



# MINING & CONSTRUCTION

**CONVERTING TO  
UNDERGROUND  
OPERATIONS  
WITH DIAVIK**

**ICE BOUND DIAVIK EXPANDS**  
*PAGE 3*

**ATLAS COPCO'S SUPPORTING  
ROLE IN BILLY BISHOP TUNNEL**  
*PAGE 12*

**NEW WAREHOUSING SYSTEM  
SPEEDS DELIVERIES**  
*PAGE 13*

*MECHANIZED ROCK  
EXCAVATION WITH  
ATLAS COPCO*

**NO. 1, 2016**

---

*Atlas Copco*

---



**M**y envious vantage point as Business Line Manager of Atlas Copco Canada Mining and Rock Excavation Services allows me to see our people working alongside our customers countrywide, teaming up to ensure Sustainable Productivity, our brand promise.

The stories in this issue of M&C Canada demonstrate the geographic reach of our support network. Billy Bishop Toronto City Airport visitors can now walk under Lake Ontario in a tunnel constructed beneath a full-length secant pile canopy, supported further with Swellex rock bolts. And there seems to be no end to the uses Diavik Diamond Mine keeps discovering for its Atlas Copco Robbins raise-boring machine 300 km north of Yellowknife.

For me, though, the most exciting achievement this year took place behind-the-scenes. I am happy to announce automation of inventory management and shipping of our Mississauga-based national distribution center. Wireless, handheld barcode scanners free our warehouse personnel from paperwork—which used to take up to one-fifth of their day! 24-hour shipping capacity has doubled already and may yet climb higher. Best yet, your customer service center is relieved of cumbersome inventory management chores, with more time and resources to serve you.

I hope you find these stories as exciting as I have. And I hope that you find continuing success, assured of our service personnel's support for you nationwide.

*Andre Bertrand*

**Andre Bertrand**  
Mining and Rock Excavation Services  
Business Line Manager



**3** Atlas Copco is a proud member of Diavik's 'Culture of Safety' on the Arctic Circle



**12** Atlas Copco Swellex used in award-winning Billy Bishop airport tunnel design



**9** Owning their own Atlas Copco Raisebore inspires cost-effective solutions



**14** New warehouse systems deliver to customers faster

**MINING & CONSTRUCTION CANADA** is published by Atlas Copco. The magazine focuses on the company's knowhow. [www.atlascopco.com](http://www.atlascopco.com)

**ATLAS COPCO MINING AND ROCK EXCAVATION TECHNIQUE CANADA**  
1025 Tristar Drive  
Mississauga, ON  
L5T 1W5  
Phone: +1 (800) 465-6719

**PUBLISHER** Anne Marie Grossi  
[anne.marie.grossi@ca.atlascopco.com](mailto:anne.marie.grossi@ca.atlascopco.com)

**EDITOR** Scott Ellenbecker, [scott@ellcom.us](mailto:scott@ellcom.us)  
Ellenbecker Communications  
30124 State Highway 264  
Round Lake, MN 56167 USA  
507-945-0100

**SUBSCRIPTIONS** [Subscriptions@ellcom.us](mailto:Subscriptions@ellcom.us)

**FREE REPRODUCTION OF ARTICLES**

All product names such as Boomer, Boltec, ROC, PitViper, DRILLCare, SmartRig and Swellex are registered Atlas Copco trademarks. However, all material in this publication, including the product names, may be reproduced or referred to free of charge. For artwork or additional information please contact Atlas Copco.

**SAFETY FIRST**

Atlas Copco is committed to comply with or exceed all global and local safety rules and regulations for personal safety. Some photographs in this magazine may, however, show circumstances that are beyond our control. All users of Atlas Copco equipment are urged to think safety first and always use proper ear, eye, head and other protection as required to minimize the risk of personal injury.







# ICE BOUND

Located in Canada's remote Northwest Territories, Diavik Diamond Mine commenced production in 2003. With 18.1 million tonnes of ore reserves (Dec. 31, 2014), Diavik's kimberlite pipes are yielding about 6 million to 7 million carats annually. An official grading of 2.9 carats per tonne ranks them among the richest diamond-yielding resources in the world. Atlas Copco embraces its role in Diavik Diamond Mine's culture of responsible productivity. »



Our predominant rock bolt type is Swellex, says **Lyndon Clark**, Diavik underground mine manager. It is reliable ground support for a wide variety of rock conditions. Clark says, “Swellex saves time, letting us use one machine to do it all.”



» **A**fter reaching what they could from the surface, Diavik Diamond Mines had to convert to underground sublevel retreat and stope-and-fill mining methods. The narrowing levels of three kimberlite pipes ultimately go as deep as 750 meters.

The transition from surface to underground mining would have been a major undertaking in any environment. Diavik, however, lies at the edge of the Arctic Circle, surrounded by a unique dike system specially made for this island operation to hold back the icy waters of Lac de Gras.

Transportation to and from the joint Rio-Tinto–Dominion Diamond Corporation venture is by air only, except for a brief period in late winter when an ice road joins it to Yellowknife 300 kilometers to the southwest.

Equipment chosen for this location needs to be not only technologically advanced but reliably supported. That’s why Diavik chose Atlas Copco to be its predominant supplier from the beginning of the underground transition.

Today Diavik has a large Atlas Copco fleet:

- 3 Scooptram ST1020 LHDs with 10-tonne capacity
- 7 Scooptram ST1530 LHDs with 15-tonne capacity

- 7 Scooptram ST14 LHDs with 14-tonne capacity
- 5 Boomer face drilling rigs
- 6 Boltec MC mechanized bolting rigs
- 2 Simba M7 long hole drilling rigs
- 3 Simba M6 long hole drilling rigs
- 3 Minetruck MT5010 underground haul trucks with 50-tonne capacity
- 11 Minetruck MT6020 underground haul trucks with 60-tonne capacity
- 1 Atlas Copco Robbins 73RH C raiseboring machine

### Unified

Marc Cameron, president and chief operating officer of Diavik Diamond Mines, said: “We really studied what it takes to be successful, to be the best business we can be. So we began by clarifying our business model. We based it on creating a consolidated workforce, a community where people want to be.”

The Diavik community places greatest emphasis on safety with a goal of zero harm, Cameron said. “Our motto is, ‘If it can’t be done safely, it will not be done at Diavik.’ Safety is that fundamental to our operating culture.”

That goes for the environment’s safety, as well, as Diavik strives to meet the highest standards for operating on the remote subarctic tundra. About one half of the mine’s workforce lives in the Northwest Territories, and 25 percent of the operation’s 1,000 people are Aboriginal.

### Availability

Diavik owns all the Atlas Copco equipment on site, which is used both by Diavik personnel and underground mine contracting and engineering company Kitikmeot Cementation Mining & Development Ltd. (KCMD). Diavik crews focus on production, while KCMD carries out the development mining. Atlas Copco personnel contribute OEM product support.

Derek Buzzi, Diavik superintendent of mobile maintenance, tracks rig availability using, he said, “real numbers” that average 92.7 percent for Boomer face drilling rigs and 83 percent for Boltec bolters. Buzzi notes that these averages don’t include preventive maintenance and repair work done while rigs are unassigned.

“Equipment does not get a rest here,” Buzzi said, “We run equipment hard, 24/7. Our reports are what I would tend to call ‘real numbers.’” High availability reports from





*Marc Cameron, president and chief operating officer of Diavik Diamond Mines, says Diavik profitability is founded on its community business model: “We operate as one business—Diavik.”*

companies who are able to rotate machines out for scheduled service, he said, have limited value for comparison. “I stand by our numbers.”

### **Collaboration**

Diavik includes Atlas Copco in all safety-related discussions concerning drilling, hauling and bolting equipment, as well as drill tooling and rock bolts. Close product support is provided by Atlas Copco’s offices in Yellowknife. The Yellowknife location is backed by the Canadian service center in Sudbury and by fast response from Atlas Copco global headquarters in Sweden.

Michel Boivin, Atlas Copco key account manager, described the unity of the Diavik community as an ideal forum for “quickly

resolving immediate requirements.”

“It’s not the usual customer-supplier relationship,” Boivin said. “When an opportunity to improve safety or productivity concerns Atlas Copco equipment, we get together as a group to analyze the situation. Then we’ll present it to Atlas Copco Canada’s technical group and the Atlas Copco Product Company technical group.”

Boivin said, “It’s an old Atlas Copco saying that the person closest to the problem is also closest to the solution.” But he said it’s not always an easy task to assemble a cross-functional team of mine personnel, OEM product support technicians, the manufacturer’s technical group, its engineering group, and marketing and service groups.

So Atlas Copco keeps four Atlas Copco

technicians skilled in trouble-shooting and analytics in rotation on site to provide 24/7 manufacturer support of the equipment: John Matt, Don Kasaboski, Zach Patrick and Sean McKay. A customer service representative dedicated to Diavik, Linda Aubin, works from the Yellowknife Atlas Copco office. Boivin himself has living quarters at Diavik for extended stays and works from his offices both at Yellowknife and at Diavik.

### **No need to break the ice**

The isolated environment fosters an esprit de corps extending long past the work day. Boivin said the “almost card game-like atmosphere” is the birthplace of many of Diavik’s innovations. Problem-solving sessions often carry over into relaxed conversations





*Having started his career in 1979 on a jackleg working in a wet and noisy drilling environment, Francis MacNeil enjoys the cab of his Simba M6C. "It's drilling automation at its finest."*

» with Diavik personnel, Boivin said. "Someone will wish out loud, 'If only there was a way to do this or that more safely, more efficiently or more economically.' The other will call and raise: 'Hey, what if?'" And then it's, 'I bet we could!'"

Then Boivin takes the concern to Atlas Copco technicians and engineers, who seem to him excited by the opportunity to "try something out of the ordinary." The engineers offer high tech analysis, cutting-edge design and OEM certification that Diavik can incorporate in its safety analysis.

"If it's not safe, it's not done at Diavik," Boivin reminded.

Overall time to get a modification or innovation from design and analysis into implementation at the mine has been short. And

the list of innovations seems endless, many of which are Canadian mining "firsts." Some are even world firsts.

#### **Tier 2 conversions**

Faced with investing \$12 million in new ventilation infrastructure to expand its underground fleet, Diavik approached Boivin for input on the possibility of upgrading to higher Tier engines. Boivin called upon Atlas Copco Canada's technical group.

Twelve of the mine's haul trucks had Tier 1 engines. The proposed solution was to progressively swap them out for Tier 2 engines on site. When technicians realized there was no kit for the upgrade, Sweden's engineers responded by making one.

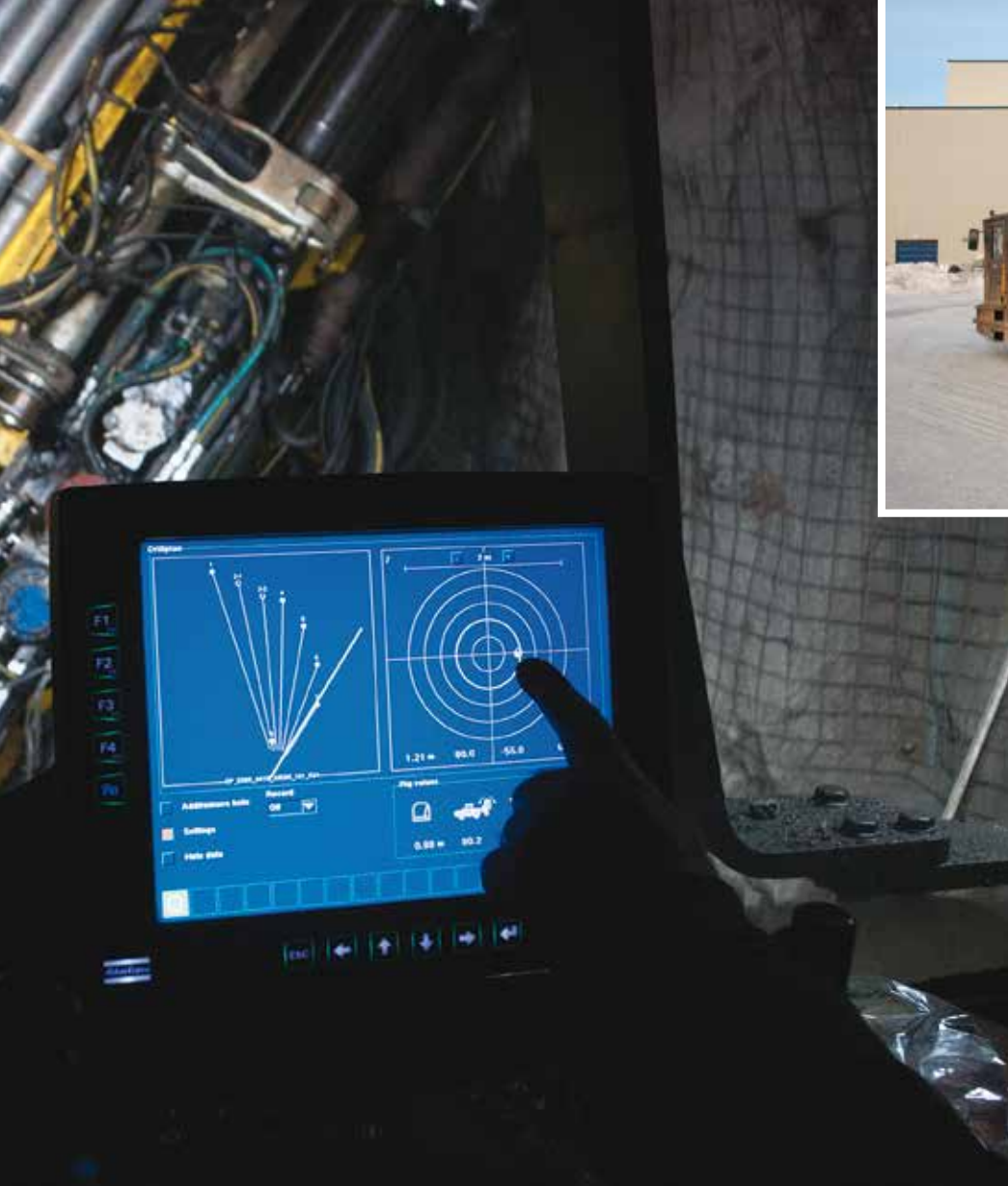
Together Diavik and Atlas Copco chose a

team of OEM technicians to come to Diavik for the project. The 760 hp Tier 2 engines took three weeks each to install, reduced cfm consumption by 43 percent, and allowed Diavik to keep vehicles it already owned and still continue to expand its underground operation.

#### **Training**

Diavik uses an Atlas Copco training Simulator with Simba, Boomer and Boltec software to train operators on site. Training on the Simulators is preformed by instructors from Diavik who were trained by Atlas Copco specialists. Diavik is currently using Atlas Copco's Master Driller program.

Diavik and Atlas Copco are working together to create the first MT6020 simulator



▲ Diavik gets nearly a 20 percent increase in capacity from three of its MT5010 mine trucks with MT6020 boxes. They are only used for kimberlite, a volcanic diamond-bearing rock much less dense than granitic waste or cement rock fill.

◀ Driller Francis MacNeil is drilling 4-inch holes to 8.7 meters for this stopping pattern. Rig positioning is guided by a laser. Drilling and rod changing are automatic.

training program. Graphics created from actual video footage of the Diavik underground operation itself will give MT6020 driver trainees dual-purpose simulator instruction. As drivers achieve competency in the mine truck they will also be oriented in the geography and protocols of Diavik. Drivers will transition from simulator to operating in the actual mine environment faster, safer.

#### Remote drilling

The Boomer M2C rigs, Boltec bolters and Simba M6 and M7 rigs all have the ability to drill remotely. This capability is used frequently for recovery drilling in the production areas and also for development through ground which may have remnant explosives (i.e. secondary development in blasthole stopping areas).

Diavik uses its Boomer rigs for 45 millimeter and 48 millimeter blastholes. It secures ground with 8-, 12- and 16-foot Swellex and

plastic-coated Swellex installed with Boltec mechanized bolting rigs. Simba long hole drills, primarily used in production stopping, drill blastholes of 89 and 102 millimeters.

#### Underground mining operations

The carrot-shaped kimberlite formations at the Diavik site are 100 to 150 meters wide at their tops, which lie just below the surface. From there they extend approximately 750 meters down into the 2.5 billion-year-old pre-Cambrian formation of the Slave Geological Province.

In 2003 Diavik initiated commercial processing of ore from its initial surface mining operations through its on-site plant, projecting a 16 year to 22 year life-of-mine production schedule.

In 2010 Diavik began concurrent underground production and converted on schedule solely to underground operations in 2012. Diavik is currently working three diamond-

bearing kimberlite pipes known as A154 South, A154 North and A418.

All transportation and haulage on site at Diavik is conducted by surface portals and ramps. At two of the pipes Diavik uses sub-level retreat mining method. The third is mined with blasthole stopping and cemented rock fill.

With an estimated 18 million tonnes of ore reserves, the pipes are yielding about 6 to 7 million carats annually at three carats per ton of kimberlite. An official grading of 2.9 carats per tonne ranks the Diavik among the richest diamond-yielding resources in the world. Dilution assessment is ongoing, although all extracted kimberlite to date is profitably processed. Selective mining is not required, and no cut-off ratio is necessary to define the retrievable resource.

Chris Auld, senior production engineer at Diavik, said approximately 100 loads are hauled to the surface each shift by the »





*(left to right) Atlas Copco on-site technician Sean McKay, Atlas Copco Key Account Manager Michel Boivin, Diavik Mechanic Supervisor Guy Lajoie, Diavik Superintendent of Mobile Maintenance Derek Buzzi. On the surface temperatures fall below minus 40 C on a winter night with more extreme windchills. Diavik's two-story high maintenance shop 400 meters below the surface is a safer, more comfortable working environment.*

» Minetruck haulers for a monthly total of more than 70,000 tonnes of waste and cemented rockfill and 182,000 tonnes of kimberlite. Due to its lower density, loads of kimberlite average 43 tonnes per truck. The trucks average 20 km/h down the ramps and 10 to 15 km/h up them, depending on what they are carrying.

A154 North pipe's production is from production is blasthole stoping. First access advances progressing south to north are drilled with Atlas Copco Boomer face drilling rigs to pass adjacent to the ore body. Entry into the kimberlite is perpendicular to the access. The overcut and undercut passes are driven with the Boomers as well. After a round is blasted and mucked, Boltec rigs secure the advance with mesh and Swellex and, if required, shotcrete.

Once the overcut and undercut are complete across the orebody, Simba M7 and M6 open the stope, cutting a slot to the level above. After blasting the slot and mucking the ore, subsequent rings are blasted into the

ever-growing stope cavity. Once the cavity is mucked out it is filled with cemented rockfill.

Stoping can occur while adjacent headings are in development; however, Diavik prefers to allow some buffer to further protect surrounding ground, an extra measure of safety during subsequent production blasting.

Production in A154 South and A418 is performed by sublevel retreat. Boomer rigs are used in the drilling and blasting of accesses alongside the pipes, similar to access development in the A154 North pipe. And ore body penetration is likewise perpendicular to the access, progressing completely across the pipe one side to the other.

All lateral headings are drilled with Boomer face drilling rigs. Each advancing round is bolted with a Boltec bolter and Swellex, and will be shotcreted and spiled if necessary (canopy support), depending on ground conditions. Boomer rigs are used to drill the spilings, which are installed before a blast. Simba drills are used for production drilling.

Penetration rate in the granitic host rock, whose average hardness rating is R5.5, is 2 meters per minute. Drilling progresses at 3.5 meters per minute in the softer kimberlite, whose hardness ranges from R1.5 in A418 to R3.5 in the North Pipe.

Overall, drilling a round in the ore routinely takes about two hours.

A fourth kimberlite pipe at Diavik, A21, is located on the mine site near the other three pipes currently in production. During fourth quarter of 2014 Rio Tinto announced investment US\$350 million at Diavik for development of the A21 kimberlite ore body. Provided by the joint venture, this funding will be used to construct the A21 dike (Diavik's third) allowing safe open-pit access to a fourth ore body. An implementation team is in place and construction activities are underway. Development includes site preparation, earthworks, water management and pre-production overburden stripping. First ore production from A21 is expected in 2018. ☉



# Raising TO THE OCCASION



Owning an Atlas Copco Robbins raiseboring machine inspires innovations that not only pay for itself but increase borehole quality, safety

Located 220 kilometers south of the Arctic Circle on an island in Lac de Gras, Diavik Diamond Mine can be reached by trucks making an 15-hour drive over an ice road only in February and March. The rest of the year, access is by air only. Some equipment and supplies can be flown to site but this is much more costly than hauling over the ice road.

So management's decision whether to use a contractor or purchase its own raise boring machine was heavily influenced by the logistics of getting the equipment to the site each time it was needed. In the end, having its own raise boring machine on site resulted in some innovative uses with huge payoffs in safety enhancement and reduced infrastructure costs.

The first project requiring a raise bore machine was a routine application. The Rio Tinto Group–Dominion Diamond Corporation joint venture needed 10-foot-diameter ventilation shafts and ore passes, which an Atlas Copco Robbins 73RH C creates more accurately than drilling and blasting.

Nigel King and Peter Gillies, Diavik superintendents of underground projects, laid out the case for buying. Moving a contrac-



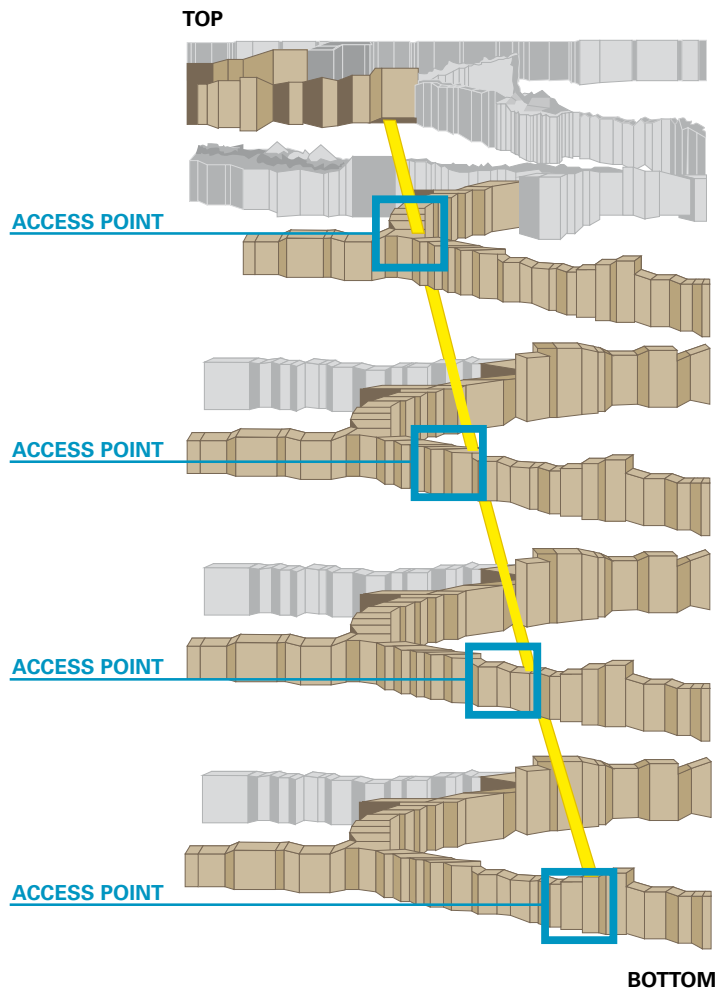
*The 100 meter Safescape Laddertube escapeway joins four raises in a single run with minimal construction. The escapeway permits workers in an emergency to safely get from an access on one level to another level above or below it. Interior handrails serve a double purpose, acting as a litter slide for nonambulatory personnel. Foldup landings spaced every 6 meters throughout the length of the tube also serve a double purpose, providing a stopping point for rest and limiting the length of a fall in case of a slip.*

tor's equipment to the site from Yellowknife would cost up to a half-million dollars per project. Therefore, owning an on-site raise boring machine would pay for itself after only a handful of projects, let alone over the remainder of the current mine plan which extends to 2023.

A single raise boring machine is also useful in other applications. In addition to ventilation shafts and ore passes, the machine could be used to bore 20-inch utility holes for 16-inch water pumping service pipe.

“When you realize all that can be done with an Atlas Copco raise drill, it just makes sense to buy it—especially considering the location, the volume of work, and that scheduling a contractor might take a year before the start of a project,” King said.

The decision to buy left one additional consideration: operation. There were two strategies to choose from. “One, we could hire a contractor and have them use our machine,” King said. “Two, we could use our own workforce to operate it ourselves.” »



» Again, the cost of mobilizing a contractor proved excessive for the remote location. Diavik's dedication to safety requires contractors who have been offsite for an extended period to go through the Diavik orientation and safety training again. Safety measures and operations protocol evolve with its focus on continuous improvement. So returning contractors must not only re-familiarize themselves with Diavik procedures but be updated on any changes to them during their absence. Orientation adds to project time and cost.

Diavik chose to cross-train select employees to run the raise borer. The strategy paid off for Diavik. "By the time we could have had a contractor on site to start a project, we'd already completed four," King said. "It's really an easy-to-use, smooth-running machine. I smile every time I see us using it. Maintenance and upkeep are minor."

Michel Boivin, Atlas Copco key account manager to Diavik, added, "The resale value of our raise drills is high as the units have a long service life. It's been said that the very first one ever built is still operating to this day somewhere in South America."

When the mine reaches its planned life, they could possibly recoup some of their initial investment in the raise drill by selling it to another mine site.

### Escapeways

Having an Atlas Copco Robbins 73RH C raiseboring machine on site inspired other uses for it, such as creating escapeways. The first escapeway for Diavik's underground operations had been built the traditional way, with drilling and blasting.

After accesses had been created in the Canadian Shield granite rock one atop another at 25 meter intervals, Atlas Copco Simba long-hole drilling rigs drilled blast-holes to connect them with a vertical shaft. Crews mucked the rubble out, scaled the sides, reinforced them with Atlas Copco Swellex rock bolts and mesh, added timbers and constructed the platforms and ladders, taking nine months to complete a job.

Before starting the second escapeway, King and Gillies ordered a 42-inch reaming bit for the Atlas Copco Robbins Raisebore 73RH C.

A 100 meter run of 12 ¼-inch pilot hole

was drilled with the machine at an incline of 70 degrees. The pilot was then back-reamed using the 42-inch reamer. This escapeway would serve to connect four levels of accesses. It took only two months to complete.

Using the raise borer for the escapeways also benefitted the development schedule. Since the raise drill could bore the entire 100 meters rather than 25 meters at a time, as with the drilling and blasting method, the mine didn't have to wait for intermediate access drifts to be created before boring the raises. Instead, once the uppermost and lowest accesses were in place, the raise was bored. Intermediate drifts intercepted the hole when they were created later.

After all the drifts had been developed, the 100-meter-long bore received a 42-inch Safescape escapeway system.

### Sump drain holes

Diavik had tried 4-inch sump drain holes but went to 6 ½-inch-diameter holes when the smaller diameter repeatedly had to be cleared of debris. But the 6 ½-inch holes did not fare much better.

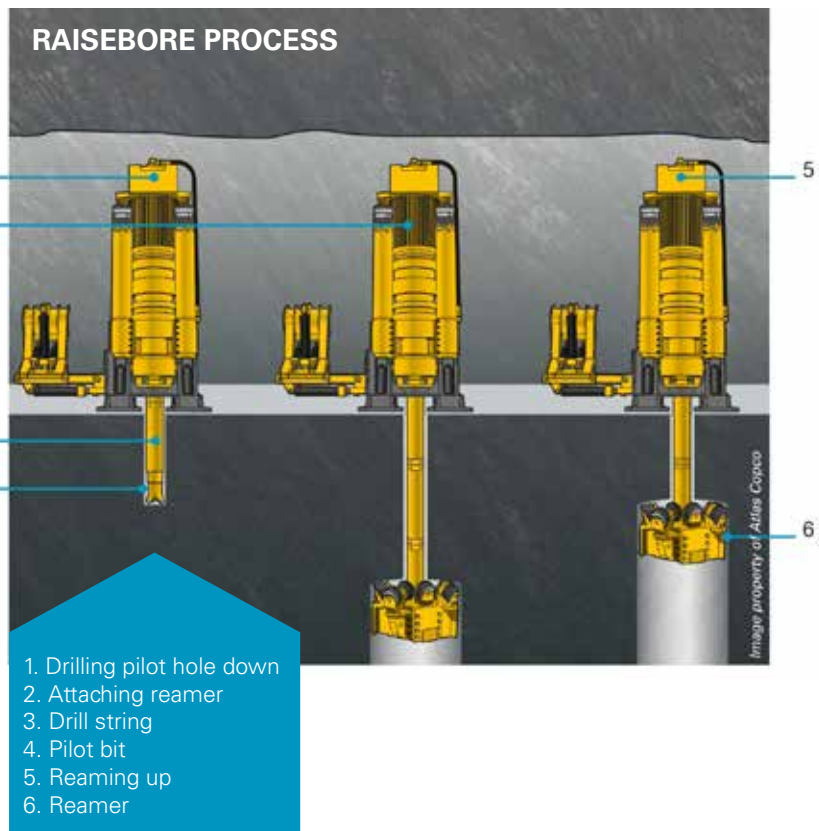
So Diavik trialed boring 12 ¼-inch drain



“By the time we could have had a contractor on site to start a project, we’d already completed four. It’s really an easy-to-use, smooth-running machine. I smile every time I see us using it. Maintenance and upkeep are minor.



**Nigel King,**  
Diavik Superintendent



holes. Four drain holes were bored on a 1-foot-high concrete pad, which was constructed with a U-shaped trough and supported the drill. The four holes ensured that now, should one hole become plugged, control gates could direct water to a different hole. Not all four holes would be used at once, since this could overwhelm the two sumps at the bottom.

Leaving the U-shaped pad in place after the Atlas Copco Robbins 73RH C raiseboring machine was removed provided a solid, raised platform for workers to operate the gates from without having to stand in water, adding convenience and increasing worker safety. The open portion of the U functions much the way a storm sewer serves to collect runoff water at its street curb opening. To date the larger holes have not plugged.

#### Power saves time

King tracks everything about underground operations. He gave an example of how fast the bores can be made to size.

“As a rule, we like to keep much less than 50,000 pounds of force on a cutter. For the pilot and 20-inch hole opener, which use tricone cutters, we use even less. The 5-foot rods weigh 1,000 pounds apiece, so we don’t have to push as hard as we add

rods. Before the hole is complete, we’re actually holding back in order to maintain the same bit force on the face of the hole.”

For back-reaming, the 17-cutter, 10-foot reamer and the weight of its rods could require up to 800,000 lbf to pull it back at maximum allowed force. “The drill will give us 1 million pounds,” King said. “But we’ve found so far that 425,000 pounds of force works well for us.”

For 20-inch holes reaming takes half the time of piloting. Wider holes with “magnum” bit reamers take a little longer. Reaming a 12 ¼-inch pilot to 42 inches takes twice as long as drilling the pilot. Reaming the pilot to 10 feet takes three times as long as the pilot.

Though the mine’s kimberlite pipes are all in the granitic Canadian Shield host rock, the granite varies slightly among them. For instance, the finer-grained granite around the kimberlite pipe designated A418 takes longer to drill and ream than that of pipe A154, whose pace for a 42-inch back-ream is about 10-feet an hour.

Since its first use in August 2012 to March 2015, the raise boring machine has been used for 18 hole projects. These consist of three 12 ¼-inch utility holes, four 20-inch utility holes, three 10-foot ventilation shafts,

two 10-foot ore passes, four 12 ¼-inch dewatering drains and two 42-inch escapeways. Total meters bored was 1104 meters.

At Diavik, buying the raise boring machine was the most economical decision. “Payback was quick for us at this location,” King said. “We’re such a remote site, for one, and then with all the water we have, buying our raise bore cost only about one-fifth to one-fourth of what it would have cost to hire a contractor.”

#### Accuracy

With the Atlas Copco Robbins 73RH C, King said Diavik doesn’t experience the overbreak it had with blasting. “The carbide cutters bore the walls perfectly smooth. And while Simbas are fine for up to 25-meter raises, the Atlas Copco Robbins 73RH C is absolutely straight at bore lengths much greater than 25 meters. For instance, we had only 4 centimeters of deviation for a 42-meter vertical, 90-degree hole. Deviation with the raise bore typically ranges from only 0.08 percent to 0.1 percent per run here.

“We do prefer to drill at 90 degrees, since there is less wear on the rods than at an angle. But if you start straight, it drills straight, even on the 70-degree incline for the escapeways.”



# PULLING TOGETHER

## Atlas Copco Swellex played supporting role in award-winning Billy Bishop tunnel construction

**A**lthough it's right in the heart of Toronto, one of Canada's top 10 busiest airports—a central hub of Porter Airlines—actually sits on a tiny little island separated from the city by the Western Channel of Lake Ontario. From the day it first opened in 1939, Billy Bishop Airport could only be reached by taking a ferry across that channel. That's why the pedestrian tunnel that opened July 30 was such a welcome alternative to the airport's patrons. It serves 24 cities in Canada and the U.S. with connections to more than 80 international destinations.

Six shaft elevators on the mainland side transport airport users more than 100 feet below the surface—35 feet below Lake Ontario—to a set of four automated sidewalks. Travelers can choose to ascend to the atrium on the island side using one of the lon-

gest escalator systems in Canada, one of two elevators, or a 153-step stairway to the top. The ferry will continue to transport vehicles across to the airport and any passengers who choose to.

Atlas Copco Swellex helped make the achievement possible and keep workers safe from the project's beginning.

Construction of the project first began early 2012 by Technicore Underground Inc. of Newmarket Ontario. Tony DiMillo is the owner/director of Technicore. His son Joe DiMillo, project manager, provided project oversight from ground breaking to secant piles and pouring of the tunnel's concrete.

Excavation of the tunnel under a water body was performed without impacting adjacent airport operations by working from very small work sites. Technicore formed an arch-

ing underground ceiling of horizontal secant piles drilled with tunnel boring machines the full length through the shale bedrock. The use of tunnel boring machines to create the secant pile canopy is a first in Canadian construction practices. To secure the surrounding ground Technicore relied on Atlas Copco Swellex rock bolts.

Joe DiMillo said, "We chose Atlas Copco rock bolts because of the ease of installation and inflation, the immediate support, very little production time delay and peace of mind that the bolt is fully inflated and providing support. Additionally we were able to utilize the available pull test equipment and benefit from outstanding product support."

The shale contained very little limestone. Strengths ranged from 80 to 100 MPa. A combination of tie-backs and struts and wal-





### Tunneling contractor

Technicore Underground Inc., Newmarket, Ontario Canada.

### Atlas Copco equipment

- Swellex PM12 x 1.2 m bolts
- Swellex MN24 x 3.6 m bolts
- Swellex PM12 x 3.6 m bolts
- PSP300 RDP pneumatic Swellex pump
- H1 hydraulic Swellex pump
- Pull testing equipment

### Results/ Benefits

- Very little production time delay (no grouting or setting time)
- Ease of installation and inflation
- Available pull test equipment
- Product support / availability



ers for both the mainland and island shafts supported the secant canopy. Rock bolting and mesh ensured safe working conditions.

Atlas Copco personnel completed on-site training for installation of PM12 and MN24 Swellex bolts and provided inflation arm instruction for using the pneumatic PSP 300RDP and hydraulic H1 Swellex pumps, as well as in use of Swellex bolt pull test equipment.

Excavation prep started at the surface with 15-meter-long secant piles through overburden into bedrock to stabilize the shaft opening, with several rows of tie back anchors in the remaining 13 meters of shaft depth down to an overall depth of 28 meters on mainland side.

The tunnel arch support was a very unique design by Technicore developed specifically

for this project. Twin tunnel boring machines nicknamed Chip and Dale then created the secant ceiling, consisting of seven interlocking, 2-meter-diameter, tunnels. Above the tunnels, Technicore installed 1.2-meter Swellex PM12 bolts for temporary support prior to filling them with cement.

The main shaft's undercut wall required installation of 3.6-meter-long PM12 Swellex bolts.


The overall main tunnel dimensions required were 11 meters wide, 7.3 meters high and 183 meters long. Once this profile had been excavated, Technicore installed five rows of 3.6-meter-long MN24 Swellex bolts for ground support.

Technicore conducted the mainland and island shaft excavations, the main tunnel excavation, ground support installation and

construction of the final concrete structure. Forms and concrete were supplied by Tec-Mix, a division of the Technicore Group of Companies.

General Contractor PCL Construction Canada built the elevator shafts in the mainland access and inclined escalators on the island. Engineering consultants Arup Tunnel Designers designed the tunnel.

A design-build project, the tunnel was constructed and financed using a public-private partnership model ensuring that no taxpayer dollars were used to fund the project.

The tunnel has won several awards for its innovation, including the International Tunneling & Underground Space Association's Specialist Tunneling Project of the Year Award and the Tunneling Association of Canada's Canadian Project of the Year Award. 

# MISSISSAUGA EXPRESS

Automated Mississauga warehouse now handles 6 times the volume with 2 times the performance

The 21 Atlas Copco Customer Centers across Canada had been doing double-duty, functioning both as sales and service outlets as well as mini warehouses. As part of continuing improvement processes, Andre Bertrand, Atlas Copco Canada national business line manager of parts and service, had been wondering: Would service be even more efficient if they could reduce excessive or cumbersome inventory at each location?

Consensus formed that much of their former inventory should be consolidated and moved to a central warehouse—“Only if our locations could be certain of quick access to it,” Bertrand said. “Our customers must not be kept waiting due to shipping delays.”

Bertrand initiated a plan to consolidate inventory to a central location while increasing the rate of line orders out the door within 24 hours to 80 percent—more than double the rate typically achieved at that time.

James Rankin, Atlas Copco Canada national warehouse and transportation manager, led the team assigned to accomplish the goals. “The biggest problem of creating a central warehouse was the sheer volume. We chose to locate the consolidated distribution center at an Atlas Copco Canada warehouse in Mississauga. The Mississauga warehouse had been filling 3,500 line orders a month. Now it would be required to fill 20,000 or more a month—and to double the rate of 24-hour completions.”

Manually tracking inventory requires time-consuming data lookup and entry procedures for each physical movement of the product, each with inherent opportunity for human error. So Atlas Copco looked to au-

tomation through warehouse management software (WMS), partnering with RF Pathways. The Mississauga-based WMS provider worked closely with Atlas Copco to phase in the new protocols in a series of steps over a several month period.

RF Pathways WMS communicates data that is instantly gathered by gun-like wireless handheld computers individually assigned to each employee. The devices have integral barcode scanners and are similar in function to the handheld computers used by airport baggage handlers.

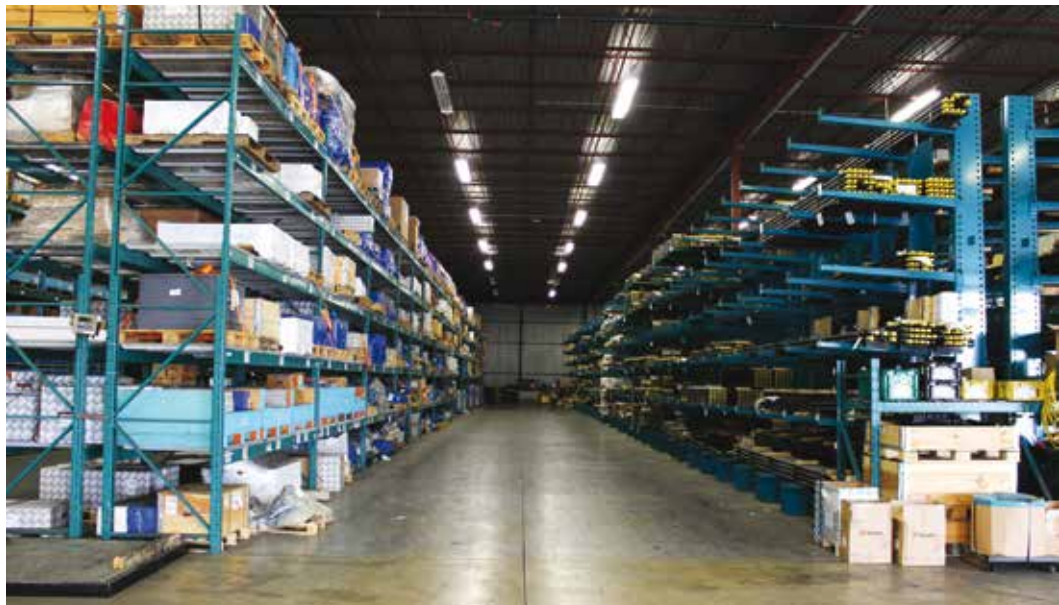
A quick scan of a product’s bar code not only tells the employee where it needs to go but simultaneously informs the system where the product is currently and who has it. Each time it is handed off or relocated, a swipe of its barcode updates its status. Every

part or parcel, from before its arrival at the warehouse until it reaches its final destination, has a complete, automatically generated “audit trail”—and no warehouse employee is ever required to refer to, search for or fill out forms.

One huge payoff is from a significant reduction in nonproductive activity. Rankin explained, “Consider that 20 percent of our labor cost was previously allotted to data entry. That’s now zero percent.”

That means warehouse employees now spend one-fifth more time actively engaged in shipping. “Shipping is still shipping,” Rankin said. “A lot of that still has to be done manually—offload trucks, pick orders, get shipments onto trucks. That’s not held up by physically inputting data anymore.”

Automation has also significantly reduced







training time. Rankin said it used to take three to four weeks to train a new hire. “Now it just takes 45 minutes to familiarize them with the scanner.”

The automated system also makes internal communication much more efficient. “We no longer have to go find someone or call them over a speaker to report to an office. We just send a message to their scanner. They get it right away.”

Further improvements in efficiency are recommended by the software itself, Rankin said: “The software ‘notices’ after a while that you’ve picked part XYZ several times when you’ve also sent out part 123. So then it might suggest moving product 123 closer to to XYZ to reduce picking and palleting time. Or it might recommend creating multiple picking areas for that product.”



Rankin explained how multiple picking points can improve shipping efficiency: “You don’t want to do this for everything, but some products might be kept in a second, closer picking point to speed things up. For example, if a customer has ordered 12 top hammer bits with a number of other items, we won’t have travel across our 80,000-square-foot (7,400 m<sup>2</sup>) warehouse to that product’s larger storage area, as we would if a customer were replenishing their onsite inventory with a huge shipment of the same item. The software identifies situations like that.”

The Mississauga distribution center began system implementation January 2015, completing it in June. As hoped, 24-hour shipping shot up to double previous rates. It’s currently at 70 percent for 24-hour turnarounds, and climbing.

Rankin said. “We are going to get to that goal, 80 percent 24-hour turnaround. And at that point we’ll analyze whether we even might want to set it higher. We’ll see.”

The project was completed well in advance of the coming year’s planned changeover from a legacy Business Planning and Control System inventory planning software to more modern, more efficient SAP software for supply chain optimization.

The RF Pathways WMS software and scanners are compatible with both inventory planning systems and will have no bearing on shipping as items are transferred to SAP.

Implementation of the software and scanners has been so successful at Mississauga that the new 50,000-square-foot (4,600 m<sup>2</sup>) distribution center in Edmonton will undergo automation in 2016. ☉

## WHERE TO FIND US

### ATLAS COPCO COMPRESSORS CANADA

#### HEAD OFFICE:

30 Montrose  
Dollard-des-Ormeaux, QC H9B 3J9  
Tel: 514-421-4121 | Fax: 514-421-1950

BC	Delta	604-940-0380
AB	Calgary	403-259-6069
AB	Edmonton	780-483-7214
ON	Kitchener	519-748-2266
ON	Mississauga	905-846-9369

### ATLAS COPCO MINING AND ROCK EXCAVATION TECHNIQUE CANADA

#### HEAD OFFICE:

1025 Tristar Drive  
Mississauga, ON L5T 1W5  
Tel: 289-562-0100

BC	Langley	604-514-5690
BC	Prince George	250-562-8786
SK	Creighton	306-688-3090
SK	Saskatoon	306-933-2900
MB	Thompson	204-778-8005
MB	Winnipeg	204-633-4888
ON	Balmertown	807-735-1104
ON	Lively	705-673-6711
ON	Marathon	807-229-9910
ON	Timmins	705-268-5595
QC	Cadillac	819-759-3601
QC	Saint Apollinaire	418-881-0101
QC	Val D’Or	819-825-6121
NF	Pasadena	709-686-2480
NF	Wabush	709-288-0216
NWT	Yellowknife	867-920-7033

### ATLAS COPCO CONSTRUCTION EQUIPMENT CANADA

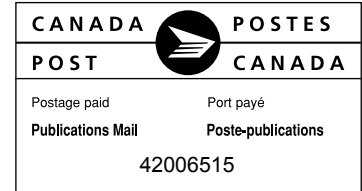
#### HEAD OFFICE:

1025 Tristar Drive  
Mississauga, ON L5T 1W5  
Tel: 1-800-465-4777

For more information, please visit [www.atlascopco.ca](http://www.atlascopco.ca)  
accmc@ca.atlascopco.com 800-465-6719

# MINING & CONSTRUCTION

1025 Tristar Drive  
Mississauga, ON  
L5T 1W5



## OUR NEW BABY WILL AMAZE YOU

### AZURE™

—proven to drill exceptionally through the entire range of medium hard to hard formations.

800-465-6719

[www.atlascopco.ca](http://www.atlascopco.ca)

  
*Atlas Copco*



SEE YOU AT  
**PDAC**  
March 6-9  
BOOTH 723