biggest raiseboring project in the world, and so far the results are very encouraging.

"One of the main reasons we think the Atlas Copco Robbins machines are ideal for this job is the power and control they give us, particularly when it comes to the hydraulic drive system on the Robbins 91.

"It has 585 kW of effective output which

enables the very high torque to be fully maintained at a high rotation speed. During pilot hole drilling this prevents the drillstring from getting jammed, avoiding delays and possible damage to essential components."

In addition to this, Bergteamet sees the RCS rig control system on the Robbins 91RH C as a major advantage enabling further automation to be used if required (*see article RCS, page 20*)

Continuous operation

Bergteamet has 57 operators and six mechanics at the site as well as a team of 12 at the nearby Malmberget Mine.

At the Kiruna mine, boring is carried out continuously, seven days a week, all year round. It takes a team of four to keep the big Robbins 91 RH C rigs working day and night while the smaller Robbins 73R machines require a team of only three.

The shift schedule, which is based on 10 hours per shift, allows for a certain overlap, but in practice only one operator per shift is needed.

During drilling of the pilot hole, the operator controls the process from the operators' control panel and also prepares

each new extension pipe to be used, greasing the threaded joints and positioning the next pipe so that it can be easily lifted into place by the machine's rod handling arm.

In addition, the operator keeps an eye on the efficiency of the flushing procedure and also checks the type of rock being encountered so that there will be no surprises when it is time to start the reaming process, pulling the reamers upwards.

During reaming, the operator supervises the process using the control system's wide variety of monitoring functions. These include anti-jamming protection which automatically stops the machine if jamming occurs and prevents the machine's motor and other essential parts from damage.

Emma's muscle

Operator Johan Garp was impressed by just how fast "his" machine – which he has named "Emma" – can drill a pilot hole.

"We are drilling at a rate of just under one meter per hour," he says. "The rock is very hard so the resistance is pretty tough. But tough or not, it makes no difference. Emma has plenty of muscle to put behind the bit."



Key component: The Secoroc Magnum V cutter, used on the raiseborers' reamers.



Rich history: The Kiruna Mine, located above the Arctic Circle in Sweden's far north, is going deeper with raiseboring technology playing a major role.

Valuable assets: The quality of the drill pipes is decisive for productivity and have to be handled with great care.

“ The Atlas Copco machines are ideal for this job because of the power and control they give us.

Håkan Johansson, Project Manager, Bergteamet

In Bergteamet's service workshop at the 500 m level, all of the 1.5 m long drill pipes are quality checked for possible cracks before use. These are no ordinary drill pipes.




Destination Kiruna: A brand new Robbins 91RH C fresh off the assembly line, in the Atlas Copco yellow and gray.

They are machined in one piece to exactly the right shape and are made of high tensile steel in an exclusive process, enabling them to withstand extraordinary loads. Therefore the pipes have to be handled with the greatest of care.

During M&C's visit, a new raise had recently been completed and its perfectly smooth and straight walls clearly showed how far raiseboring technology has come in recent years.

All miners will no doubt be keeping a watchful eye on Kiruna Mine as the expansion project progresses. But it is by no means the only Swedish mine to launch a major expansion as the current strong demand for minerals and metals continues to increase. The Garpenberg mine in central Sweden, is also undergoing a similar transi-

tion, and here too, Bergteamet is installing shafts and ore passes using Atlas Copco's Robbins 91RH C raiseboring rigs. 

NEW CHAPTER FOR KIRUNA'S IRON

Iron ore has been mined in Kiruna for more than 100 years and today the mines in this region claim to be the most modern underground iron ore operations in the world.

The Kiruna Mine consists of a single, continuous orebody almost 4 km long, 80 m thick and 2 km deep. More than 950 Mt of ore has been mined from this site over the years yet only one third of the orebody has been extracted. In 2010, LKAB produced more than 26 Mt of iron products.

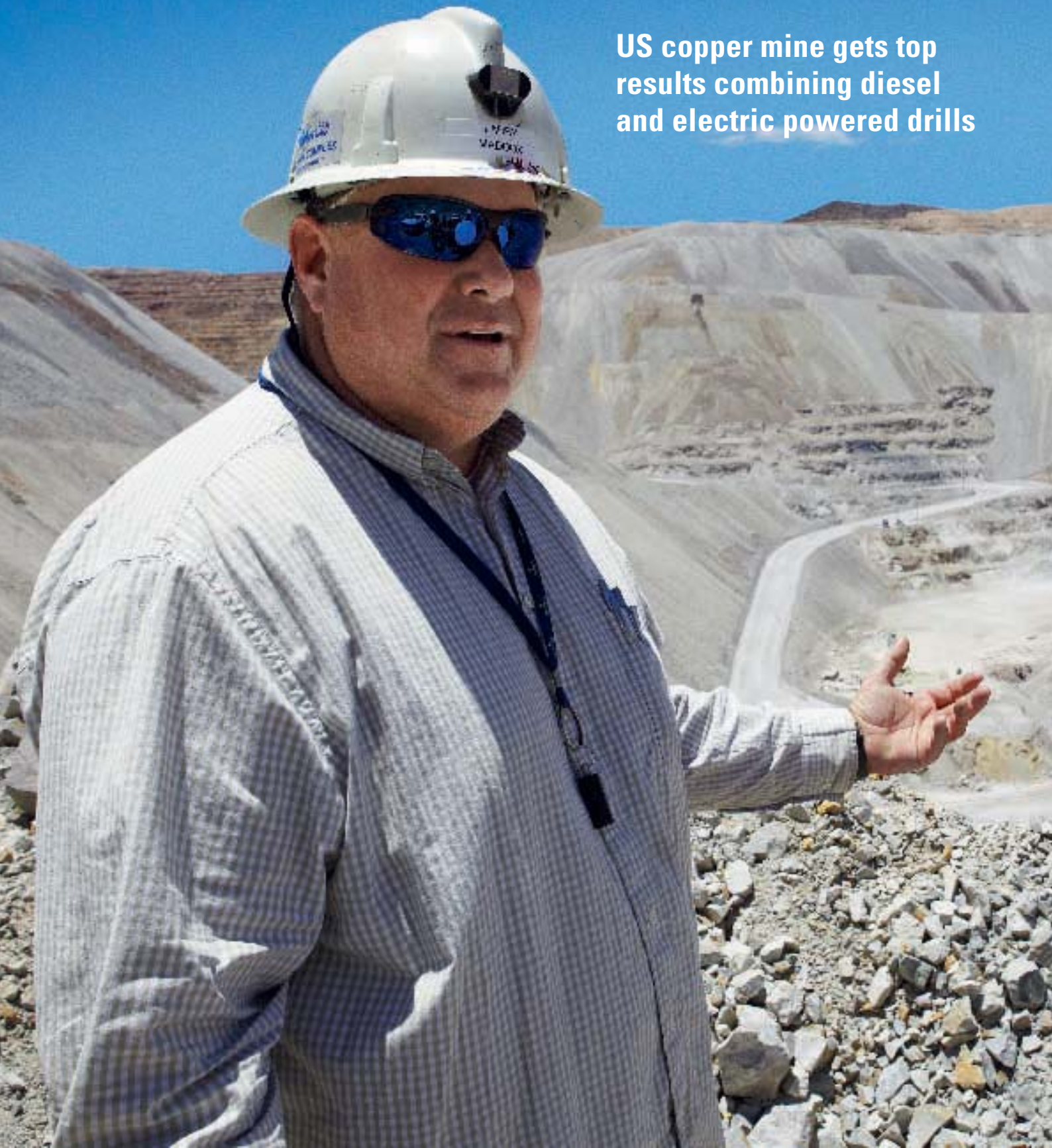
The new main level is now being constructed at a depth of 1365 m – the seventh time the level has been lowered since 1957.

Based on annual production of about 19 Mt of finished products, the operating life of the mine is expected to be extended by more than 20 years.

The expansion project is estimated to cost some EUR 1.2 billion and the first sections of the new main level are planned to be operational by 2013.

A simple choice for **Mission Complex**

US copper mine gets top results combining diesel and electric powered drills





The best of both worlds: Depending on the operation, the mobility and versatility of the diesel powered Pit Viper 271 has the advantage, but the electric version is also a good choice, especially when fuel costs rise.

When it came time to replace its fleet of drill rigs, Asarco's Mission Complex Mine decided to invest in two different power sources. The choice it made resulted in a winning combination.

Mission Complex, located some 30 km south of Tucson, Arizona, is one of the largest mining operations in the USA. Operated by Asarco Inc., a subsidiary of Mexican mining group Grupo Mexico, it has an annual production in the region of 50 million tonnes and an ore-to-waste cut off of .25 percent copper.

When selecting drill rigs to replace its aging fleet, Asarco looked for those that could provide cost-effective, high production management of the mine's 11 m (36 ft) high benches with an additional 2.1 m (7 ft) of sub-drill.

Mission's bench patterns vary by formation, from limestone to wollastonite with many variations in between. In softer rock, a 9 m x 10.6 m (30 x 35 ft) pattern is used and reduced to 5.5 m x 6.7 m (18 x 22 ft) in the harder formations.

In the past, this presented problems with pipe, due to the abrasiveness of the rock. To meet the demanding conditions of a mine of this size and of rock this hard on tools, the mine combined the features of diesel and electric rigs. They focused on two Atlas Copco Pit Viper blasthole drill

models, ultimately choosing the single-pass capability of the PV-271 over the PV-351.

They are now running two PV-271 drills – a diesel model just under three years old and an electric model which went into service in December 2009. The diesel model was purchased to extend the drill reach from the existing power capacity and to add versatility to the drill fleet.

At the time, the mine was operating vintage electric-powered rigs and one fairly new diesel-powered DMM2 in three pits. Adding a diesel-powered PV-271 met the bench and drilling requirements in a single-pass drill rig that also offered versatility and could be moved anywhere in any of the pits.

To make the holes, the PV-271 is used with two 7.6 m (25 ft) and one 2.4 m (8 ft) section of Atlas Copco 219 mm (8⁵/₈") Team-alloy pipe. Below that, they use a 1 m 41") stabilizer above a Secoroc air-bearing 270 mm (10⁵/₈") tricone bit.

Diesel versus electric

Aside from the fact that one of the drills has a power cable, they operate identically, »



Atlas CopcoTEAMALLOY™ pipes at Mission Complex: The PV-271 drill runs with two, 7.6 m (25 ft) sections and one 2.4 m (8-ft) section, 219 mm (18⁵/₈") in diameter. Right, the Mission crew sets up the power supply for the electric-powered version of the PV-271 which is used when time allows.

» says Mission driller Juan Salido. The electric drill came with a larger compressor –74 m³/min (2 600 cfm) – whereas the diesel Pit Viper has a 54 m³/min (1 900 cfm) compressor. Both average 8 000–10 000 m per month.

Mine Manager Hal Galbraith says the diesel PV-271 works great for his mine. “I wouldn’t say we ran the tracks off the rig, because we did haul it on our lowboy too, but it went everywhere in the mine,” he says. Since then, the mine has focused operations to just two of the pits, but the diesel Pit Viper still moves to wherever it is needed within the mining complex.

Drill and blast manager Larry Maddox notes that the diesel rig offers a significant advantage, working well at moving into tight spots on the bench to allow drilling to continue before power is moved into the working area for the shovels.

“Moving an electric drill just takes more time compared to a diesel rig: having the cable crew available, cutting the power, moving the cable, planning the cable drops. You just can’t put a value on the mobility you get from a diesel drill,” he says.

Salido adds: “It may only take 20 minutes to move the cable but 40 minutes or more for the crew to get there.”

Anything that slows down a cable-moving crew stops operations. For example, if the cable needs to be moved for an afternoon blast and the crew get a flat tire on the

cable truck, everything would be held up until the tire could be changed.

The diesel rig maximizes time spent drilling. Softer rock at the mine may take only 20 to 30 minutes to drill each hole. However, other formations that contain more garnet-tectite and wollastonite, may require as much as two hours for the same hole requirements.

Maddox says: “I think if you had plenty of time, electric would be better because of the cost to operate and maintain, but mobility more than makes up for it with the diesel drill.”

Comparing costs

One exception to this preference for diesel is the operating cost. The electric drill currently operates at 61 percent of the energy costs of the diesel drill and when diesel fuel edged up to USD 4 per gallon (approx USD 1 per liter), the electric rig was more attractive.

Galbraith lists some of the additional, indirect costs to be factored in with regard to an electric drill. Each electric rig requires four, 1 200 mm (4 000 ft) cables at USD 100 000 each. A 138 kV–4160 V substation to power the drill costs USD 250 000. Additional manpower required to build the infrastructure and to move the cable during each relocation must also be considered.

Efficient drilling operations at Mission are the result of strategically matching pipe and bits to these PV-271 rigs. The

Teamalloy pipe has a much higher cost per piece price than other pipe, but its durability and longevity mean cost per meter is less in the long run.

A 7.6 m (25 ft) section of Teamalloy pipe lasts six weeks at Mission. Initial outside dimension of the pipe is 220 mm (8.65"). They will run it down to 203–200 mm (8 or 7.9") before replacing it. The pipe shows its wear at the lower end of the joint, in what operators refer to as a “pencil” effect. They rotate these sections, since sections closer to the bit wear faster. This distributes wear evenly among the sections to increase longevity overall.

As for bits, the air-bearing type works the best in this formation with an average life for a bit at 2 300–2 440 m (7 500–8 000 ft). Each drill uses about two bits per week, depending on the ground.

Simple choice

For Larry Maddox the choice is simple. “I want to keep them both,” he says. “Electric may be cheaper, but the mobility with diesel is better,” adding that each has characteristics that make the operation more efficient and productive which, for the company, means greater profitability.

Galbraith said the decision to buy this equipment for the drill and blast process is justified by the bottom line. He concludes: “For every dollar more you spend up front on drilling, you’ll make ten dollars on the back end.”

“ Electric may be cheaper,
but the mobility you get
with diesel is better.

Larry Maddox, Drill and Blast Manager, Mission Complex.



PLAIN SAIL AT THE PANAMA CANAL



The Panama Canal is currently being expanded in order to double its capacity and boost its revenues from international shipping. Paving the way for the container ships of tomorrow is a fleet of a different kind.



Location of the Panama Canal: A popular short cut for merchant ships sailing between the Caribbean and Pacific oceans.

The Panama Canal is one of the world's most important international trading routes. Opened in 1914, it now enables more than 14 000 ships per year to travel back and forth between the Pacific and Atlantic oceans.

But now, almost 100 years since the canal was built, the Panamanian authorities are preparing to receive bigger, heavier vessels than ever before.

It is predicted that the world will see a major upswing in seagoing cargo traffic over the next few years, and to meet this challenge the Panama Canal is racing to double its capacity.

Two new giant lock facilities are under construction – one at the Pacific end and one at the Caribbean end – to accommodate bigger ships, and carrying out the necessary drilling and blasting work is a fleet of six Atlas Copco drill rigs.

This fleet, made up of ROC D7 drill rigs is owned and operated by Jan De Nul of Belgium, one of four companies within Grupo Unidos Por El Canal (GUPC) in cooperation with Sacyr of Spain, Impregilo of Italy and Cusa of Panama.

Dual purpose drilling

Equipped with COP 1840 hydraulic top-hammer rock drills, 89 mm drop center Secoroc bits and folding booms, these rigs are used for drilling and blasting at the so-called Third Lock Segment at the Pacific end of the canal.

LING



The rock here is broken and abrasive basalt and nine million tonnes is expected to be removed. In addition to preparing the site, the drill rigs serve the dual purpose of providing aggregate for the construction of the lock at the Caribbean end where rock is scarce. This aggregate, which will be barged up the canal, will be used for making concrete.

Perfect accuracy

The ROC D7 rigs are working two, 10-hour shifts per day, drilling to a depth of 9.5 m on three benches. About 2 000 m is drilled for each blast.

To ensure accuracy, each rig is equipped with the Atlas Copco hole quality system HQS MKI2 which provides a wide range of practical features for hole quality optimization. These include hole depth

measurement, feed angle optimization and an alignment device with a laser receiver which enables the operator to position the rig by lining it up with a distant reference point.

Each rig is also equipped with Atlas Copco's Procom satellite monitoring system which provides real time informa-



Pieterjan Versteede of Jan De Nul: "The service and support we get from Atlas Copco is extremely important on this type of job."

tion on hammer percussion, engine hours, maintenance schedules and rig location.

The rock is a challenge but the rigs' arsenal of modern technical aids is helping the operation to progress smoothly. Comments Pieterjan Versteede, Jan De Nul's Plant Equipment Manager: "After you remove the overburden, there are slopes and angles in the rock surface and the drilling has to be perfect. You just can't correct it afterwards."

First timers

It is the first time that contractor Jan De Nul has used an Atlas Copco drilling fleet and full support is provided by the recently opened Atlas Copco Customer Center in Panama. This support includes both ROC Care and COP Care preventive maintenance service agreements. >>



The fleet on land: Some of the Atlas Copco ROC D7 crawlers drilling at the Third Lock Segment at the Pacific end of the Panama Canal.



Hugo Arce of Atlas Copco: "The operators have been very quick to learn and apply our MK12 hole quality system."


» Hugo Arce, Atlas Copco's Business Development Manager for Central America and the Caribbean, says: "Maintaining quality tooling, parts, and experienced technicians are all very important for a contractor like Jan De Nul and a project with the size and scope of the Panama Canal expansion.

"There are fifteen operators on the site, and all of them have been trained by Atlas Copco. They are very happy with the HQS MK12 system and have been very quick to learn it and apply it in their everyday work."

Versteede adds: "The just-in-time support and service provided by Atlas Copco is extremely important for us on this type of job. We are very happy with the productivity. Although we are seeing variable life on the bits as there are so many variations in the basalt formation.

"Overall, I think we're getting very good performance. The COP 1840 hammer is strong and fast and the rigs' feed alignment control system is a perfect tool to assist in the shaping and designing of the bench."

The largest preferred size of the fragmented rock is 30 cm. Drill and blast manager Jorge Perez Blanco says he has no problem keeping to that fragmentation with the 89 mm bits, but would like to experiment with larger diameter holes and variations in the drill pattern.

The drilling operations got under way in June 2010 and are expected to take 30 months to complete whereas the entire expansion project is on schedule to be completed by 2014. 

PREPARING FOR THE BIG SHIPS

The Panama Canal is around 80 km long and runs across the center of Panama linking the Pacific and Atlantic oceans.

It was built by the American government between 1904 and 1914 and is today owned by Panama and managed by the Panama Canal Authority (ACP).

Locks at the Pacific and Atlantic ends either lower vessels to sea level or raise them up to the level of the canal.

At present, the canal can only accommodate ships of less than 294 m long and 32 m wide but

when the new locks have been built, container vessels up to 366 m long, 49 m wide and with a draft of 15 m will be able to pass through.

The expansion scheme is a huge undertaking. A workforce of more than 1 000 people are currently employed at the site and this is expected to increase to about 7 000.

In addition to the six Atlas Copco ROC D7 drill rigs, a wide variety of other Atlas Copco equipment is being used at the site including compressors, breakers and concrete vibrating and compacting equipment.



The competitive EDGE in DTH deep hole drilling

Now drillers can really tell what goes on inside the hole

More than two years of research has resulted in a major advance in deep hole drilling efficiency. Called EDGE, this system (patents pending worldwide) provides deep hole drillers using DTH equipment with the eyes and ears they need at the bottom of the hole.

One of the biggest challenges that constantly faces deep hole drillers is how to predict the changes that take place at the bottom of the hole during drilling, especially at depths of 100 meters or more.

Traditionally, the driller's competence, based on years of experience and often a special talent or "sixth sense" enables assumptions to be made with a high degree of accuracy. But at the end of the day, these assumptions are educated guesses.

About two years ago, we, together with our development partner SPC Technology, decided to try and do better than guesswork. We wanted to find out if it would be possible not just to predict, but to actually see what goes on at the bottom of the hole.

Now we know. Not only can we see these changes, we can see them instantly thanks to EDGE, the world's first system for continuous deep hole monitoring.

EDGE can be fitted to all types of deep hole drill rigs that use Secoroc's DTH (down-the-hole) hammers. It consists of a sensor, a data capturing and processing unit – the brain of the system – and a rugged PC with a 7-inch display screen (Fig 1).

How EDGE works

The sensor is mounted on the drill head or rotation unit and connected by a cable to the data capturing unit mounted on the mast or rig. The display PC is mounted next to the drill controls at eye level so that it can be easily seen by the operator.

The process starts immediately when the

piston in the DTH hammer strikes the bit, creating vibration. The vibration is captured, processed and interpreted and the data is transmitted to the PC where it is displayed both graphically and in numbers (Fig 2). Any unexpected changes that occur at the bottom of the hole are displayed in real time and early warnings alert the operator to any occurrence that might have a negative impact on the drilling process or cause damage to the equipment (Fig 3).

The graphic "spikes" can be interpreted as representing different in-hole scenarios such as the sudden presence of a new type of rock or geological zone. This immediate and continuous feedback enables the driller to continuously optimize the drilling process.

No more "blind" drilling

Aimed primarily at the oil and gas industries where the majority of deep hole drillers are at work, it enables drillers to follow the drilling process in real time and to make continuous adjustments to the feed force, rotation speed and so on, in order to optimize the drilling of a hole from start to finish.

In other words, it means the driller will no longer be drilling "blind", eliminating the fear that something unexpected may be happening that could hinder progress, or even require stopping the rig and removing the drillstring altogether, an operation that could take two or three days, significantly reducing productivity and increasing costs.

It could be that the rock drill suddenly encounters a new type of formation that threatens to "shank" the bit. Perhaps the hole is not cleaning properly and the drill string is in danger of jamming. Or perhaps a slight vibration caused by movement inside the chuck as a result of insufficient feed force, is gradually reducing the cutting capacity. Whatever the scenario, the earlier the driller knows about it and takes preventive action, the better it will be.

New dimension

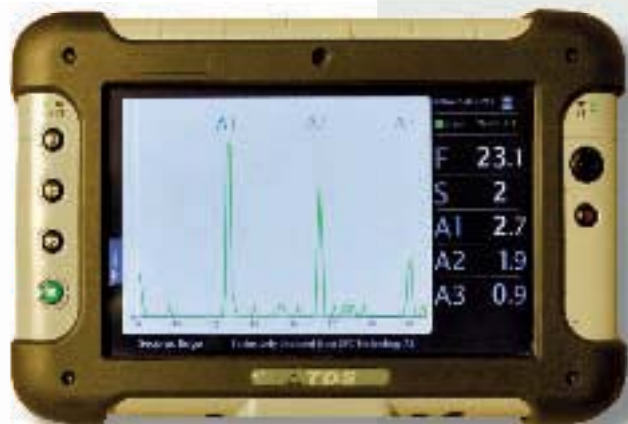
In this way, EDGE brings a whole new dimension to the deep hole drilling industry, and not least for those engaged in horizontal drilling such as in the huge oil and gas fields of the United States where equipment loss, trouble-shooting and maintenance represent a major portion of the investment.

Obvious benefits are continuous high productivity and improved overall economy through increased penetration rate, improved equipment life and reliability, less fuel consumption and lower costs. But there are other benefits too that are important.

Not only does EDGE enhance the skill of experienced drillers, it also substantially reduces the time it takes to get new drillers up to speed as they do not need years of experience to learn to identify what's going on in the hole by "watching and listening".

A typical example

In Sweden, it normally takes about six to eight months to train a driller up to proficiency standard. Using the EDGE system, our Swedish customers are cutting this training time drastically. A typical example is the deep hole drilling specialist SYDAB which recently trained a former truck driver up to drilling proficiency standard in just a few weeks. Furthermore, the company has



realized substantial economic benefits since it mounted the EDGE system on one of its rigs.

Another aspect is that the system also relieves the stress normally associated with deep hole drilling as the driller does not have to constantly worry about getting “nasty surprises” during drilling.

If the driller makes an adjustment to the feed force, for example, the effect is immediately shown on the display. Also, if the driller wants to review what happened in the hole overnight, he can do this too by checking the data that has been collected in the system’s log. Furthermore, this data can be printed out which makes reporting to authorities easier and quicker.


EDGE is also equipped with GPS and wireless internet which opens up a whole new world of possibilities such as monitoring the deep hole drilling process from a remote location via the internet. 

Fig 1. The main components of the EDGE system: sensor, data capturing and processing unit, PC with 7-inch display and mount cable.

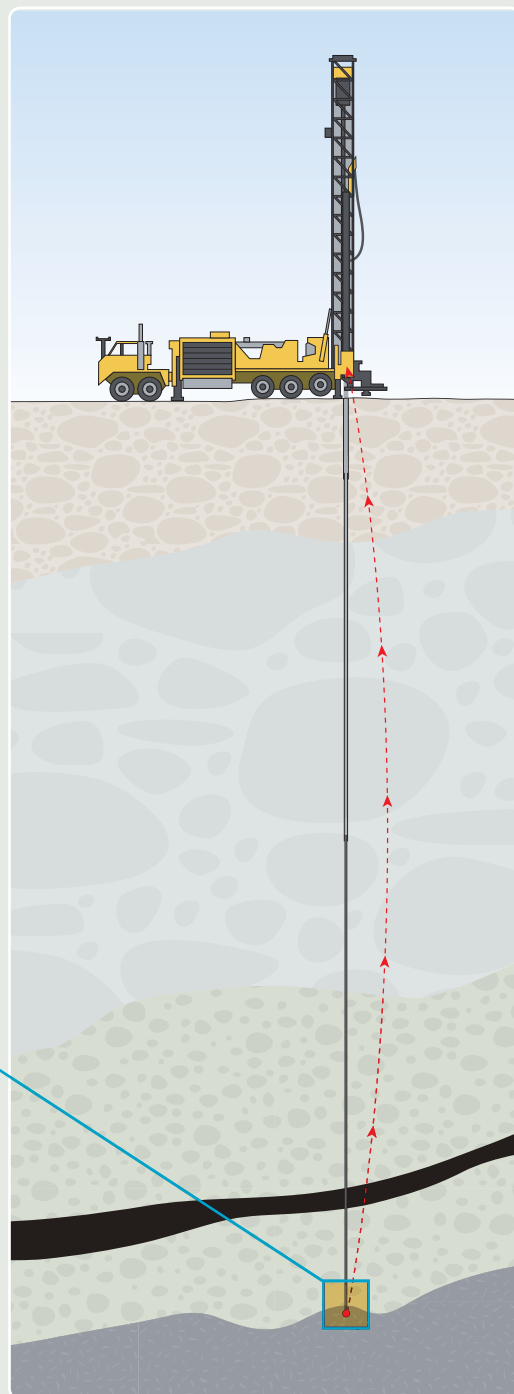


Ron Boyd, Project Manager Oil & Gas Development at Atlas Copco Secoroc, is currently team member and Project Leader for the development of EDGE technology.

Fig 2. Changes in the hole are displayed on the PC screen both graphically and in numbers. Drill rigs fitted with the EDGE system provide the driller with vital information, in real time, on what is happening deep in the hole.



Fig 3. All occurrences in the hole during DTH drilling are captured and transmitted to the rig’s EDGE system for analysis.



WHY DEEP DRILLERS NEED EDGE

EDGE helps drillers by monitoring the most common challenges encountered in a hole. These are:

Changing Rock Formations. Changing rock formations at the hole bottom with variations in compressive strength, joints, fissures, and beddings/schistosity planes, all affecting drillability.

Maintaining Correct WOB (weight on bit). When the bit is kept consistently pressed to the bottom of the hole, all of the impact energy is used to crush the rock. Too low WOB reduces drilling speed and may cause damage to the hammer and bit resulting in catastrophic shank failure of the bit. Too high WOB can result in jamming and excessive

wear on the bit and damage to the drillstring. Correct WOB will produce a straighter hole.

Keeping the Hole Clean. Poor hole cleaning can cause cuttings to clog on the hole wall and to the drillstring, increasing the risk of getting stuck in the hole. Poor cleaning also leaves cuttings on the hole bottom that have to be re-crushed, slowing down performance and wearing the bit.

Low Cutting Efficiency. Incorrect rotation speed affects cutting efficiency. The speed has to be adapted to the impact rate so that between each blow, the indexing of the bit can be done, enabling the inserts to strike fresh rock and not re-strike in the same grooves.



In total control: RCS technology displays all the necessary data on a screen and allows it to be shared with others for total optimization of the operation.

to the central PC for storage and analysis.

The result was a system that enabled the operator to exercise full control over all of the drilling functions using the onboard computer screen and control panel, providing a much higher level of precision and paving the way for automation.

Full scale development got under way in 1990 and evolved over the next eight years, finally culminating in the launch of the first underground rig, a Boomer L2 C, equipped with the first generation RCS.

Technically it was a triumph but, as suspected, it was not an immediate success. Drillers were sceptical towards computerization and automation, with many dismissing it as inferior to the skill of an experienced driller. To some extent, they were absolutely right. The system was not a substitute, but used correctly it was a fantastic complement.

Convinced that the future lay in automated systems, Atlas Copco pressed on with RCS technology and over the next 10 to 12 years the company released a constant stream of RCS-based products. And with each new release, the system had

also been upgraded in line with the evolution of computer hardware, software and connectivity.

The second generation RCS platform for Boomer rigs was launched in 2000–2001 and 2002–2006 saw the launch of the third generation RCS-based equipment including loaders, exploration rigs and Robbins raise-borers in rapid succession.

The fourth generation RCS platform was introduced in 2007–2010 with the launch of the Diamec diamond core drill rig and the Pit Viper 271 rotary blasthole rig.

Today, the entire portfolio of Atlas Copco equipment for mining and construction is available with the same RCS platform and Atlas Copco is now working on what will be the fifth generation.

All about communication

M&C asked Mikael Ramström, Product Line Manager Underground Drilling Equipment and a member of the RCS team during most of this development period, to put the project into perspective.

“The key driver in this effort was not just to improve the way a drill rig could be >>

WHAT THE EXPERTS SAY



Mikael Ramström: “It can fine-tune operations in ways previously not possible.”



Ted Aikman: “It eliminates inevitable periods of downtime and lost productivity.”



Marcus Lundbergh: “It’s the key to effective preventive maintenance.”



Olav Kvist: “One of the big benefits is to be able to document everything you do.”

FULL POTENTIAL UNDERGROUND



Underground equipment specialists Mikael Ramström and Marcus Lundbergh.

With an entire underground fleet of drill rigs, loaders and mine trucks sharing the same RCS platform, enabling them to communicate in the same language, they can be easily controlled and coordinated from a single point.

This requires total integration with local area networks based on the IREDES format (International Rock Excavation Data Exchange Standard), which Atlas Copco has also played a leading role in developing.

For example, all data obtained by the RCS systems can be fed into a central server. This can then be used by managements to optimize planning and maintenance, navigate machines to different locations, save energy and reduce costs.

Mikael Ramström explains: “We know that information and coordination leads to process optimization. For example, drilling data is not only of interest to drillers, it is also important for optimizing the procedures for charging and blasting.

“Looking ahead, we will also be able to apply our RCS technology to improving

the wider environment through better management of ventilation and electricity. For instance, studies show that half of the operating costs in the mining industry go to the cooling or heating of air and ventilation. With the information provided by RCS, ventilation can be optimized so that full ventilation is only applied in the areas where it is needed.

“The information will also show the mine how to optimize water consumption, and by doing this the service level of the equipment will improve. In other words, better performance per rock drill, better precision, follow-up and quality control leading to more sustainable productivity.”

In loading and haulage, material transportation is the main function and is where RCS shows its strength. By constantly monitoring key components such as engine, transmission, hydraulics and brakes RCS is not only used to display a warning, it also helps the operator to take the correct action. This helps to increase safety, availability and reduce operation costs.

Faults and warnings are logged in the

system and can be accessed on the machine or exported to a USB memory stick which helps to reduce downtime as problems can easily be identified and preventive maintenance can be planned.

Marcus Lundbergh, Product Manager loaders and trucks, says RCS technology makes LHD operations more effective. “For example, information on production and engine hours is easily available and load weighing is more efficient. Here the mine truck operator can monitor the process on his screen while the loader operator can check the status via a status light. This interaction can eliminate over-, or under loading, thereby optimizing the whole process.

“A unique function made possible by RCS is traction control which limits the power transferred to the wheels during mucking. This improves performance, minimizes tyre slippage and reduces tire wear. It enables the operator to attack the muck pile at full throttle, focus on filling the bucket and not worry about spinning the tires which all helps to increase productivity and reduce operating costs.”



Technology in action: All of the information stored in the central computer on board this Boomer XE3 C can be accessed by everyone engaged in the project.



Technology in action: Thanks to the RCS control system, this Scooptram ST14 loader is able to collect and share information on, for example, load weighing, tonnage, and service.



ON THE FA

Gothenburg rail tunnel speeds to completion with new drilling technology



ST TRACK

A major upgrade of the Swedish railway system in the Gothenburg area is on schedule for completion in 2012. Much of the progress is attributed to a new drill rig and its automatic rod handling system.





Anders Östberg, Veidekke's Plant & Machine Manager: "The automatic rod handling on this rig has made a great contribution."

» **T**he Hede-Älvängen railway tunnel near Gothenburg, Sweden, is rapidly on its way to completion. The project got under way in February 2010 and by January this year, more than two thirds of the 1.8 km tunnel had been excavated.

The new, twin-track railway is part of a major upgrade of the Gothenburg to Trollhättan line – a stretch of about 70 km – paving the way for high speed trains and doubling the capacity of the existing network in the south west of the country.

The tunnel, which is being driven through the Kattleberg mountain, is 13.5 m wide, 10.8 m high and includes the construction of an emergency escape tunnel (cross section 35 m²) as well as a 500 m long adit.

"Everything has been going smoothly on this job so far and we are achieving all of the targets we set out to achieve," says Anders Östberg, Plant and Machine Manager for the contractor, Veidekke Entreprenad.

Östberg attributes this to the skill of the Veidekke engineers coupled with the advanced capabilities of the drilling equipment being used – an Atlas Copco Boomer XE4 C, a new, fully computerized, four-boom drill rig that drills holes for pre-grouting as well as blast holes. Automatic rod handling is making a significant contribution to speed and efficiency.

Joint development project

Sweden is one of the few countries in the world where pre-grouted, unlined tunnels are consistently used for civil tunnel works and the Hede-Älvängen rail tunnel is no exception. When the contract was won by Veidekke, a sub-contractor to the Swedish construction company PEAB, the company decided it would need a four-boom drill rig that could drill all of the required



Inside the Kattleberg mountain: The fully computerized Atlas Copco Boomer XE4 C drill rig drills blast holes as well as pre-grouting holes in what will be the new rail tunnel.

pre-grouting holes as well as the blast holes – and preferably without increasing the number of operators.

The company worked with Atlas Copco on the design and, after several months, unveiled the Boomer XE4 C. The rig features four booms, each equipped with high frequency COP 3038 rock drills, the automatic rod handling system (Auto RHS E) for drilling up to 30 m long grout holes, and the Atlas Copco Rig Control System (RCS) enabling all of the functions to be handled by just one operator.

The rig was delivered in mid-2010 and today, with some 70 000 m of grout holes and 300 000 m of blast holes to its credit, it is clearly proving its worth in terms of production as well as increased safety.

Focus on operator safety

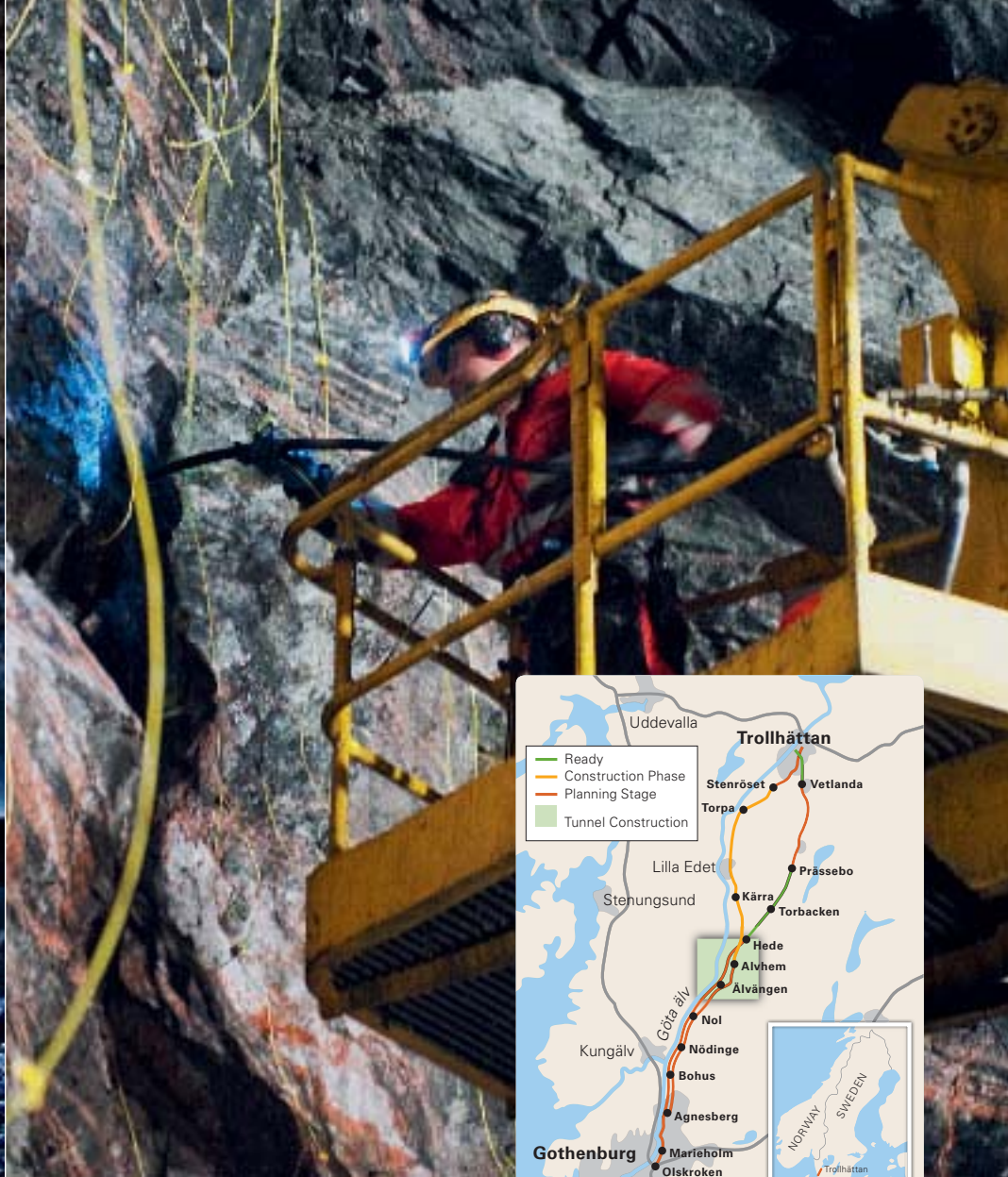
Like most European construction companies, Veidekke normally uses one operator for its three-boom rigs. With the new

Boomer XE4 C, not only has the number of booms been increased from three to four – increasing productivity – but still only one operator is required, reducing the risk of communication errors between different operators.

Safety is further enhanced thanks to the rod handling system which eliminates the need to stand on a platform, manually coupling and uncoupling threaded joints in order to extend drill rods.

Östberg says: "The Boomer XE4 C is doing great and we are especially pleased with the automatic rod handling system which has made a great contribution to efficiency and safety."

Each rod carousel holds up to eight, 3 m rods. This is particularly appreciated when drilling grout holes which are all more than 20 m long. Comments Site Manager Peter Ahlgren: "Instead of spending time on adding rods, this allows our operators to concentrate totally on drilling."



The rig's service platform is used for preparing holes for charging and blasting.




He continues: "When you can drill four holes at the same time, the rate of advance is extremely fast. With the Boomer XE4 C, we are able to advance the face about 25 meters per week, including pre-grouting of all the tunnel meters. With each blast, we advance six meters and that means we don't have to drive the rig in and out of the tunnel so often."

Precision is also important and it is vital that the tunnelers achieve the roof height of precisely 10.8 m. Once the high speed trains start running, a powerful vacuum will be created in the tunnel and there has to be enough room above the trains, as well as at the sides, to release the pressure.

To the operator, Niklas Karlsson, who has more than 25 years of tunneling experience, the Boomer XE4 C is the ideal solution. "I've been in this business a long time and I have tested most of the drill rigs that are out there," he says. "I can quickly tell if a particular rig is going to be suitable for a specific

tunnel or not and I think this one is perfect for the work we are doing here, especially when it comes to pre-grouting. I like having rod handling carousels on all four booms, and the rig drills fast and straight holes, just as they should be."

For navigating and positioning, the operator can use Total Station Navigation, an automated system that increases precision drilling and eliminates the need for surveyors. Meanwhile, Veidekke is also simultaneously driving the emergency/service tunnel using the smaller rig, the two-boom Atlas Copco Boomer E2 C.

The entire railway upgrade, which also involves a number of new bridges and stations along the Gothenburg to Trollhättan line, will cost approximately EUR 1.5 billion. The new rail tunnels are expected to be completed by mid-2011 with the first high speed trains running from December 2012, gradually building up to an average of about 120 trains per day. 

TACKLING DIFFICULT GROUND

The engineers working on the new Gothenburg railway have encountered difficult ground conditions with some sections of the railway having to be built in up to 100 m of layered clay.

Furthermore, the stretch between north Älvängen and Slumpen, north of Lilla Edet, crosses large areas of so-called quick clay, a particularly sensitive variety which is known to have caused landslides in Scandinavia and on the east and west coasts of Canada.

Difficulties have also been encountered as a result of rising water levels in the nearby River Göta and extensive ground stabilization is being carried out to minimize the risk of settlement.

The solution is the installation of limestone cement piles, a proven method of stabilization for deep clay layers, that reduces settlement and dampens the vibrations from the trains. The track embankment is also being raised by a minimum of 1.5 m.

As a complement to traditional geological surveys, a satellite positioning system is being used which monitors geological changes in the area.

Here's Omega — a good bit better

USA Atlas Copco Secoroc has introduced a new sealed bearing tricone drill bit for rotary drilling. Called Omega, the bit is described as a “technological leap forward” over standard air-bearing roller cone bits.

High precision machining to close tolerances, innovative seal technology, premium lubricants and proprietary materials and processes have resulted in premium performance bits with superior service life and cost savings.

These sealed bearing bits are made with extremely smooth bearing contact surfaces. A patented outer “excluder” ring keeps contamination from cuttings, grit and water out of the bearings under virtually all circumstances, while an inner seal retains grease in the bearings to lubricate the bearing elements.

Excellent penetration rates and bit life have been achieved during fields tests in coal and copper mining in both Australia and the USA. ⊙



The new Omega bit: Providing vastly superior performance in rotary drilling compared with conventional air-bearing bits.



New names make the ROC choice easier

WORLD Atlas Copco’s ROC crawler rigs have been given new names to make it easier to distinguish between the various models and their different characteristics. The range has four categories: AirROC, PowerROC, FlexiROC and SmartROC.

- The AirROC series consists of pneumatic and manually operated drill rigs, easy to operate with simplicity in design and a robust steel structure.
- The PowerROC series consists of hydraulic drill rigs with a straightforward design and trouble-free hydraulics.
- The FlexiROC series consists of high technology rigs with a medium level of sophistication.
- The SmartROC series consists of high technology rigs with a high level of sophistication and equipped with the latest optional equipment to minimize costs in each drilling and blasting operation.

Tophammer, DTH and COPROD drilling methods are used right across the range and this is evident from the product designations such as FlexiROC T30 R where “T” stands for tophammer.

Bo-Göran Johansson, Vice President, Marketing at Atlas Copco’s Surface Drilling Equipment Division explains: “Several rigs in the range have similar basic technical specifications such as drill method, hole range, installed power and flushing capacity for specific applications, but there are also various control systems that meet basic requirements for different levels of technical capability.

“The new structure makes it easier to distinguish between the models and easier to understand the advantages that each category has to offer. It also better defines the segment and application for which each rig is intended.” ⊙

IN BRIEF

Atlas Copco at WTC 2011



Atlas Copco will be a “Gold Sponsor” at the World Tunnel Congress in Helsinki, Finland, May 20–26. The theme is “Underground Spaces in the Service of a Sustainable Society”. Atlas Copco will present two papers: “Setting Up The New High Quality Standards For Pre-grouting Drilling In Tunneling” and “Opportunities To Optimize Project Economies Through Integration Of Digital Drilling and Blasting Technologies”.

Robbins goes yellow

Atlas Copco Robbins raiseboring machines, a leading name in the raiseboring industry since the 1960s, are now all instantly recognizable. Previously produced in white, these popular machines are now manufactured with the same distinct yellow and gray design that characterizes all Atlas Copco products. This new design “language” is intended to convey robustness, serviceability and sustainability, which describes the strengths of the Atlas Copco range. Robbins raisedrills were introduced in 1962 and incorporated into the Atlas Copco Group in 1994.

True colors: A new Atlas Copco Robbins 91RH C raiseborer with the new design in yellow and gray.



World's biggest silver mine places multi-million dollar order


The Scooptram ST 1030: One of several Scooptram loaders included in the latest batch to be delivered to Fresnillo, starting this year.



Silver skyline: The Fresnillo Mine, located approx. 60 km northwest of Zacatecas, Mexico, aims to develop and expand with new Atlas Copco equipment to add to the Atlas Copco fleet it already owns.

MEXICO Fresnillo PLC has placed a multi-million dollar order for new mining equipment with Atlas Copco. The order, valued at USD 45 million, is the largest ever for Atlas Copco's Construction and Mining business area and involves underground drill rigs as well as equipment for rock reinforcement, loading and haulage.

The equipment will be used for new development, production and expansion of the Fresnillo Silver Mine in Zacatecas, the largest primary silver mine in the world. Included in the package is the single boom Boomer S1D drill rig, a Boltec 235 rock bolting rig, a Scaletec scaling rig, a Robbins raiseboring machine and Scooptram loaders ST 1030 and ST 14.

"We are very happy that Fresnillo has selected Atlas Copco as one of its main suppliers," says Björn Rosengren, President of Atlas Copco Construction and Mining Technique. "Our high quality equipment and customer support positions Atlas Copco well in the world of silver mining." Deliveries are scheduled to start during the second half of this year. 

New fluids range

Atlas Copco has introduced a complete range of oils, coolants and greases designed for construction and mining equipment. Called "Atlas Copco Fluids", the range includes 34 types of



oils, two different coolants and five different greases, all offered in various packaging sizes. Also included are products that meet the demands of all temperature zones as well as requests for biodegradable options.

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Austria	Vienna	+43 (0)1 760120
Belgium	Brussels	+32 (0)2 6890511
Bolivia	La Paz	+591 (0)2 2112000
Brazil	São Paulo	+55 (11) 34788200
Bulgaria	Sofia	+359 (0)2 4893178
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Japan	Tokyo	+81 (0)3 5765 7890
Kazakhstan	Almaty	+7 727 2588 534
Kenya	Nairobi	+254 (0)20 6605 000
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Latvia	Finland, Vantaa	+358 (0)9 2964 42
Lithuania	Finland, Vantaa	+358 (0)9 2964 42
Macedonia	Skopje	+389 (0)2 3112 383
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Singapore	Jurong	+65 6210 8000
Slovenia	Trzin	+386 (0)1 5600 710
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Spain	Madrid	+34 (0)916 2791 00
Sweden	Stockholm	+46 (0)8 7439 230
Switzerland	Studen/Biel	+41 (0)32 3741 581
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www.miningandconstruction.com

Precision for everyday safety



By integrating precision into our construction solutions, initiating global training programs and establishing international certifications, we ensure safety throughout your operations. Every day. We bring together experience and innovation to contribute to performance that withstands the test of time. This is what we call – Sustainable Productivity.

www.atlascopco.com/rock

Sustainable Productivity

Atlas Copco