SEPTEMBER 2010
VOL. 62 NO. 9

Mining engineering

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Special Editorial Section:
Tunneling & Underground Construction



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POSTMASTER: Send changes of address to MINING ENGINEERING, 8307 Shaffer Parkway, Littleton, CO, 80127–4102. Article copies and back issues available on microfilm or microfiche from Linda Hall Library in Kansas City, Mo. Printed by Cummings Printing Co.

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Cover Story
Incorporating changes such as commodity prices, customer sales, fluctuating cost assumptions and newly acquired geologic data requires quick turnaround for model building and planning to keep mine plans on pace with changes as they occur. To meet these challenges, many companies have turned to computer software to help them with their mine planning process, page 39. The Pinto Valley concentrator of BHP Copper Inc. restarted its sulfide mining operations in 2007 and chose to meet demand by installing three flotation columns, page 43. And the always important issue of sustainability in mining was discussed at the 5th Annual Elko Roundtable, Brian Ulrich and Rick Frechette recap the discussion on page 52.



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SME is on the move,

new headquarters building will give the society room to expand



by Nikhil C. Trivedi,
2010 SME president

SME is moving. Yes, figuratively and literally. In fact, as everyone can imagine, both are interdependent.

I have the pleasure of informing the membership that SME is moving its headquarters from its current location in Littleton, CO to Englewood, CO. The new SME building is about 32 km (20 miles) east of the current one, which has served as SME's office for the past 31 years. Those familiar with the current building know that it is a very attractive all-brick building with an aesthetically pleasing exterior. However, those who work there day in and day out, along with members who visit the SME offices, have known for a long time how cramped it is on the inside. SME's Facebook friends may have already seen the "for sale" sign in the front lawn of the Shaffer Parkway site.

The new building, which SME will be acquiring shortly, is located in a beautiful office park, is 12 years old and currently houses a local Denver television station. Most importantly, to Denver Broncos fans, it is within a stone's throw of the Bronco's headquarters and practice field near Centennial Airport in southeast Denver. It is conveniently accessible from Denver International Airport and from all Denver suburbs via major highways.

I would like to share with you the steps involved in making this decision. SME's leadership and staff have, over the years, discussed the severe space shortage at the current location. The recent affiliation of Mii and the society's increased book sales made it necessary for SME to lease some badly needed storage space. The recent member benefit initiatives, such as OneMine.org and SME Tech, warranted hiring additional staff and our planned initiatives for SME's future growth pretty much demand staff additions in the near future. For all of those initiatives, the current space was not adequate and SME was in great need of additional office space.

With that as background, Will Wilkinson, 2009 SME president, established an ad hoc committee to develop a list of options for SME to consider. The ad hoc committee was established in January 2010 and was made up of five members — Marc LeVier (board member), Doug Peters, Jim Komadina, Dave Kanagy and Mike Hedges.

During the following months, this ad hoc committee explored several options with the only criterion being "the best interest of SME." The committee looked at expanding the current building, buying land and constructing a new building, buying an existing building, leasing space and deferring the decision to a later date. I had not mentioned to the ad hoc committee that, in my opinion, that last alternative was a nonstarter. I would have been very disappointed if the ad hoc committee had returned to the board with the recommendation to do nothing. To its credit, I found out afterward the committee dismissed that option early on.

The ad hoc committee worked closely with SME's Finance Strategic Committee currently chaired by Bob Shaffer, board member. It put together financial models and projections for several different combinations of options and eventually concluded that SME's best option was to buy an existing facility that could be upgraded or modified to suit SME's needs with minimal expenditures of time and money. Ensuring minimum impact on the staff's daily commute to SME was also a key criterion. That was a key factor as the ad hoc committee expanded its charter to initiate a search for proper office space.

The ad hoc committee concluded that the best choice for SME was to move to Englewood in the Dove Valley office park at 12999 E. Adam Aircraft Circle. At this stage, we were just

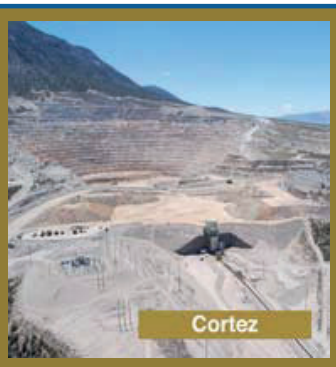


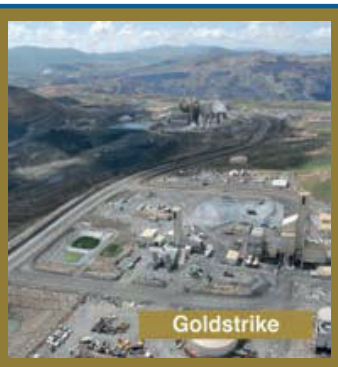
SME will move its headquarters into a larger building in Englewood, CO shortly after the 2011 SME Annual Meeting in Denver, CO.

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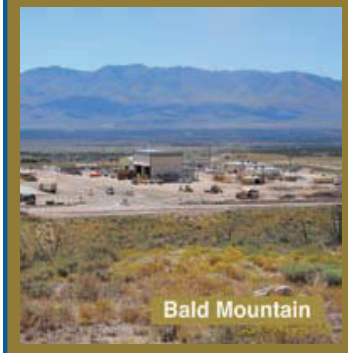


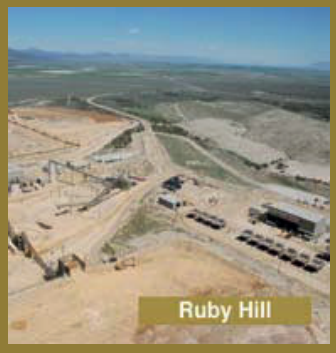
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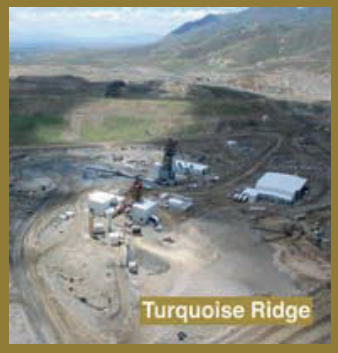
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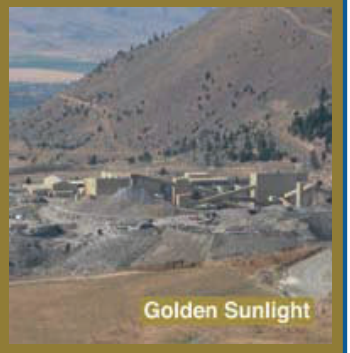
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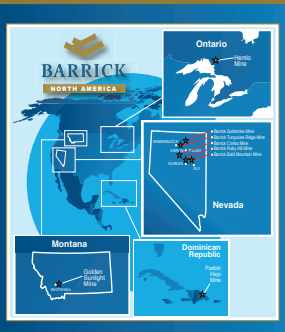
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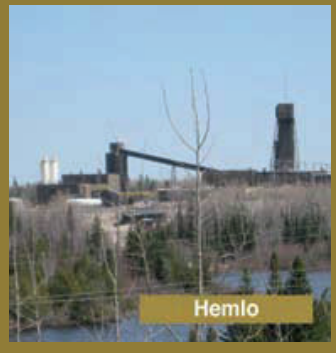














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NMA files suit against EPA and Army Corps over Appalachian coal permits

CITING VIOLATIONS of the Administrative Procedures Act, the Clean Water Act, the National Environmental Policy Act and the Surface Mining Control and Reclamation Act by disregarding explicit requirements for public comment and formal rulemaking procedures, the National Mining Association (NMA) filed suit against the U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (Corps) for unlawfully obstructing permitting of coal mining operations in the Central Appalachian coal region.

NMA said the moratorium placed on Appalachian coal permits has jeopardized thousands of jobs and limited a vital supply of fuel to meet the nation's electric power needs.

NMA's lawsuit, filed in the Federal District Court for the District of Columbia, contends the EPA and the Corps have circumvented clear requirements for public notice and comment of a host of federal statutes and ignored calls for peer-reviewed science as part of a deliberate policy to substitute agency guidance for formal rulemaking.

"The Corps is allowing EPA to impose unilateral control over coal mine permits throughout Appalachia, imposing a moratorium on jobs, energy production and the economic future of communities in the region."

Hal Quinn, NMA president

"NMA members' efforts to navigate this unlawful process and obtain reasonable and predictable permit terms have been unsuccessful, leaving us no choice but to challenge the EPA and Corps policy in court," said NMA president and chief executive officer Hal Quinn.

The NMA said that the EPA has usurped authorities clearly granted to the states and other federal agencies and has used technical benchmarks for assessing water quality that are both arbitrary and capricious.

The NMA said the result has been a de facto moratorium on coal mining that is irreparably harming NMA's member companies, the welfare of coal communities and the economy. According to a May 21 report by the Senate Environment and Public Works Committee Minority staff, nearly 18,000 new and existing jobs and more than 80 small businesses are jeopardized by the policy EPA and the Corps have applied to the 190 permits still awaiting action in mid-May. The loss of jobs and economic opportunity will continue to mount, as additional permits fall into the permitting nadir, NMA said in a statement.

"The Corps is allowing the EPA to impose unilateral control over coal mine permits throughout Appalachia, imposing a moratorium on jobs, energy production and the economic future of communities in the region. The faulty science at the heart of this policy serves no environmental good. These actions must be held to the same standard required of all substantive rules," Quinn said. ■

Mine safety bill approved by House panel

THE INVESTIGATION into the explosion that killed 29 miners at the Upper Big Branch Mine in Montcoal, WV is not expected to be completed until the end of the year (see page 10), however, a U.S. House panel approved sweeping mine and workplace safety reforms prompted by April 5 explosion.

The 30-17 vote came over the objections of the mining industry despite last-minute changes to exempt all mines except underground coal mines and about 10 other underground mines that produce flammable gases.

A vote in the full House is expected before the end of the year. Should it pass, the bill would increase penalties for serious mine safety violations, make it easier for the government to shut down problem mines and offer more protection for whistle-blowers. Mines shut down for a pattern of violations would have to keep paying workers during the closure.

Those opposed to the bill called the legislation premature because state and federal investigations have not yet revealed the cause of the explosion at the Upper Big Branch Mine. They said the bill focuses too much on stiffer penalties without correcting flaws in how the U.S. Mine Safety and Health Administration applies the rules.

Supporters of the bill, backed by the Obama administration, say the measure would rein in bad actors in the mining industry. Supporters say the changes to the Occupational Safety and Health Act respond to a spate of deadly explosions at refineries, power plants and food processing plants that show a need to hold employers accountable if they knowingly put workers in danger.

The bill would sharply increase civil and criminal penalties for all private employers, strengthen whistle-blower laws and require businesses to fix major violations immediately, even if the employer disagrees and decides to mount a legal challenge.

The Senate had yet to take up its own mine safety measure, as lawmakers there were working to gain some bipartisan support. The broader penalties in the House bill affecting other private employers have drawn heavy criticism from business groups and may not survive in the Senate version. ■

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Mine explosion report delayed;

difficult conditions at site of explosion slow investigation

A DEFINITIVE REPORT on what caused the explosion that killed 29 miners inside the Upper Big Branch Mine in Montcoal, WV on April 5 might not be completed until the end of the year.

Davitt McAteer, a special investigator who was appointed by West Virginia Gov. Joe Manchin to investigate the cause of the worst mining U.S. disaster in 40 years, said difficult conditions inside the mine have hindered the investigation. McAteer, a former federal mine safety official, and his team had been able to enter the mine. However, he described the mine as "debris-strewn" and "very dark" from soot-covered walls caused by the explosion. He said investigation teams have encountered dangerous roof conditions that had to be repaired, as well as water gathering in locations that hampered traveling in the mine, *The Wall Street Journal* reported.

"It's difficult working conditions," McAteer said at a news briefing. "Our best estimate is that we're looking at the end of the year for any kind of report."

McAteer's teams is conducting its investigation concurrently with teams from the U.S. Mine Safety and Health Administration.

Federal prosecutors are conducting a separate criminal probe of the accident.

McAteer did not comment on any findings to date. Investigators, state and federal, have been gathering evidence inside the mine since late June and have jointly conducted 126 interviews so far with miners and others who have knowledge of the mine's operations.

McAteer said the force of the explosion was "tremendous" and carried more than 3.2 km (2 miles) through the mine killing miners instantaneously. The scale of the explosion would further complicate evidence gathering, he said.

McAteer identified antiquated record-keeping at the mine as a systemic problem that needs to be addressed throughout the mining industry. He said many records are still made with pencil and paper underground, and that it would have helped the investigation at the Upper Big Branch Mine if air readings and other information were also kept above-ground in a computer.

He added that it was too soon to assign blame or determine the cause of the accident. "I haven't blamed Massey (the mines owner). I haven't blamed anyone," he said. ■

Newswatch contents

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Methane monitors tested at UBBM

Communications system for underground mining shows promise

LOCKHEED MARTIN, a company known more for its work in aerospace and national defense, is also working on technology that could one day save miners trapped underground.

The wireless system, MagneLink Magnetic Communication Systems, has already passed a number of tests using magnetic waves. It has successfully transmitted a signal through mines to a depth of more than 472 m (1,550 ft) and could be certified by the federal government in a matter of months, according to a report by *The Wall Street Journal*.

Each of Lockheed's MagneLink Magnetic Communication Systems consist of two units. One remains on the surface, weighs about 32 kg (70 lbs) and is about the size of a steamer trunk.

The other, which is larger and is encased in an explosion-proof box, goes next to the mine's refuge chambers.

Trapped miners would need to reach one of the chambers and speak into the handset or type text on a PC-sized keyboard to alert those above ground to their location and condition.

Lockheed Martin told *The Wall Street Journal* that it had not worked out the cost to customers, and it would not say how much it had invested in development.

Current communication and tracking systems, which include some hardwiring underground, can cost anywhere from $300,000 to $1.5 million, depending on the size of the mine that's involved.

A fully wireless system would better enable rescue teams, who often have to navigate miles of debris-strewn and smoke-filled passageways in hopes of finding survivors, to more quickly pinpoint the location of miners.

Lockheed retiree Gary Smith, a former manager of ocean and sonar systems, first proposed the idea of developing a system that would allow for communications with miners.

Continued on page 13

Xstrata approves major projects;

Swiss miner has invested $14 billion in 15 projects

XSTRATA CHIEF EXECUTIVE officer, Mick Davis, said his company currently has 15 major growth projects approved and in the construction phase, representing a capital investment of $14 billion.

Davis said the diversified miner is on track to deliver 50 percent volume growth and 20 percent cost reduction from its organic growth pipeline by 2014.

During the first half of 2010, Xstrata commissioned Nickel Rim South in Canada, and Blakefield South coal and Goedgevonden coal in South Africa.

Xstrata, which invested more than $8 billion on new projects during the reporting period, also announced that it had approved the $4.2-billion Las Bambas copper project in southern Peru and the $1.1-billion Ulan West coal project in Australia, *Miningweekly.com* reported.

Construction of the $4.3 billion Las Bambas project is expected to begin in the third quarter of 2011.

A month earlier, Xstrata said that it had given the go-ahead for an expansion at its Tintaya Mine in Peru, which is about 150 km (93 miles) from Las Bambas. The company expects to save on infrastructure and other costs by developing the two projects in tandem.

The group will now formally exercise an option to transfer the Las Bambas mining titles from the Peruvian government agency Proinversión to Xstrata Copper.

Final government approvals of the environmental- and social-impact assessment and other permits are expected in the first half of 2011, based on the company's recent experience with the Tintaya expansion.

Las Bambas will have an initial production of 400 kt/a (440,000 stpy) of copper in concentrate, with significant gold, silver and molybdenum byproducts.

Las Bambas will be one of the two biggest greenfield copper projects to start production globally in the next decade, Davis said in a statement.

The group expects the first ore will be processed in the second quarter of 2014, and production will ramp up to full capacity by the end of that year.■



33 miners found alive after 17 days;

Chilean miners could be in mine for four more months

MINE RESCUE WORKERS made contact with 33 miners trapped in a gold mine in Chile 17 days after the main access tunnel to the mine collapsed.

Rescuers lowered a probe into the mine and made contact with the 33 miners who found refuge in a shelter 700 m (2,300 ft) down. The miners sent up a note saying "All 33 of us are fine in the shelter."

Fresh air, water, food and communication equipment were sent down the hole to the miners as teams began to plan a rescue hole that could take as long as four months to dill

The chief engineer in charge of the rescue operation, Andres Sougarret, said a larger and more powerful drill would be needed to drill the hole at the San Jose gold and copper mine near the city of Copiapo.

"A shaft 66 cm (26 in.) in diameter will take at least 120 days," he said.

Before drilling the borehole, rescuers reportedly had to give up efforts to get past the cave-in and try to reach the miners through a ventilation shaft because of the instability of the mine.

For the first 16 days following the collapse, there had not been contact with the miners and hopes of finding them alive were fading.

The announcement that they were still alive was made on August 22 by Chilean President Sebastian Pinera.

"It will take months to get them out," Pinera said. "They'll come out thin and dirty, but whole and strong," the BBC reported.

The accident has raised concerns about mining safety in Chile, the company that owns the mine and the national mining service have both been criticized for failing to comply with regulations.

News that the miners were still alive was met with relief across Chile, and people gathered at the main square in the capital, Santiago, to celebrate. ■

Freeport lines up copper projects;

company plans to grow without acquisitions

FREEPORT-MCMORAN Copper & Gold is poised for some great expansion, and it plans to do it with its own operations.

Richard Adkerson, chief executive officer of the company, told *Miningweekly.com* that, because of exploration around some of Freeport-McMoRan's existing orebodies, the company's total reserves and resources have expanded to more than 91 Mt (200 billion lbs) of copper. The company is the world's largest publicly traded copper producer.

Acquisitions "in my opinion are going to become increasingly expensive and difficult to do because of the shortage of copper in the world," Adkerson said.

As copper prices rise, Freeport-McMoRan continues to bring some production that had been shelved back online. Adkerson said he expects that all of the projects currently on the table will eventually go ahead.

Among the projects that are expanding are the Cerro Verde Mine in Peru, where the company plans to increase the mill rate from 108 kt/d (119,000 stpd) to 120 kt/d (132,000 stpd). A feasibility study regarding a larger concentrator project is expected to be completed by mid-2011.

The company also has a project under way to develop the large sulfide resource at its El Abra Mine, with the first phase scheduled for completion in 2012.

At the Morenci Mine, in Arizona, Freeport has restarted the mill and will ramp up to a throughput rate of 50 kt/d (55,000 stpd) by 2011, up from the 28 kt/d (31,000 stpd) average reported for the second quarter. Mining rates are also being increased at the operation.

At the end of 2009, Freeport-McMoRan started mining at its Miami operation in Arizona and expects to reach 40.5 Mt/a (100-million lbs/year) of copper by the second half of 2011.

At the Grasberg Mine in Indonesia, the company is preparing to shift focus to the underground reserves as the openpit nears the end of its life, which is expected to be sometime between 2015 and 2018.

The firm is also still looking at restarting construction on the Climax molybdenum project in Colorado, but has yet to make a final decision, Adkerson said.

In its newest operating region, the Democratic Republic of Congo (DRC), Freeport-McMoRan continues discussions regarding its Tenke Fungurume copper/cobalt mine.

In the meantime, the company continues to operate under its contract.

The Tenke Fungurume Mine currently has the capacity to produce 113 kt/a (250 million lbs/year) of copper and 81 kt/a (18 million lbs/year of cobalt. And Freeport-McMoRan has been conducting studies for some time already into the next stages of expansion.

The company plans to boost copper production to 131 kt/a (290 million lbs/year) over the next few months by taking advantage of the mill's ability to operate above capacity, increasing the mining rate and addressing some operating issues to improve plant performance. ■

Methane monitors tested at UBBM;
investigators find no evidence of tampering

THERE WAS NO EVIDENCE of tampering found on the monitors taken from the longwall mining machine at the site of an explosion in Massey Energy's Upper Big Branch Mine that killed 29 miners on April 5.

West Virginia State Office of Miners' Health Safety and Training chief Ron Wooten said tests of methane monitors show the safety devices had not been tampered with before the explosion.

The Associated Press reported that the tests on the monitors were conducted following claims by former Massey employees that monitors were routinely electronically "bridged" so machines would keep running. Methane monitors are designed to shut down mining machines when they encounter explosive levels of gas.

Officials with Massey have repeatedly denied the allegations.

There were two sensors on the longwall miner and "electronically, everything tested fine," Wooten said.

Shane Harvey, Massey's vice president and general counsel, said the tests verified "these sensors were in working condition and capable of automatically shutting down the longwall in the event that methane readings exceeded safety thresholds."

Teams of investigators have been working their way through the mine, but an complete report of what happed is not expected to be completed until the end of the year.

On Aug. 11, during a press briefing, U.S. Mine, Safety and Health Administration (MSHA) director Joe Main said investigators had found no evidence of a giant floor crack that Massey Energy said could have flooded the mine with explosive gas.

Main said investigators did find evidence of "floor heaving" and several small cracks, some 152 mm (6 in.) deep and 203 mm (8 in.) wide, "but we've not seen any massive crack that's 46-m-(150-ft-) long underneath the shearing machine," said Kevin Stricklin, coal administrator for MSHA.

Massey has suggested a large crack under the coal-cutting machine could have allowed methane to surge into the mine just before the April 5 explosion, noting it experienced similar inundations in 2003 and 2004 without any injuries. State mine safety officials, however, have said a preliminary review of data does not indicate a sudden rush of methane.

Main said the underground investigation involves eight mapping teams and 10 rock-dusting teams that are methodically scraping the walls for samples that could show whether the mine was adequately coated to prevent explosions. The 1,803 samples collected so far will also indicate how much coal burned off after the blast, he said.

Also working underground are four electrical teams, three photography teams, a geology team, an evidence-collection team and a directional-forces team. About 250 pieces of physical evidence have been collected already, Main said, and that number will grow. ■

Communications system

Continued from page 8

"If we can communicate with a submarine at sea, I knew we should be able to talk to a miner," Smith said.

A year-and-a-half later, the technology was being tested inside coal mines in West Virginia and Pennsylvania.

Lockheed has been working with the National Institute for Occupational Safety and Health (NIOSH) and the U.S. Mine Safety and Health Administration (MSHA). NIOSH has been encouraging companies to develop wireless communications by providing grants.

The Miner Act of 2006, prompted by the Sago Mine disaster and other accidents that year, required mining companies to submit plans for wireless communications by June 2009. But at this point, commercially available systems rely on some wired infrastructure underground. ■



President's page;
SME headquarters is expected to move after annual meeting

Continued from page 6

beginning the process. The SME board has the ultimate authority to act on such a major initiative. So we had a task at hand, convince the board.

The board was keenly interested. Each board member had questions. Each had concerns and rightly so. And each member was aware of the implications to SME's financial strength. But the board's approval of the project was unanimous.

Was I surprised? No. The ad hoc committee did a thorough job, the Finance Strategic Committee provided its timely, sage advice on financing options. And the board was kept fully informed throughout the process. Moreover, the board recognized that this action is in the best interest of SME and it provides the means to accomplish some big audacious goals we have for our society. The board was made aware that its decision on this initiative was unprecedented. No previous SME board had made any decision with the magnitude of dollars that was involved in this decision. My thanks to the board members for showing leadership and vision. I know that they have made a good decision.

So what is next? There are several things to do before SME can print its new stationary. "Closing" will take place in early November. Architects will put the finishing touches on the remodeling where warranted. Interior construction contractors will work during the late fall and winter months and the big move is scheduled for March 2011 after the SME Annual Meeting.

To each member of SME, this is what I would like to say. SME leadership has made a very bold decision that shows its confidence in the sustainability and good financial health of SME and our industry. The new SME logo introduced two years ago, this new building, the bold initiatives, such as OneMine.org and SME Tech, are all tools to take SME to a greater height, to give SME a broader influence over the mining community and to provide SME members an unparalleled opportunity to derive professional excellence. These tools are for you to use, improve and update.

I am privileged that this literal "SME on the move" is happening on my shift. But I want to give credit where it is due. SME members, industry leaders, past SME presidents and SME staff have all driven SME to the threshold on which it is standing today. We are poised for unprecedented, exciting times ahead. We have the tools in place and, most importantly, we have the most outstanding group of skilled and talented mining industry professionals who call SME "home." Thank you for your support. ■

SME has outgrown the current headquarters office in Littleton, CO.



Simandou iron ore project to be developed;
Rio Tinto teams with Chalco for mine in Guinea

THE SIMANDOU IRON ORE project in Guinea will be established through a joint venture (JV) agreement between Rio Tinto and Chalco.

The companies announced the binding agreement that follows the signing of a memorandum of understanding between Rio Tinto and Chalco's parent Chinalco that was announced in March 2010. The agreement covers all aspects of how the JV and the project itself will operate and be governed, including planning, construction and management of the mine and associated rail and port infrastructure.

Under the terms of the agreement, Rio Tinto's 95 percent interest in the Simandou project will be held in the new JV. Chalco will acquire a 47-percent interest in the new JV by providing US$1.35 billion on an earn-in basis through sole funding of ongoing development work over the next two to three years. Once Chalco has paid its $1.35 billion, the effective interests of Rio Tinto and Chalco in the Simandou project will be 50.35 percent and 44.65 percent, respectively. The remaining five percent will be owned by the International Finance Corporation (IFC), the financing arm of the World Bank.

Simandou is a world-class iron ore mining project located in southeastern Guinea. The project has completed initial feasibility studies and development work is progressing. Rio Tinto is partnered with the IFC. Chalco also contributes dedicated capability in the delivery of major projects and access to the infrastructure expertise and experience of other organizations in China. ■

Business Profiles

SEPTEMBER 2010

MINING ENGINEERING • SPECIAL SECTION



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Veyance is Committed to Serve a Thriving Coal Industry

Veyance Technologies, Inc., the exclusive manufacturer and marketer of Goodyear Engineered Products globally, has its roots in an 1898 gamble when The Goodyear Tire & Rubber Company made its first product— poker chips—even before it made its first tire. It was a gamble that paid off and eventually led to the creation of Goodyear Engineered Products.

In August 2007, The Carlyle Group purchased the successful Goodyear Engineered Products division from its parent, The Goodyear Tire & Rubber Company, and established its new identity—Veyance Technologies, Inc. Veyance Technologies opened its worldwide headquarters in Fairlawn, Ohio in the fall of 2007 and its Innovation Center one year later.

Veyance Technologies is the world's largest manufacturer of conveyor belting with enhanced support for installation, splice and repair services, and is the exclusive manufacturer and marketer of Goodyear branded industrial and automotive hose and power transmission belts, air springs and rubber track.

The name Veyance combines two critical components of the company's daily operations. Veyance products convey materials, fluids or energy, with the ultimate goal of optimizing their customers' business performANCE.

The Goodyear-brand remains the stronghold of the company's marketing efforts as it supplies the coal industry with a wide range of quality conveyor belt products, monitoring systems and services with one goal in mind: safely deliver the lowest cost-per-ton conveyed. This means keeping miners safe and driving cost of ownership down by offering innovative products and services specifically for the coal industry, supported by over 110 years of rubber compounding experience.

Veyance Technologies Innovation Center, supported by its global conveyor belt technology center in Marysville, Ohio, has proven its innovation within the coal industry once again through the introduction of its latest Goodyear-branded conveyor belt compound. SHIELD™ was the first underground conveyor belt compound to receive the MSHA B.E.L.T. Certification for flame resistance—a standard that is required for all underground belts installed after Dec. 31, 2009.

With miner's safety as the catalyst for development, SHIELD exceeds the B.E.L.T. standard by ensuring flame resistance and virtually eliminating the use of materials that generate toxic smoke. The new compound is available for Veyance's three tiers of fabric-reinforced underground belts, including CoalQuest®, Glide Plus™ and Contender®, as well as in the steel-cable reinforced Flexsteel®. CoalQuest® is the company's premium belt with a patented Triple Warp™ Weave fabric that resists rips and tears from high impact damage.

Veyance also provides innovative belt monitoring systems designed to protect a mine's investment. Goodyear Engineered Products Sensor Guard® with RFID technology provides the ultimate conveyor belt rip detection. It is complemented by the technologically-advanced Cord Guard™, a continuous belt monitoring system that looks deep inside Flexsteel® conveyor belts to detect cable damage.

Goodyear Engineered Products backed by quality service

Veyance Technologies recognizes the value of providing conveyor belt services to improve its customer's productivity and return on investment. To that end, in 2008 it made a strategic move to acquire National Belt Services and began to build upon their outstanding reputation of unparalleled experience and support to the mines.

Service technicians complete extensive factory, shop and field training to ensure that the work is completed safely, efficiently and correctly. Using the best available equipment customized to maximize quality and capabilities, Veyance's service goal is to minimize customer downtime and cost of ownership.

Technicians are available around the clock, with eight service centers ideally positioned throughout Northern, Central and Southern Appalachia, the Illinois Basin, the Powder River Basin and the Rocky Mountain coal regions. Our services group can be reached anytime at 1-800-927-2709.

Beyond Belting: More great Goodyear Engineered Products for mining

In addition to conveyor belt products, Veyance Technologies, using the Goodyear Engineered Products brand, manufactures the broadest line of industrial hoses for the mining industry—from rock dust to rock drill hose and from mine-spray to welding hose. Its offering also includes a comprehensive line of hydraulic hose and fittings as well as a complete line of power transmission belts—all proven performers in the coal and other aggregate industries.

Beyond Service: Goodyear Authorized Distribution Network offers expertise and convenience

Veyance Technologies distributes through the Goodyear Engineered Products Authorized Distributor (GAD) network, pulling together products and services for their coal customers. With the footprint and expertise needed to handle anything from product recommendations to complete product supply programs, Veyance's GADs offer a local solution in coal markets.

Veyance Technologies, Inc. has more than 35 other manufacturing and distribution facilities worldwide producing products that set industry standards for strength and versatility. For more information visit http://www.GoodyearEP.com.

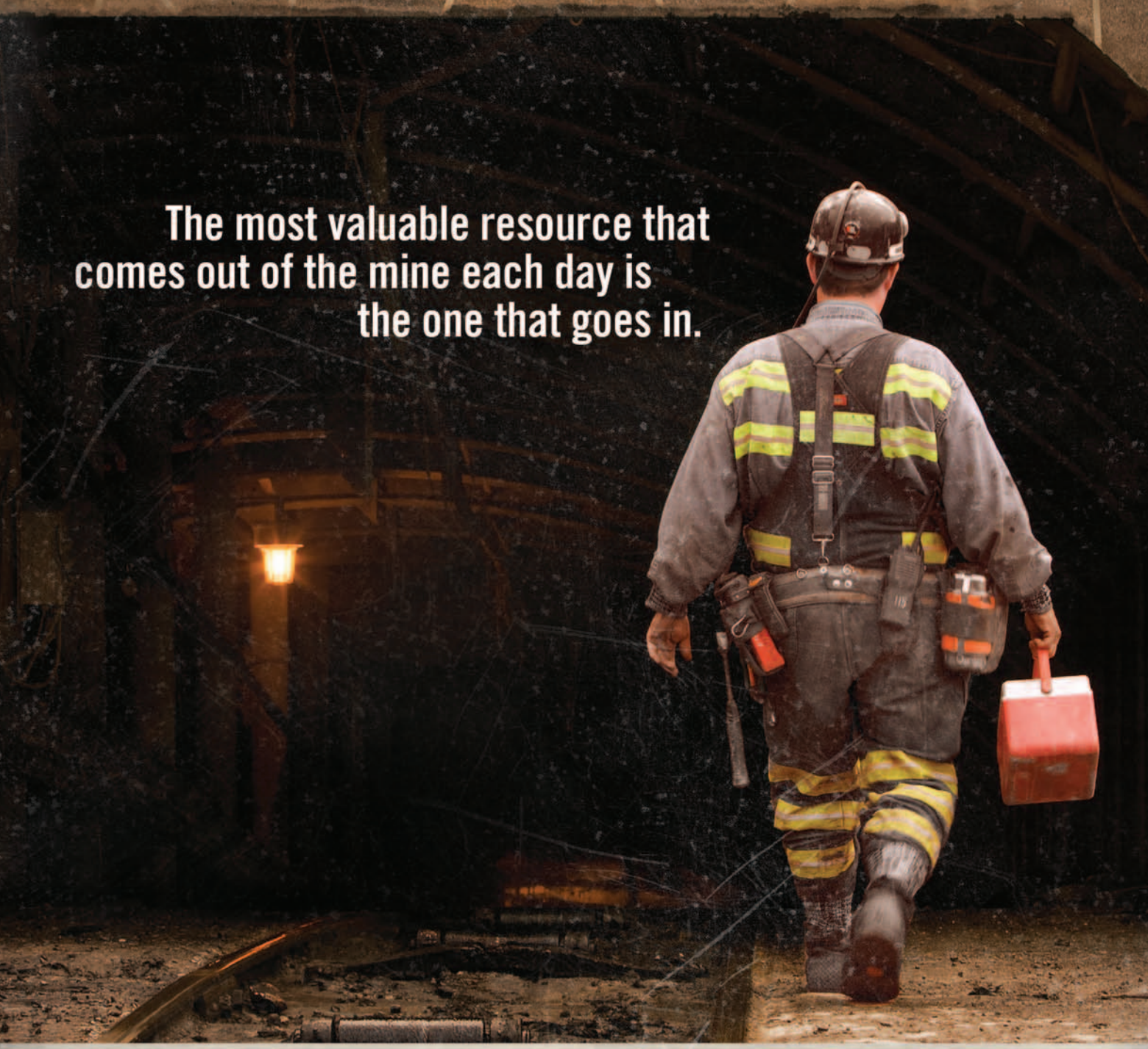


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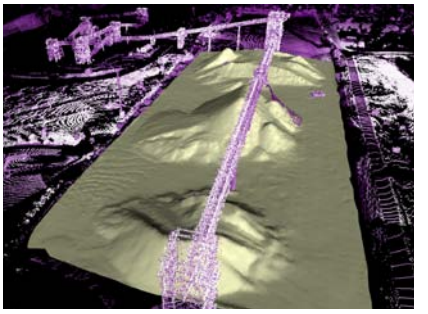
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The I-Site 8800 is the complete package. It creates reliable stockpile volumes, helps with reconciliation for contractor payments, makes end of month surveys easy and is safe for active mining face surveys. The I-Site 8800 can even be mounted to site vehicles using a prefabricated mount which means the job gets done quicker.

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- Improve productivity, treating water for specific production process requirements to optimize mineral production efficiency and process stability
- Manage environmental hazards by treating contaminated pond or other mine water sources to remove heavy metals, arsenic, TDS and other contaminants
- Treat contaminated water to optimize water balance and maximize reuse
- Add value by treating and minimizing sludge streams, recovering suspended and dissolved constituents
- Provide drinking water and wastewater treatment for remote mining sites

VWS has worldwide references in the mining industry, offering our technologies, process expertise and services locally through a strong team of business units. Our mining industry applications are based upon years of research and development as well as field experience that has resulted in the expertise needed to resolve all water issues facing the mining industry. Selected applications are described below.

Acid mine drainage treatment systems

AMDRO™ technology is a reverse osmosis (RO) process for treatment of acid mine drainage. This technology is an ideal solution for meeting increasingly stringent requirements for reduction of TDS.

This patented process includes VWS' proprietary ACTIFLO® clarification technology and media filtration for pretreatment, followed by a double-pass RO and ion exchange polishing to produce a treated water stream suitable for discharge and reuse. AMDRO technology significantly reduces the pre-treatment costs associated with chemicals and sludge disposal. The technology has low capital cost and incorporates effective scaling control to minimize cleaning frequency.

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Separation and filtration technologies

VWS uses technologies such as Auto-Jet® and Filtra-Matic® to clarify the pregnant liquor in gold and silver recovery circuits. This improves the efficiency of the Merrill Crowe process, which uses a sodium cyanide solution to dissolve the precious metals, followed by precipitation of the dissolved ions on metallic zinc. Both of these filtration technologies are very successful in filtering the fine solids that otherwise could cause major system upsets.



DenseSludge™ technology provided Potomac Coal with a cost-saving solution for its 10,000-gpm acid mine drainage treatment system at this West Virginia site.

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HPD crystallization systems process a wide variety of specialty metals such as vanadium, tungsten, lithium, and molybdenum. Evaporation and crystallization systems can also purify alumina from the refining of bauxite (Bayer process) and recover aluminum and product salts from aluminum dross.

Application-proven water treatment chemicals

VWS offers Hydrex™, a comprehensive range of water treatment chemicals from proven formulations, to ensure that the treated water quality is suitable for environmental discharge or reuse.



The Hecla Mining Company acid mine drainage treatment system in Nevada was delivered on a fast-track 90-day schedule as a modular solution expandable for full-scale operation.

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FLSmidth Pekin
Part of the FLSmidth Minerals Family

FLSmidth Pekin—part of FLSmidth Minerals Inc. with new headquarters in Salt Lake City, Utah, and its parent company, Copenhagen, Denmark-based FLSmidth & Co. A/S—traces its roots back more than 75 years. Beginning as part of Excel Foundry and Machine, which provides crusher and mining machinery parts and service, FLSmidth Pekin, with engineering offices based in Wales, Wisc., and a manufacturing facility in Pekin, Ill., engineered and launched its own line of capital equipment in 2003 under the name of Excel Crusher Technologies. The company today manufactures a full line of Raptor® High-Performance Cone Crushers, with the larger models ranging in size from the 900 hp XL900; to the XL1100, with a maximum throughput of almost 2,000 tonnes per hour; to its largest—the XL2000—with capabilities of up to 2,000 hp and 3,175 tonnes per hour. Rounding out the model line are the XL300, XL400, XL500 and XL600 Cone Crushers.

The company gathered valuable input from aggregate and mining operations of all sizes, and integrated many productive ideas into the Raptor line. From its extra-heavy-duty, high-grade steel mainframe to its leading edge automated control package to the hydraulic tramp cylinder and clearing system, the Raptor line is designed to keep operators crushing efficiently, day-in and day-out. Utilizing state-of-the-art engineering techniques with some of the most modern foundry facilities in the world, along with advanced CNC machining technology and tight quality control, FLSmidth is able to produce premium component parts that are manufactured to exacting levels of precision and accuracy. The Raptor delivers high-performance crushing in a rugged, dependable, automated machine.

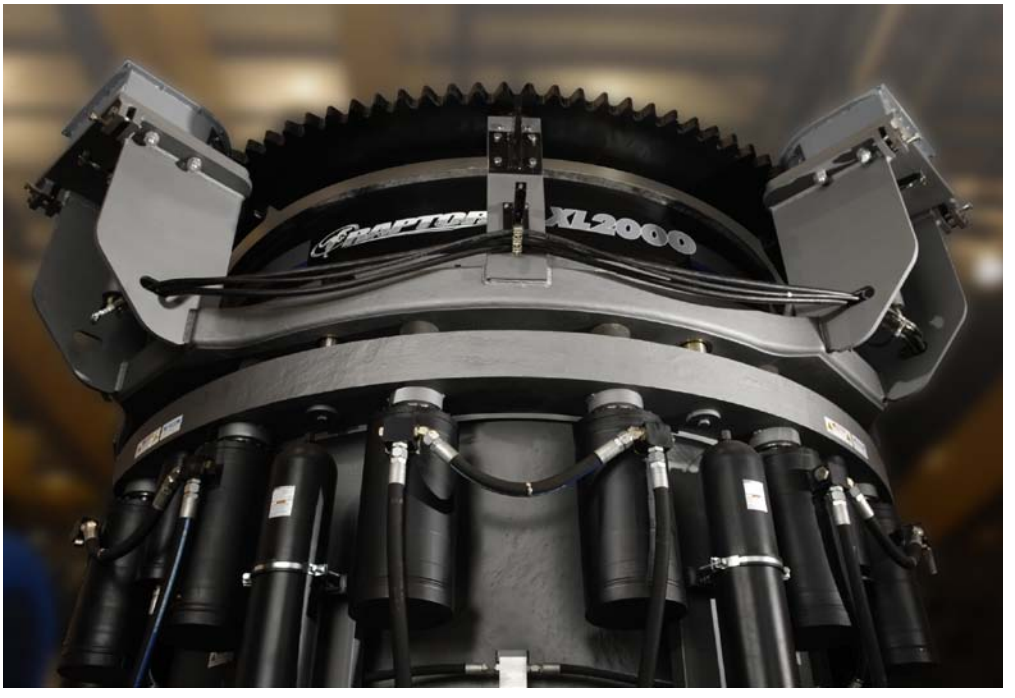
A leading supplier of equipment, systems, service and support for operators in the global mining, ore and aggregate processing industries, FLSmidth Minerals serves the material handling, cement, flotation, crushing and grinding and pyroprocessing markets.

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The FLSmidth Minerals group consists of many well-known brands: ABON feeders, sizers, screens and crushers; RAHCO, Möller and KOCH/MVT materials handling; Buffalo feeders and sizers; Vecor mine hoists and related equipment; Dorr-Oliver Eimco liquid/solid separation equipment; Krebs hydrocyclone separators and Techniquip valves; PNEUMApress filters; AIRTECH air pollution control systems and Raptor® Crushers. These companies offer all products from primary gyratory crushing through flotation, with capabilities to handle processing of materials throughout the entire mining operation.

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SIEMAG M-TEC² has changed its name to SIEMAG TECBERG and has moved



AngloGold Ashanti, Moab Khotsong Mine, South Africa: Mine-Cooling Plant, Cooling Power 50 MW

The brand TECBERG stands for Mining Technology and emphasizes the close bonds of the world market leader in shaft-hoisting technology with the global mining industry as its prime supplier of systems and solutions. Just recently, SIEMAG TECBERG relocated its headquarters from Netphen to its new 35,000 sq. m. facility in Haiger, Germany.

SIEMAG TECBERG is an independent and owner-managed company with roots in 1871. Today, the worldwide activities of the company, with a head count of about 230 employees, are supported by affiliates in China, Poland, South Africa, Switzerland, and the USA as well as by a worldwide net of sales and service partners.

The company succeeded in penetrating the worldwide market with its differentiated products and established its niche market position as a supplier who offers a remarkable range of customized special solutions to the mining companies.

Today, the company operates with two business units in the marketplace, i.e. the shaft hoisting and inclined hoisting technology for the raw material industry, the underground and tunnel climatisation, as well as lifting and lowering of heavy loads for the infrastructure industry.

SIEMAG TECBERG's product and service portfolio starts with project consulting, continues with engineering, delivery, assembly and erection to commissioning of complete plants; it equally covers automation and long-term after-sales service models, such as maintenance and inspections, repairs, components and spare parts supply and plant monitoring. The complete service model provides clients with an outsourced plant-operating model, if desired.

In addition to complete solutions for shaft hoisting up to depths of 3,000 m, typical refurbished or upgrade solutions provide the clients with options and variety in the product mix. In the core mining business a focus is placed on hoisting machines (Koepe, single drum, double drum and Blair multi-rope hoists) with a payload of up to 65 t, hoisting speed up to 20 m/s, and motor powers in excess of 12 MW.

Mine cooling is an increasingly important subject as shaft depths are going deeper and ever more complex. SIEMAG TECBERG developed the Pressure Exchange System (P.E.S.) which comprises the key components of state-of-the-art mine cooling. In contrast to other systems, P.E.S. distinguishes itself by high energetic efficiency and low cost which is achieved by using the energy from the water column in the shaft piping as a principle of operation. The four largest P.E.S. systems ever built, with a cooling power of 50 MW, are operated at AngloGold Ashanti's Moab Khotsong Mine in South Africa. Moreover, the P.E.S. system is applied in large tunnel cooling projects where long tunnels and depth require cooling for personnel and operations.

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Double-Drum Winder with 2 Clutch-Systems, Kidd Creek Mine (Canada)

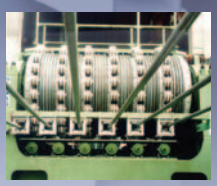
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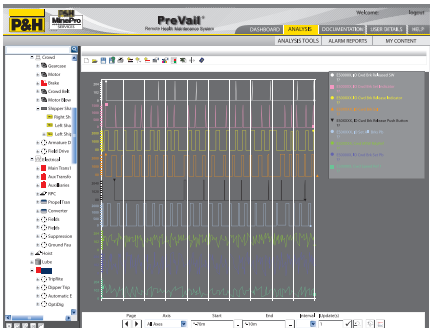
Tested and Proved in Western U.S. Mine Operations, P&H® PreVail® Remote Health Monitoring Technology Eyed for P&H Mining Shovel Applications Worldwide



Western U.S. mine operations helped P&H Mining Equipment test and fine-tune its new "PreVail" remote health monitoring system for increased mine operations efficiency.

During a routine shift within a Western U.S. coal operation, the operator of a P&H 4100XPC shovel was loading haul trucks with overburden when he noticed an odd weakening in the "crowd" or forward-thrust force being applied to the dipper as it gathered up material during the hoist phase of the dig cycle.

The shovel's GUI or graphical user interface did not reveal anything specific, no fault notices. So the operator reported the crowd force problem to mine maintenance and, in turn, the P&H MinePro Services office in Gillette, Wyoming.



Within that office is a team of technicians applying a powerful new remote health monitoring (RHM) system called "PreVail" that P&H Mining Equipment developed and officially rolled out in 2010.

Using PreVail, one technician quickly locked into the drive system on the shovel experiencing the weakened crowd force problem.

Applying the systems monitoring, performance history and analytical tools contained within the PreVail RHM system, the technician zeroed-in on the cause: A failing crowd field drive, evidenced by a normal signal wave form that abruptly yielded to an out-of-control oscillating wave form.

Within three hours of the reported weakened crowd force issue, a replacement crowd drive was installed and the P&H 4100XPC was back to full-bore truck loading. Pre-"PreVail" that issue resolution process would likely have consumed far more diagnostics and corrective time.

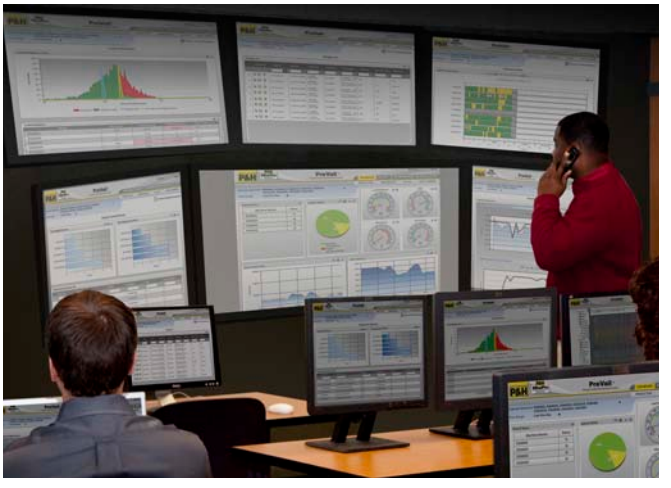
PreVail is the realization of a vision shared by mine operations managers and P&H Mining Equipment alike: Namely, a powerful information-processing system leveraging high-speed communication links to help shovel operators, mine maintenance and P&H engineers and service support personnel optimize the full productivity potential from a mine's investment in P&H electric mining shovels.

PreVail is built upon a powerful supervisory control and data acquisition (SCADA) platform called "Centurion" that P&H Mining Equipment introduced in 2004. Centurion encompasses shovel drives management and it utilizes a neural network of over 500 input-output devices to continually monitor and help optimize shovel electrical and mechanical systems performance.

Large volumes of data from those systems are stored, buffered and relayed to a data concentrator. At frequent intervals, the concentrated data is relayed from the shovel to a PreVail RHM server via the mine communication network for storage and processing. That same technology is applied to many other kinds of equipment in modern mining operations to optimize their operations systems through increased reliability and productivity.

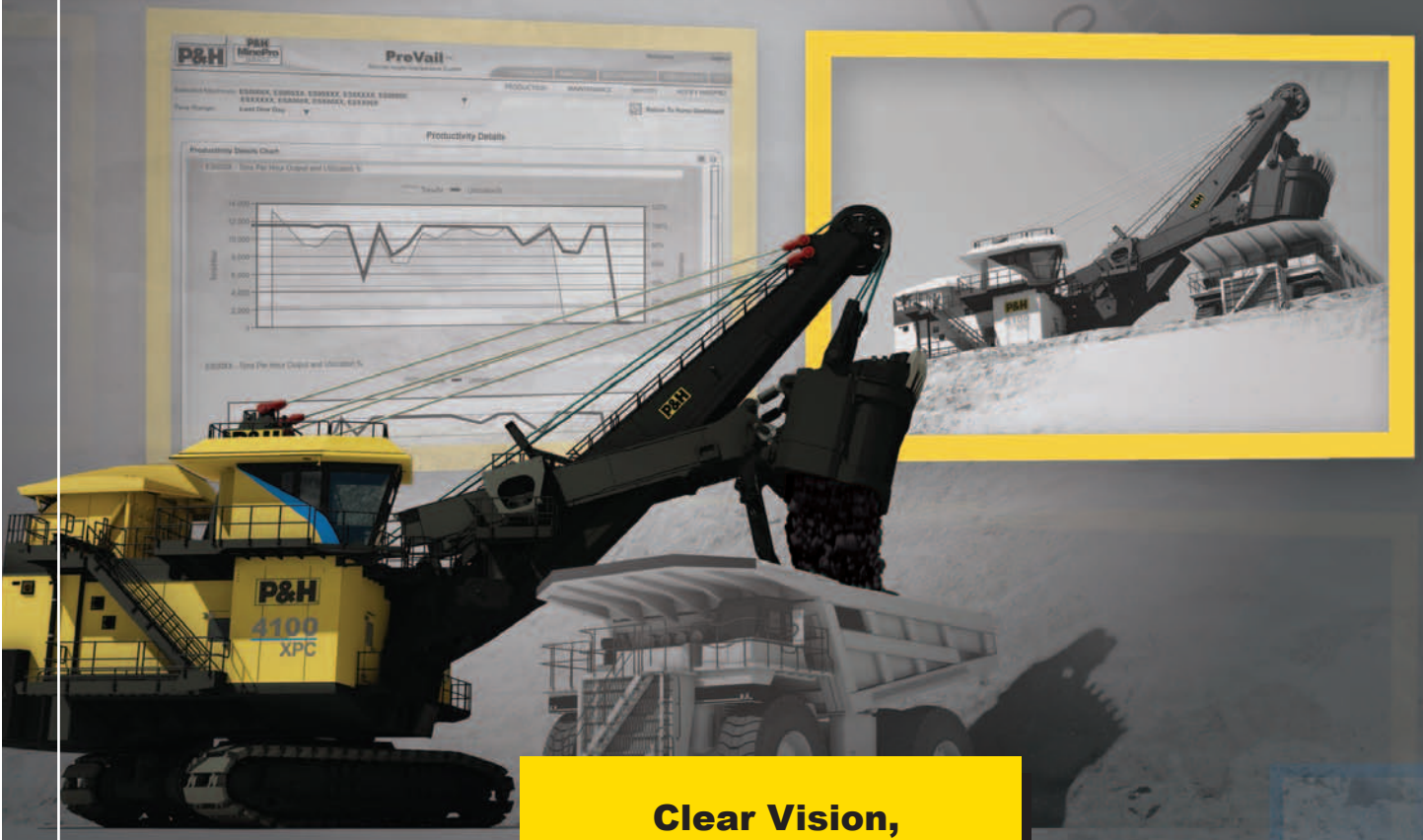
P&H Mining Equipment and its MinePro team in Gillette worked closely with Western U.S. coal mining operations to test, fine-tune and prove the effectiveness value of the PreVail RHM system. Similar "beta" tests occurred elsewhere in the global mining industry. More such cost-reducing technology inspired by "voice of customer" inputs is under development at P&H Mining Equipment to help increase mine operations efficiency.

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Frank Calandra Jr.
President

Jennmar is a multi-national company owned and operated by the Calandra Family. Frank and Jack Calandra are the two common stockholders. In 1972 Frank Calandra shifted Jennmar's focus to manufacturing ground support products for the mining and tunneling industry.

Over the years most of Jennmar's growth has been internally driven. The company currently owns over 80 patents relating to ground support applications. The majority of Jennmar's ten plants have been built exclusively by Jennmar. We maintain eight steel related bolt plants, located throughout the Appalachian, mid-west, and western coal fields. All of them are within two hours of our major customers.

During the late 1990's and into this century, we have been aggressively transplanting our values and technology in the international markets. Currently we have manufacturing facilities in Sturgeon Falls, Ontario; Sydney Australia; Paget, Mackay, Queensland, Australia; and Jining City, Shandong Province, China. Jennmar has two more international expansions coming in 2010 and 2011. This includes, moving from a small, leased space in Sturgeon Falls, Ontario and into our new 50,000 square foot building also located in Sturgeon Falls. Jennmar is also in the process of opening a new facility in Santiago, Chile.

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Tony Calandra
Executive Vice President

As a company we believe that our most important asset lies in our 1500 dedicated employees. We believe in developing a closeness to our customers by keeping the lines of communication open at all levels. We believe that hard work on our part is as important as the quality of products we sell. We are a customer-oriented company. It's the only way we do business.

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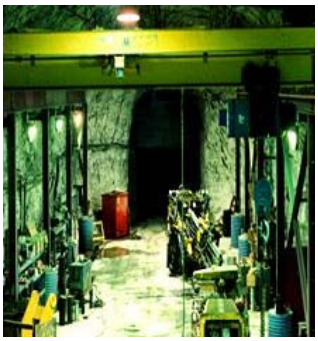
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- Environmental Baseline Studies
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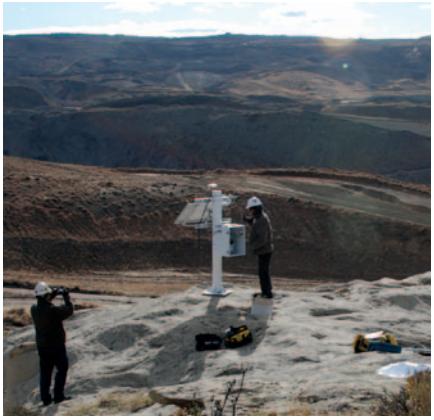
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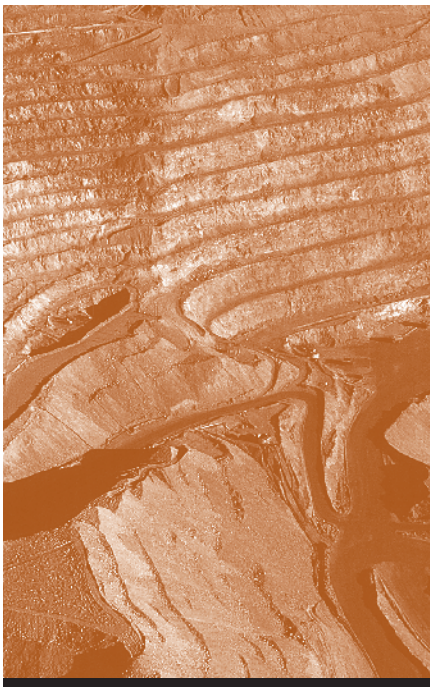
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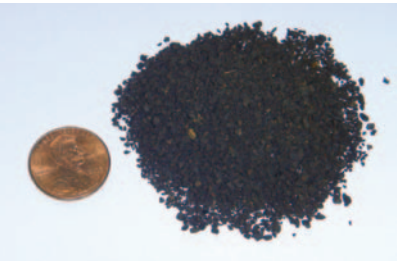
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Benefits of building
an efficient mine planning process

by W.A. Wilkinson



The use of plow systems fell out of favor in the U.S. in the 1970s, but recent advancements have made the technology safer and more efficent. ©iStockphoto.com/pamspix.

Mine planners are under pressure to evaluate the impact of changing economic times and newly acquired data on their mine plans. Incorporating changes such as commodity prices, customer sales, fluctuating cost assumptions and newly acquired geologic data requires quick turnaround for model building and planning to keep mine plans on pace with changes as they occur. Because of the length of time required to perform some of the geologic modeling and mine planning tasks, planning frequency may not be keeping pace with the frequency of change.

To meet these challenges, one leading North American mining company successfully increased the frequency rate and accuracy of its mine plans to stay current with incoming data, ensuring its mine plans reflect the latest information, thereby minimizing or eliminating production cost variance.

This case study features a truck and shovel surface coal mine in the western United States that produces approximately 23 Mt/a (25 million stpy) of coal. The mine employs two geologists and seven mining engineers to gather new data, build geologic models and produce short-, medium- and long-range mine plans. The mine was acquired by another company, which had implemented Mincom MineScape software to replace its existing mine planning systems. The majority of the company's existing engineering staff was retained and trained in the use of Mincom MineScape software.

The mine planning process

The production of mining plans follows a fairly linear workflow. Drillhole and mine survey information is gathered to measure the structure and sample the chemical analysis of the deposit. The collected data is then used to create a geologic model of the structure and chemistry and define the resource based on mining constraints.

Mine planning uses geologic modeling information to design three-dimensional mining blocks that reflect the ground control plan and are sized to provide sufficient resolution for mine scheduling. The resource quantity and quality contained in the mining blocks are estimated, and then the data is used to produce a planned production schedule based on mining constraints.

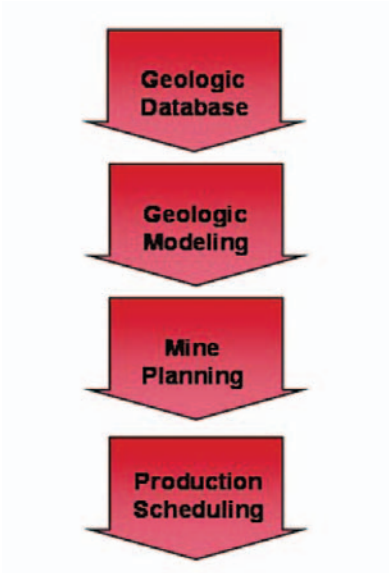
Optimizing the plan typically requires completing multiple plan scenarios. Having an efficient, integrated and streamlined process will reduce the amount of time required to complete a mine planning scenario. Additionally, the process should be repeated as new geologic information becomes available to ensure mining plan assumptions will reasonably reflect actual field conditions. Inaccurate geologic models will introduce error into the downstream mining plans, which can result in surprise cost increases and revenue reductions to the operation.

Opportunity for improvement

At this particular North American coal mine, the mine planning process was reviewed after the mine was purchased. Planners obtained new geologic data during a planned drilling season. Drillhole information was accumulated, but planners would only update the geologic model at the end of exploration drilling. Therefore, continuous updates were not performed due to the time required to generate the geologic model.

The geologic model consisted of two areas. One included the

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Mine planning workflow.

site planned for the next two years of mining. The other covered the remaining mine area. The model covering the next two years of mining was built on a 30.5-m (100-ft) grid cell size, while the longer-term area was built on a 122-m (400-ft) grid cell size.

The amount of time required to update these two models was approximately 18 hours. The time required to complete the workflow limited the availability of new data to the mine planning system, so engineers were not working with the latest information.

Mine plans were completed with multiple software systems. Mine layout and design was performed in one system, while mine scheduling was performed using Microsoft Excel. Long-range mine plans on average took five weeks to complete. The majority of time was spent generating economic pitshells, which were then estimated for volume and quality. Resource estimates from the pit shells were then exported to Excel for scheduling. Plan-progress maps were constructed manually in CAD by color-coding the scheduled blocks in Excel by planned periods.

Optimizing the mine planning process

Drawing from experience gained at its other mines, the company began improving processes to reduce geologic modeling and mine planning turnaround times, thus providing an opportunity to develop more accurate and optimized mine plans. A significant part of the plan to improve the process was replacing the multiple existing mine planning systems with a single, integrated mine planning system — the Mincom MineScape geologic modeling and mine planning system.

A major improvement in geologic modeling process flow was made by combining both short- and long-range model areas into one model with a 30.5-m (100-ft) grid cell size, eliminating the need to build more than one geologic model. Eliminating the necessity of building a second model, and the increased automation provided by the Mincom MineScape geologic modeling system process, reduced model building time by 75 percent.

Using a single, integrated mine planning and geologic modeling solution also improved the process flow. Rather than exporting block-resource estimates to Excel, scheduling was completed in one mine planning system. Plan progress map generation was automated as the scheduling system was integrated with the CAD system. By implementing this change, the time to complete long-range mine plans was reduced by 60 percent.

Better mine planning yields tangible results

Improvements in the process flow resulted in direct and indirect benefits to the operation. Faster geologic modeling and mine planning provided significant benefits and cost savings to the operation, and not through the reduction of engineering staff. Liberating technical staff from tasks to facilitate the process enabled them to spend more time investigating better design solutions, which increased minable reserves and reduced operation costs.

Improved geologic model and mine design accuracy

The significant time reduction in developing geologic models allowed multiple models to be created on the fly as new drillhole and quality data was received. Geologists were able to analyze the effect of the additional drilling on the model and continually keep the geologic model updated for mine planning. Accuracy was increased through a higher resolution model, which reflected measured data more closely. The model-publishing capabilities of the Mincom software enabled new model updates to be distributed to the mining engineers quickly and easily, so they were always designing with the latest information.

Incorporating the latest information into the geologic model improved the accuracy of the mining plans. The reduction in time to develop mine plans resulted in better decision making through the ability to compare multiple mine plan scenarios.

Enhanced operations

Operations staff encountered water-bearing sand zones, which impacted shovel production and ground control. Prior to modeling the sand units, the shovel would explore for the zones during operations. Exploring for problem zones with the shovel posed a significant risk of getting the shovel stuck in the sand or worse, a highwall slope failure resulting in an unproductive shovel. This would impact coal production and, more importantly, potentially result in injury or death.

Improving geology model turnaround and accuracy provided geologists time to model the noncoal, water-bearing sand zones. Once identified, shovel bench plans were developed to efficiently work in these difficult areas and communicated to operations. Planning for the sand zone improved shovel productivity and reduced highwall failure risk.

Streamlining the work flow gave the engineers more time to get out of the office and get experience in field management roles, where their analytical skills improved the operational work flow and daily decisions made in field operations.

Reduced exploration costs

Because geologists were provided more accurate models in less time, they were able to spend more time optimizing the exploration drilling plan. Through this exercise, they were able to reduce the number of planned exploration holes for the next drilling season compared to the previous method of planning holes.

The increased geologic model accuracy and resolution also eliminated the cost of drilling pilot holes in areas where infill drilling was performed to get supplemental coal quality data. The model's predict function was performed at the proposed drillhole locations, and the information was provided to the drilling crew. The predicted holes were found to correlate well with actual coal elevations and geology.

Increased minable reserves

Exploration drilling revealed a geologically complex area within the mine site. Typically, two coal intervals were being modeled and mined in the planned and active operations. The geologically complex area showed eight coal units, which were splits from the main two coal intervals. Adding to this complexity in the coal formation was the presence of a sand channel unit, which presented a significant ground control risk to the mining operation.

Prior to implementing the MineScape modeling system, this complex area was mined around, because the existing modeling system could not confidently model and, therefore, plan mining in this area. As a result of the improvements made in the geologic modeling and mine planning system, the area was modeled and multiple mining scenarios were developed to address the challenges of the area. Coal reserves that were previously avoided due to geologic anomalies are now part of the mining plan, increasing the available reserves and extending the mine life.

Greater confidence in purchasing decisions

Because coal sales drive the production for this mining operation, accurate geologic modeling using the latest data increased the confidence in the mine plans to meet coal quality specifications on upcoming shipments. Furthermore, optimizing the mining plan enabled engineers to accurately predict when a significant multi-million dollar capital investment in new equipment would be required due to upcoming increased overburden volumes and sales volume.

Summary

The mine planning process improvements described have resulted in direct and indirect cost savings for this mine. Streamlining the workflow has reduced the effort required and increased the quality of the mining plan.

Some may think that streamlining the mine planning process leads to cost savings by reducing staff. However, as experienced by this company, greater cost benefit and business value can be realized by maintaining existing staffing levels and reinvesting the newly available time and expertise of these skilled mining professionals back into the operation.

In the case of this mine, its staff had more time available in which to examine ways to make the operation more efficient, such as optimizing exploration drilling programs, building internal confidence in the accuracy of mining plans, increasing mine reserves by uncovering ways to mine in difficult geologic conditions, and helping execute the final plans with field operations.

Ultimately, improving the overall efficiency of the mine planning process with Mincom MineScape has allowed this mining company to reap more benefit by applying available staff time to efficiency programs that have boosted the performance of its mining operation. ■

Prior to implementing the MineScape modeling system, this complex area was mined around, because the existing modeling system could not confidently model and, therefore, plan the mining in this area.

Sandvik and Gemcom to collaborate
on equipment performance and tracking software

With the aim of working in conjunction to develop a system and interface for monitoring underground mobile mining equipment, Gemcom Software International Inc. and Sandvik Mining and Construction signed a collaboration agreement.

The two companies are teaming up to create an innovative equipment performance and production tracking solution that will improve consolidation and validation of information from mine operational systems.

Sandvik service solutions and automation technologies help manage mining equipment and production. With growing requirements in the industry for new enabling technologies to drive greater efficiencies, there is a need for a flexible and well-integrated system for mining operations management.

Gemcom InSite delivers operations management capabilities that complement planning and sched-

uling activities, along with a continuous improvement engine that drive improved recovery, throughput, equipment utilization and performance.

"InSite features innovative technology that monitors in near real time equipment, events, and tracks production, which enables timely operational decision making," said Rauno Pitkänen, manager of projects, systems and new offering, Sandvik Mining and Construction. "This industry-leading technology, when combined with Sandvik's Optimine capabilities, will allow mining companies to follow up on their production, equipment and personnel performance metrics in a simple and effective manner. Ultimately, they will be better able to manage and utilize their capital expenditures, and be able to back up business decisions with hard data."

"Sandvik has developed an in-depth understanding of the demands of modern mining operations and how automation of loading and hauling processes in the mining cycle can contribute to the improvement of safety and efficiency of ore transportation," said Allen Vaughn, Gemcom executive vice president. "Sandvik's desire to provide customers with more in-depth knowledge on the condition of the equipment for maintenance purposes, as well as production monitoring to more effectively manage draw and production control, creates the opportunity to leverage InSite."

A prototype of the Sandvik Gemcom collaborative solution is in place at the Sandvik test mine in Tampere, Finland. ■

Hitachi purchases part of Wenco

Agreement will streamline fleet management efforts

Equipment manufacturer Hitachi has purchased a significant interest in Wenco International Mining Systems Ltd., a manufacturer and supplier of PC-based mine management systems.

Wenco brings more than 25 years of experience and the philosophy that data belongs to the customer, which is why it uses open architecture. It has worked with numerous mining companies.

Hitachi is collaborating with Wenco to streamline the process of collating machine health data from onboard systems found on Hitachi excavators and trucks. The result is timely, proactive and reliable information mines can use to prevent unscheduled downtime and meet fleet-maintenance objectives.

Wenco's mine management system offers features and benefits like precise positioning, machine guidance, effective fleet-utilization data, accurate machine-health information, improved maintenance practices, extended tire life and automatic dispatching systems.



Wenco software will help with fleet management.

The company's mine management system encompasses a range of available products, from onboard computers that provide equipment operators with performance metrics and interaction, to survey-grade GPS applications for precise positioning and guidance of equipment. Additional software applications provide the maintenance department with real-time and historical information on equipment conditions.

The system will be put to use to assist the North American Construction Group (NACG) at Canadian Natural Resources Ltd.'s Horizon mine site in the Canadian oil sands to assist in removing overburden. Wenco is installing rugged mobile data terminals on 34 trucks and four shovels. Wenco is also installing a mobile supervisor's terminal in the foreman's truck — a rugged computer that provides snapshots of operations and real-time reporting of current production versus targets.

The complete system selected by NACG includes FleetControl (main dispatcher screen), MineVision (real-time view of the equipment and mine), and Wenco's Line-up Utility, a software component that facilitates the allocation of operators to mining equipment at the start of the shift.

Wenco's system for NACG also includes a contractor-integration module to manage the tracking and movement of their mining equipment to and from the CNRL fleet on a periodic basis. The module will allow the contractor and the owner to jointly move the mine-management system control of selected contractor equipment from the contractor's system to the owner's system and back again. When the mining equipment is under owner control, all data for that specific equipment will be stored by the owner's mine management system.

This module is available for all contractors working alongside an owner/operator, both of whom are running Wenco mine management systems. ■

Design, installation and operation of Pinto Valley moly flotation columns

by R.Rodgers, L. Hallin, F. Palacios and M. Neira

The Pinto Valley concentrator of BHP Copper Inc. restarted its sulfide mining operations in September 2007 to produce copper and molybdenum concentrates. During the plant production ramp up, the copper/molybdenum circuit quickly reached the copper grade and recovery targets, but the production and quality of the molybdenum concentrate continued to be a challenge. Even though several improvements in the molybdenum circuit were completed, the final molybdenum concentrate did not meet contractual specifications. After reviewing several options to improve grade and reduce contaminants, the installation of three flotation columns were chosen. The column design and construction were done using in-house craftsmen and engineers. Ten days after commissioning, the columns successfully reached a steady operation and began producing molybdenum concentrate to the required specifications, that is, high molybdenum tenors and low copper and iron content.



A welder puts the finishing touches on the new molybdenum flotation columns that were installed at the Pinto Valley concentrator of BHP Copper Inc.

The Pinto Valley operations, are comprised of the Pinto Valley concentrator, the Pinto Valley dump leaching and a solvent extraction/electrowinning (SX/EW) plant. The concentrator operated from 1972 to 1998 when mining and milling operations were curtailed for economic reasons. The SX/EW plant continued operations for copper cathode production. After a cessation of mining operations of almost 10 years, Pinto Valley operations began a restart project in January 2007, to bring the mine and the concentrator back into production. Copper concentrate production started in October 2007 after refurbishing and upgrading the facilities with a new DCS system and filter plant. The daily targets of the concentrator were to treat 56.7 kt (62,500 st) of ore, produce 762 t (840 st) of copper concentrate containing 27.5 percent copper at recoveries of 86 percent and produce 2.2 t (2.5 st) of molybdenum concentrate containing more than 80 percent MoS_2.

During the restart of the concentrator numerous breakdowns occurred that delayed achieving copper and molybdenum production targets.

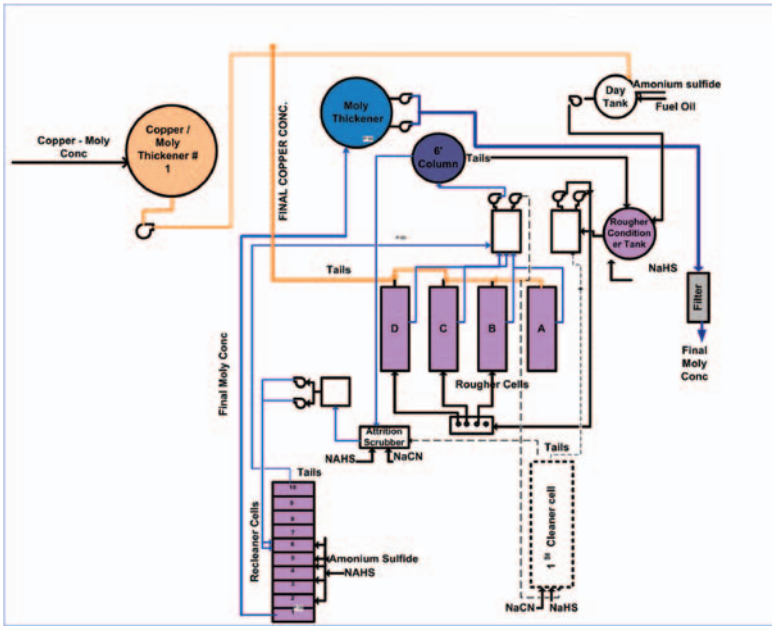
The breakdowns were due mainly to failures of old equipment and reduced ore quality as well as oxidation due to rains and being stored for many years. Despite those issues, the targets of copper grade and recoveries were achieved but production targets suffered from lower mill throughputs. The molybdenum flotation circuit started to operate in March 2008 after reconditioning of the existing equipment. The quality of the molybdenum concentrate did not reach the contractual specifications required by the buyer due to plant feed variations, slow progress in the operator's learning curve, failure of a storage tank and continual problems with flotation banks.

Several improvements in the molybdenum plant were completed but on-specification molybdenum still could not be produced. Several options were evaluated to obtain the molybdenum concentrate specifications and it was decided to add three flotation columns to the molybdenum circuit, two columns as recleaners and one column as a recleaner scavenger to improve grade and molybdenum recovery. After commissioning of the new columns, the

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Figure 1

Former molybdenum plant flowsheet.



molybdenum concentrates quality reached the required specifications on MoS_2 content and low grades of copper and iron. The Pinto Valley mining operations and concentrator were then put on care and maintenance in January 2009 due to economic reasons.

Mineralogy

Pinto Valley ore mineralogy contains primary sulfide ore minerals consisting of pyrite, chalcopyrite and minor molybdenite that occur in veins and microfractures. The major gangue minerals are quartz, mica (predominantly muscovite) and feldspars (both potassium- and sodium-rich species).

Chalcopyrite is the predominant copper mineral with minor amounts of tenorite, chrysocolla, brochanthite, chalcocite, covellite, bornite, enargite and turquoise. Molybdenum distribution generally reflects copper distribution, with higher molybdenum values usually found in the high-grade copper zones.

Table 1

Moly plant flotation parameters.

Parameter	Low	High
Molybdenum in ore, % MoS_2	0.07	0.12
Cu - Mo concentrator, % MoS_2	0.7	1.1
Cu - Mo thickener U/F, % solids	50	55
Feed Ro. banks, % solids	25	30
Amm. sulf. to day tank, cc/min	1,000	1,500
NAHS to conditioning, cc/min	70	510
Fuel oil to conditioning, cc/min	30	100
NAHS to recleaner launder,cc/min	500	1,200
Rougher flotation pH	10.6	11.2
Rougher flotation ORP, mV	-480	-550
Re-cleaner flotation ORP, mV	-480	-500
Moly concentrator, % MoS_2	>80	>85
Moly concentrator, %Cu	<1.25	<1.5
Moly concentrator, %Fe	<3.8	<4.5

Process description of the Pinto Valley concentrator

The run-of-mine ore is delivered by haul trucks to a Fuller 1.5- x 2.26-m (60- x 89-in.) gyratory primary crusher. The crusher discharge, 177 mm (7 in.) in size, is conveyed to a coarse ore stockpile. The fine crushing plant contains three secondary 2.1-m (7-ft) Nordberg standard crushers and six, 2.1-m (7-ft) Nordberg tertiary shorthead crushers with their respective screens and conveyor belts. The ore from the coarse stockpile is sent by apron feeders and belt conveyors onto three 2.1- x 5-m (7- x16-ft) Simplicity doubledeck vibrating secondary screens. The screen oversize is passed to the three secondary crushers. The screen undersize is sent to the fine ore stockpile. The secondary crusher product is sent to the tertiary feed bin ahead of the tertiary crushers. Ore is withdrawn from the tertiary bin by six feeder belts and sent to six, 2.4- x 6-m (8-ft x 20-ft) Simplicity doubledeck vibrating screens with final screen openings of 19 x 76 mm and 12.7 x 76 mm (0.75 x 3 in. and 0.5 x 3 in.).

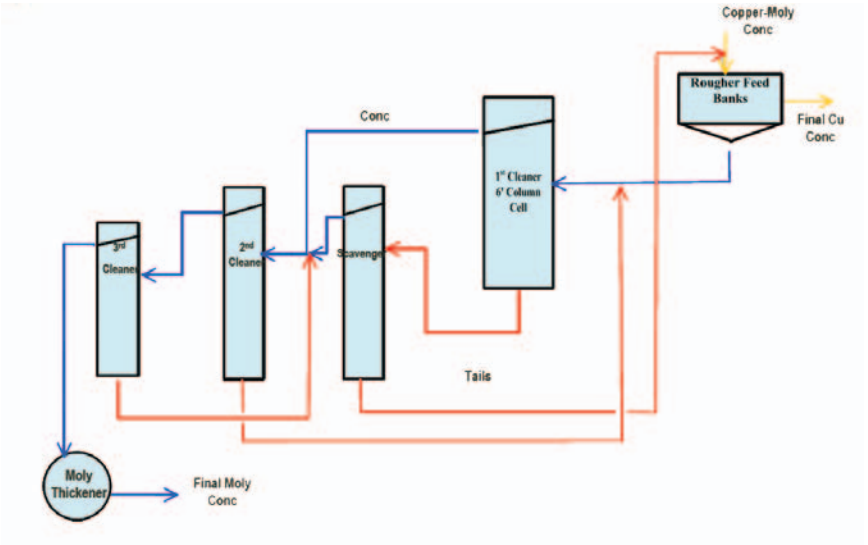
The screens undersize are sent to fine ore stock pile ahead of the mills. The screens oversize is sent to the tertiary crushers and then back to the tertiary feed bin. The primary grinding circuit consists of six 5.5- x 6.4-m (18-ft x 21-ft) Allis Chalmers overflow ball mills driven by 3,000 kW (4,000 hp) synchronous motors. Each mill is in closed circuit with three 838-mm (33-in.) Wemco cyclones. The circulating load is approximately 350 percent and the feed rate to the mills is 400 to 444 t/hour (440 to 490 stph).

Cyclone overflow is sent to three flotation sections of copper-molybdenum roughers. The copper-molybdenum flotation circuit contains 65, 28m^3 (1,000 cu ft) Wemco flotation mechanical cells, 14, 8.5 m^3 (300 cu ft) Wemco rougher scavenger cells, and four, 2.4-m (8-ft) diameter by 12-m (40-ft) tall column cleaner flotation cells. Two regrinding mills treat the rougher concentrate. The bulk concentrate product of the columns containing copper and molybdenum is sent to one of two, 27-m (90-ft) Dorr Oliver thickeners and then to the molybdenum flotation circuit.

During the copper flotation process, the concentration of copper is raised to about 28 percent copper while the molybdenum is upgraded from about 0.07 percent MoS_2 to about

Figure 2

Three cleaners and scavenger columns flowsheet.



1.1 percent MoS_2. In the molybdenum circuit, the final molybdenum concentrate contains about 80 percent molybdenite. The final copper concentrate (or molybdenum plant tails) is thickened in two 27-m (90-ft) Dorr Oliver thickeners to 60 percent solids and sent to either of two 900,928 L (238,000 gal) storage tanks. The slurry is pumped from the storage tanks to the filter plant. The filter cake is sent by conveyors to the concentrate storage building for shipment. Tailings from the copper flotation circuit flow by gravity to three, 107-m (350-ft) diameter thickeners. The underflow (thickened slurry) from these thickeners flows down a large pipeline to the tailings dam. Clear water from thickener overflow and tailings dam reclaim water is pumped back to the grinding and flotation circuits.

Molybdenum flotation process at Pinto Valley

The flotation process to separate molybdenum from copper consists of adding ammonium hydrosulfide and sodium hydrosulfide (NASH) to the bulk copper-molybdenum concentrate to "depress" copper and iron sulfides, thus allowing molybdenum to float naturally. The copper-molybdenum flotation circuit produced about 3,154 to 3,785 m^3/s (500 to 600 gpm) of bulk copper-molybdenum concentrate containing 28 to 30 percent copper, 0.7 to 1.1 percent MoS_2 and 30 percent iron. This product is sent to the thickener where water is recovered increasing the slurry density of the thickener underflow to 50 to 55 percent solids. Thickening prior to molybdenum flotation is very important to remove copper flotation collectors that would inhibit the copper depression. The thickener U/F slurry is pumped to a holding tank of 75,700 L (20,000 gal) of capacity for 10 hours of retention time. This permitted a constant flow to the molybdenum plant. The slurry from the holding tank is sent to a conditioner tank for 30 minutes of retention time. NASH and fuel oil is added to this tank. From the conditioner, the slurry is pumped to a distribution box that feeds to four flotation rougher banks of six Agitair 1 m^3 (40-cu ft) cells. Nitrogen is used as gas phase in the rougher circuit to avoid NASH oxidation.

The rougher concentrate is pumped to a 2-m (6-ft) diameter cleaner flotation column. Water is added through a drip pan washer on top of the column to remove any insoluble or copper sulfide carried out in the flotation bubbles. Nitrogen is also used to form the gas bubbles. The cleaner column concentrate is directed to an attrition scrubber to clean the copper surfaces and additional NASH is added for copper and iron sulfide depression. From the attrition scrubber, the concentrate is pumped to the recleaner bank that consists of 10 Denver cells. The final molybdenum concentrate is thickened in an 8-m (26-ft) thickener, filtered on a disk filter, dried in a Holoflite screw dryer and drummed for shipment.

The final molybdenum concentrate contains 2 to 4 percent moisture (Fig. 1).

Molybdenum flotation - process parameters

Molybdenum flotation is affected by the following parameters: slurry density, particle

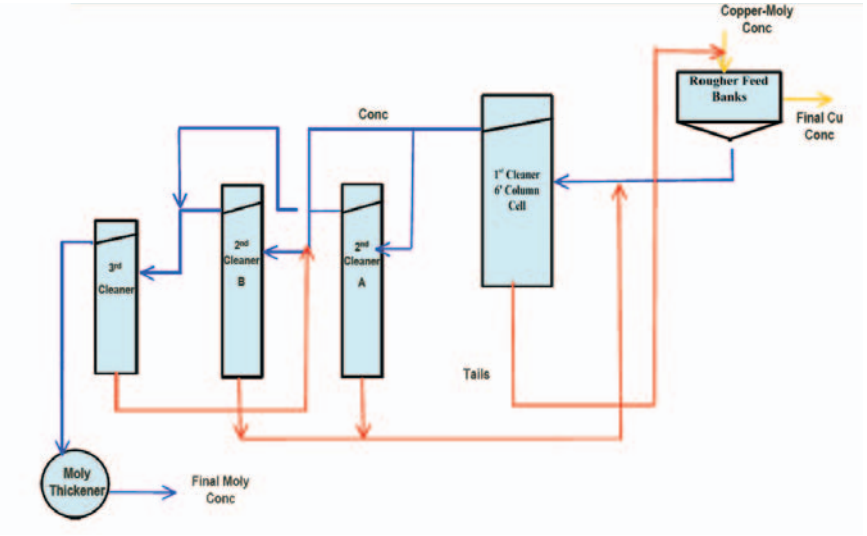
Table 2

Molybdenum liberation profiles of the samples.

	Moly feed May 20-21	Moly feed May 5	Comb moly tail May 20-21	Comb moly tail May 5	Moly final conc May 5	Moly final conc May 20-21
Free Mo	30.7	28.3	41.7	22.6	71.5	71.4
Lib Mo	36.6	28.6	17.6	10	19.5	23.8
Mo mids	21.3	20.5	22.8	28.5	6.1	3.7
Mo sub mids	5.4	10.3	9.1	17.3	2.2	0.9
Locked Mo	5.9	12.4	8.8	21.6	0.7	0.2
Total	100	100	100	100	100	100

Figure 3

Parallel cleaners flowsheet.



size distribution, oxidation reduction potential (ORP) of the pulp, water quality and flotation cells type and cell configuration.

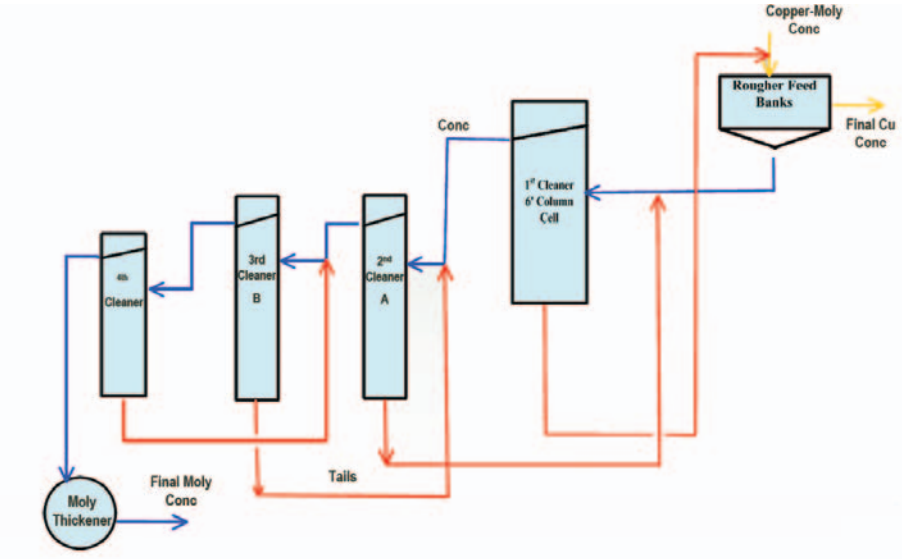
The molybdenum flotation parameters are summarized in Table 1.

Slurry density. The slurry density of the copper/molybdenum thickener underflow (U/F) is one of the most important parameters to obtain molybdenum concentrate with low copper and iron contents. The required density of the copper-molybdenum thickener U/F is 50 to 55 percent solids. Lower slurry density contains high amounts of collectors that inhibit the effective depression of copper and iron sulfides.

Higher slurry density causes line plugging which interrupt normal flow to the plant.

Figure 4

Four cleaners in series flowsheet.



Oxidation reduction potential (ORP). This parameter is one of the other important factors for good molybdenum-copper separation. According to the literature, copper is totally depressed when the pulp ORP is -480 to -550 mV. To obtain this pulp potential, the addition of ammonium sulfide (NH4S) and sodium hydrosulfide (NASH) is a well-known practice in the industry. The ORP in the molybdenum plant is monitored by in-line probes installed in the rougher and recleaner bank tails. Nitrogen gas, as the gas phase in the flotation process, injection is important to obtain a stable ORP and minimize NASH consumption, since this reagent is oxidized with air.

Particle size distribution. The adequate particle size in the slurry is important to the molybdenum flotation since particles that are too fine will cause entrainment of copper and iron in the final molybdenum concentrate. Coarse material will cause low molybdenum recovery. The adequate particle size is 30 to 32 percent + 325 mesh in the feed to the molybdenum plant. The size distribution is controlled by a good operation of the cyclones in the primary grinding and copper-molybdenum regrinding circuits.

Molybdenum content of the ore. Low molybdenum content in the molybdenum feed causes low molybdenum concentrate grades with high copper grades. Flotation operators were forced to recirculate the final concentrate through the cleaners to upgrade the concentrate creating high circulating loads and low molybdenum recoveries.

Production of sulfur and fine copper activation resulted from recirculation. Other results of high circulation of concentrate is the dilution of the slurry, which affected the recovery and final product quality. The density of the slurry rougher feed varies from 25 to 30 percent.

An acceptable ore grade is above 0.08 percent MoS_2.

Operational challenges in the molybdenum flotation circuit

Several challenges faced the operations of the molybdenum flotation circuit. One of the challenges was the lack of experience of the operators. Most of them had not been exposed to mining or plant operations.

Training programs and operation manuals were developed. An experienced consultant helped in the training and the development of trouble shooting guides. Initially, the feed flow and density to the plant had high variations due to mill throughput variations causing difficulties in reaching and maintaining an operating equilibrium. Each copper-molybdenum thickener had an automatic underflow valve coupled with an in-line pulp density transmitter and controlled by the DCS system from the main control room. This also solved the issue of low pulp densities and plugging of the slurry lines. The day tank was bypassed as a result of this control.

The operation of the first cleaner (2-m or 6-ft diameter column) was also a challenge. Continuous loss of froth height in the column and variations in bubble size were the main issues. The automatic valve located in the column tail pipe was changed for a bigger one and a new Honeywell 3000 controller was installed to control the froth depth.

An operation manual of this controller was prepared. The column spargers to generate the nitrogen bubbles were cleaned and adjusted to produce the required bubble size and volume.

Variations in the ORP in the roughers and cleaners was solved by continuous calibrations of the in-line probes, manual checks of the ORP and training the operators in the importance of keeping the ORP values as established.

The operation of the recleaner bank was a major challenge and the most difficult to solve. This bank produced high internal slurry circulation and used high amounts of copper depressants, creating high levels of dilution in the whole molybdenum circuit. The internal cell separation presented leaks and was not possible to fix due to the age of the cell.

Table 3

Mass balance of the new moly plant configuration.

	Solids			Water, GPM		Pulp
Stream	% MoS_2	DTPD	% Solids	Drip pan	Launder	GPM
Ro feed	1.6	953.7	26.0			489.6
Ro tails	0.4	883.1	27.1			430.4
Ro conc	17.4	70.7	17.7		15	57.5
First cleaner Feed (6' col.)	15.2	102.1	12.0			283.4
First cleaner Tail (6' col.)	9.0	62.0	14.0	10		212.6
First cleaner Con(6' col.)	25.0	39.5	10.0		10	70.8
Second cleaner Feed (30" col.)	34.7	72.1	8.0			111.3
Second cleaner Tail (30" col.)	9.0	31.4	6.5	10		78.7
Second cleaner Con (30" col.)	60.0	40.6	18.0		10	32.9
Third cleaner Tail (20" col.)	50.0	34.9	16.5	5		20.4
Third cleaner Final con (20" col.)	90.0	5.7	35.0		5	12.5
Scavenger cail (30" col.)	6.0	53.7	4.0	10		160.4
Scavenger con (30' col.)	25.0	9.6	3		10	62.2

Mineralogical investigation of molybdenum samples

In spite of the various improvements in the molybdenum circuit and training of the operators, the achievement of on-specification molybdenum concentrate continued to be a challenge. It was decided to send eight metallurgical samples to a laboratory in Canada for mineralogical investigation. The objectives of the investigation were to determine the overall mineralogy, the liberation and association of copper and molybdenum minerals. The mineralogical analysis was carried out using QEMSCANTM and applying the particle mineral analysis (PMA) method. Molybdenum feed, tails and two types of molybdenum concentrate samples were analyzed. The results are summarized in Table 2. Two samples of molybdenum concentrate were analyzed, one with high MoS_2 grade (82 percent) from May 5, 2008 production and the another from the May 20-21 production with low values of MoS_2 (60 percent).

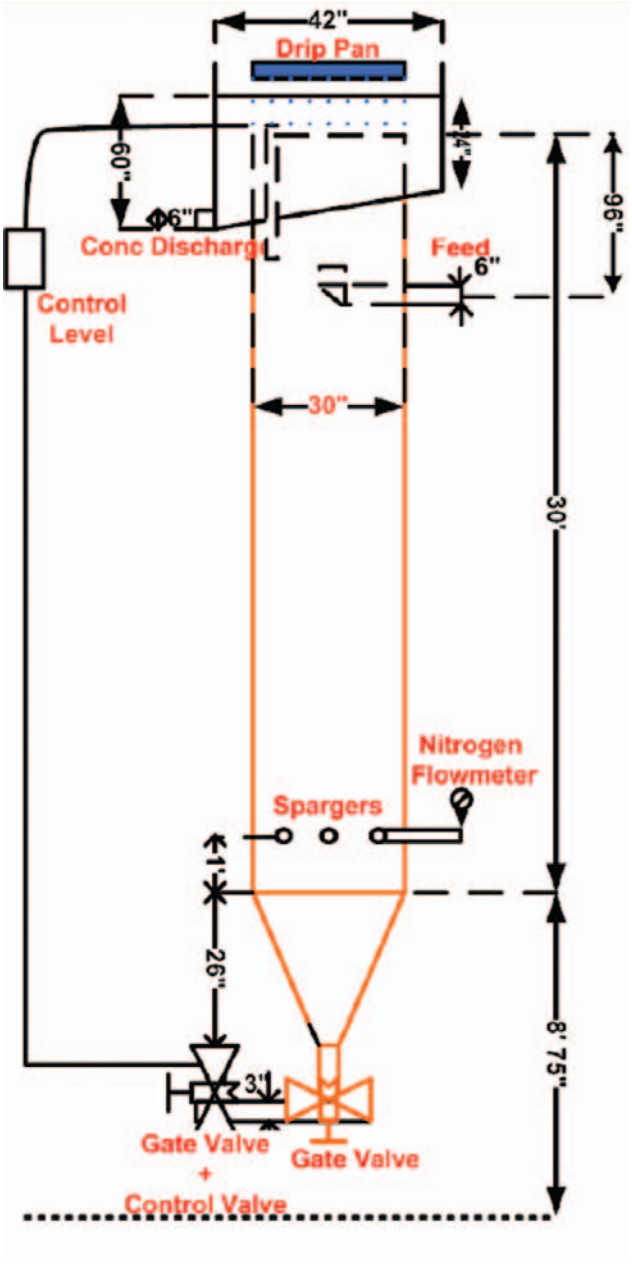
Liberation (free and liberated) of copper-sulfides (essentially chalcopyrite) was high in both the combined molybdenum feed. The main association of chalcopyrite is with pyrite. Liberation of molybdenite in the May 5 molybdenum final concentrate sample was 91 percent and in the combined molybdenum final concentrate May 20-21 was 95.2 percent. The liberation of the molybdenum feed and tails was low as can be seen in Table 2.

Column flowsheet design

After evaluating the mineralogical report, it was clear that the low molybdenum concentrate grades were not due to coarse particles or interlocked sulfides but fine copper and iron that reported into the concentrate, the result of internal leaks in the recleaner cells that caused high recirculation and flotation of fine material. For these reasons, it was decided to install

Figure 5

Schematic of the 30-in. diameter column.



flotation columns to improve grade and recovery.

The column design included a flexible flowsheet to easily operate and make changes to accommodate any variations in flow, molybdenum content in head and type of ores. BHP Billiton standards of safety, health and care for the environment were included in the design. The design considered the input of in-house expertise of metallurgists, process engineers, mechanics and operations. The construction of the columns would be done in house by skilled welders and boiler makers. The flexible flowsheet included a basic (with a scavenger stage), parallel cleaner and cleaners in series flowsheet. Mass balance for the basic flowsheet was performed.

Basic flowsheet. The basic flowsheet must contain two additional cleaner columns and a scavenger column to treat high flows and high head grades and obtain good molybdenum concentrate grades without affecting molybdenum recovery (Fig. 2).

The rougher concentrate would be treated in the 2-m (6-ft) first cleaner column, the concentrate from this column would be sent to the second column or second cleaner and the concentrate would be upgraded in a third column which concentrate would then be sent to the molybdenum thickener as final concentrate. The tails of the first cleaner would be sent to the scavenger column to recover any molybdenum not floated in this column. The concentrate from the scavenger column would be sent to the second column and the tails would be sent back to the rougher flotation banks.

Parallel cleaners flowsheet. The purpose of this flowsheet configuration is to treat high flows with three cleaners in total. This flowsheet can be used when the tonnage in the mill is high and the head grades are low. The concentrate from the first cleaners are fed to two columns in parallel whose concentrate would be sent to a third column cleaner to get the final molybdenum concentrate. The tails from the parallel columns would be sent to the feed of the first cleaner and the tails from the last column to the feed of one of the parallel column. The final concentrate of the third column would be sent to the molybdenum thickener (Fig. 3).

Four cleaners in series flowsheet. This flowsheet consists of four columns that include the first cleaner (2-m or 6-ft column) and the three new columns. The rougher concentrate would be to the first cleaner whose concentrate would be pumped to the second cleaner, the concentrate of this column to the third column and so on, to obtain the final concentrate in the last column. The tails of the column would be flow in counter current to the concentrate. The purpose of this configuration is to treat molybdenum ores with very low grades that require several cleaning states to reach the concentrate specification (Fig. 4).

Mass balance

The next step was to perform a mass balance for the four optional flowsheets and obtain the design parameters to size piping, pumps and valves. A mass balance of the original molybdenum plant operations was performed to determine stream flows, density and dilution. Flotation recoveries of the rougher and cleaners were also obtained. Laboratory assays, specific gravities of the streams were also obtained. The mass balance was done for three levels of copper-molybdenum bulk concentrate or feed to the molybdenum plant: 523, 751 and 816 dry t/d (577, 828 and 900 dry stpd), which represent three levels of the mill copper production, low, average and high. A summarized mass balance for a

flowsheet configuration of rougher, three column cleaners and scavenger column (Fig. 2) and a 816-dry t/d (900-dry stpd) feed to the molybdenum plant is shown in Table 3.

Column cell design and construction

The column design was based on the columns in operation in the Pinto Valley mill and the molybdenum column of San Manuel mill. The column flotation cells were manufactured in the Pinto Valley shops with BHP Billiton craftsmen and mechanics using drawings designed by BHP Billiton's technical, graduate, summer student and engineering personnel. The material for the fabrication of the columns used was stainless steel pipe from the SX/EW plants. Constraint of the building height and provisions to run the overhead crane, and process control, similar to the current first cleaner column, were considered. It was decided to make the column without the cone bottom part and to install the columns into the building. It was necessary to cut the columns into two pieces with flanges at both ends.

A column diameter of 762 mm (30-in.) was chosen for the scavenger column and for the second cleaner and a 508-mm (20-in.) diameter column for the third cleaner. Column heights of 10 m and 8 m (32 ft and 25 ft) were chosen for the 762- and 508-mm (30- and 20-in.) diameter column, respectively. The feed enters at about 3.6 m (12 ft) below the top of the column at superficial pulp velocity of 1.2 to 1.5 cm/s. The drip pan for wash water was installed at the top of the column. The water pipe contains a water flow meter to adjust the necessary downward flow of water to provide a positive bias and wash the rising bubbles loaded with the concentrate of molybdenum and insoluble. The specific water flow to the column was 0.108 - 0.122 cm/s. Nitrogen is added at the bottom of the column to generate the rising gas bubbles. The nitrogen pipe contains a pressure gauge and a gas flowmeter to regulate the amount of gas to the column, and the bubble size. Table 4 shows the basic design parameters and a schematic representation of a 762-mm (30-in.) column is shown in Fig. 5.

Provisions to perform a bias control were included in the design. The positive bias control could be performed by keeping a slightly greater flow of the tails than the flow of the feed to the column which can be accomplished by regulating the wash water flow. A spool in the concentrate pipes of the scavenger and second cleaner was included to install a flowmeter later in the operation for bias control. The feed to the scavenger column or second cleaner (when operated with the four cleaners) contained a flow

Figure 6

Assembly for the 30 in. and 20 in. columns.



Figure 7

Sump box of the new columns.



Figure 8

Discharge of the three new columns showing the controls and flowmeters.



Figure 9

MoS_2 grade in the final moly concentrate by ship Lote #.

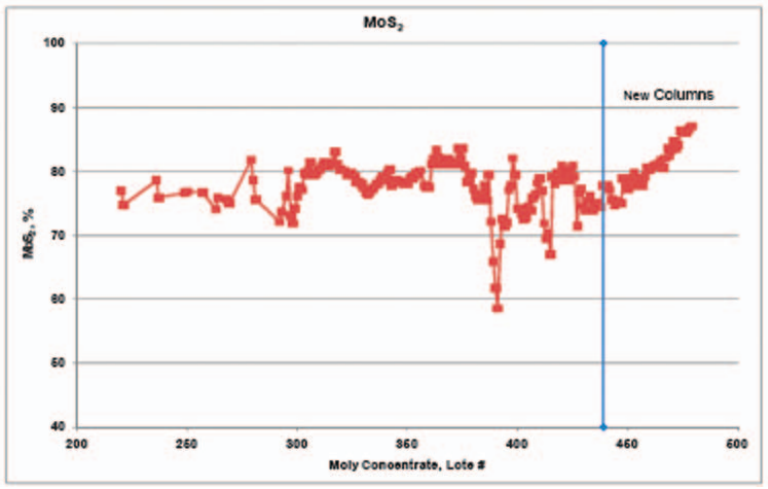


Figure 10

Cu content in the final moly concentrate by ship Lote #.

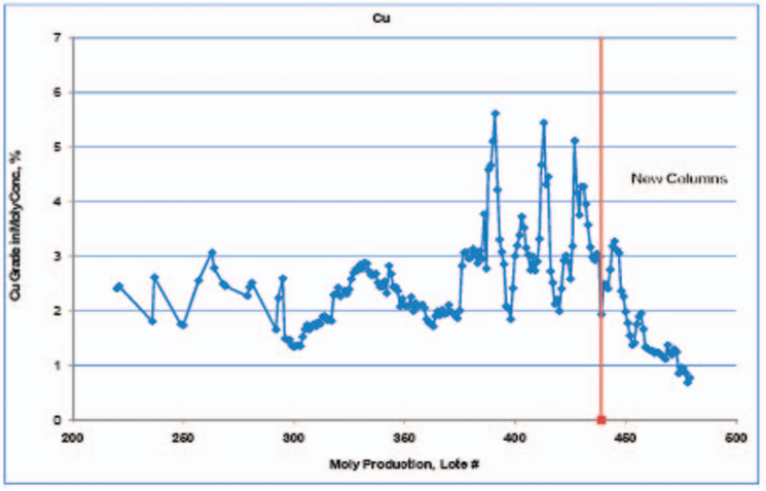
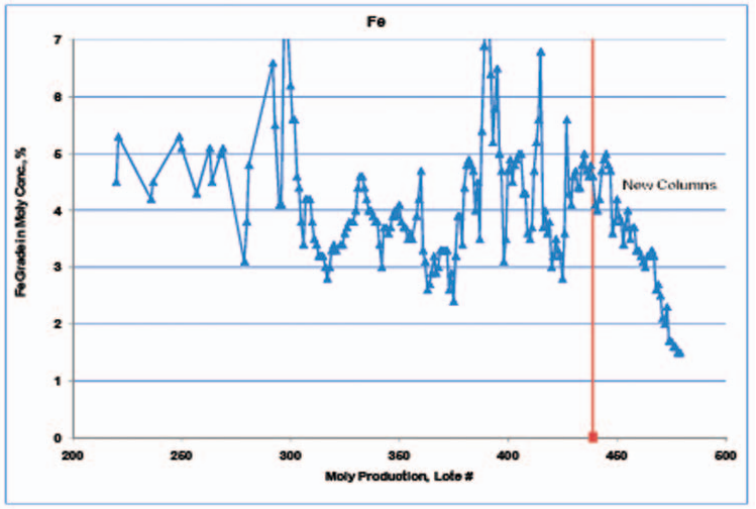


Figure 11

Fe content in the final moly concentrate by ship Lote #.



meter. The level indicator-transmitter was made of a perforated pipe that contains a special tape in the interior of the pipe to sense the level of the slurry. The P&ID drawing and the specifications were made by the technical services department and sent to engineering to build the detailed isometric drawings for construction.

Procurement and installation

Each department of the concentrator was to specify and buy the items needed for construction in coordination with the purchasing department. Thus, the electrical and instrumentation department acquired the control system such as flowmeters, control valves, level control, control panels, motors for pumps, electric wires and conduits, etc. The mechanical department got the pump, sump box and piping. Two pump sizes were installed in the sump box to give the flexibility to operate with any of the flowsheets. A smaller pump that will operate with flow of 189 to 378 m^3/s (30 to 60 gpm) and a bigger pump to handle flows up to 388 m^3/s (220 gpm) were installed in the sump box.

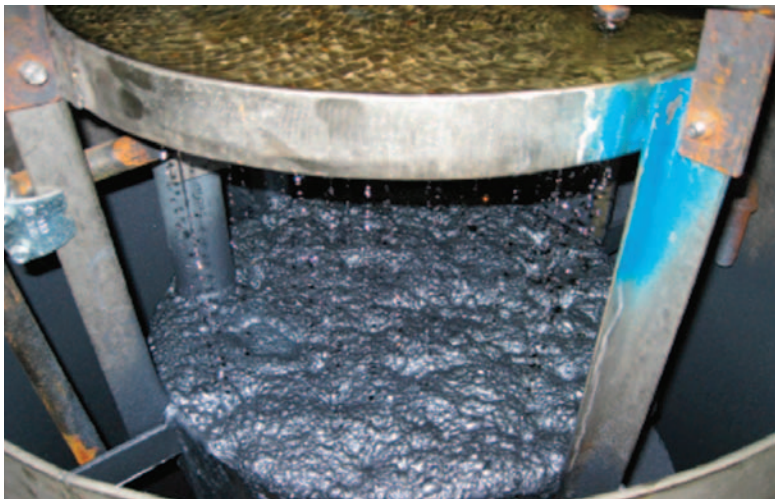
Western Industrial was the contractor to assemble the columns in the building, install piping, pumps, valves, spargers, rebuild the pass ways and reinforce the building structure. The sump box and pumps were also installed with the planned bypasses to operate the four alternate flowsheets. Figures 6, 7 and 8 show the assembling of the 762-mm and 508-mm (30-in. and 20-in.) columns, the sump box and the tail pipes of the column of the three columns, respectively. The column tail pipe material was stainless steel containing two gate valves, a flowmeter and pinch valve as automatic valve. The pipe material for the feed lines and concentrate were of PVC.

Commissioning

After installing the columns, pumps, piping, process control and electrical conduits the new molybdenum flotation circuit was tested with water to look for leaks. After fixing leaks in the column flanges and pipes, the new circuit was handed to operations. Operation manuals and training of the personal was carried out prior to commissioning. The operation parameters for the new circuit were the same as the old circuit except the parameters for height levels and flow to the columns that are shown in Table 4. The NASH reagent to the new columns was added to the concentrate launder of the second column or feed to the third cleaner. Only the circuit of four cleaners in series was tested (Fig. 4) but only three cleaners was necessary to reach the specification in the concentrate.

Figure 12

Final moly concentrate from the 20-in. column.



Results

The molybdenum production prior to the new columns varied and did not meet the specifications for marketing and was sold as off-specifications and near-specifications according to the analysis of MoS_2, copper and iron. The results of the final concentrate using the new columns were excellent as the MoS_2 grades were above the specs of 80 percent, copper grade was below 1.5 percent copper and iron below 3 percent. Initially the molybdenum production grades were below the specifications due to previous production that remained in the molybdenum thickener. After clearing the old inventory, results were more consistent and are shown in Fig. 9, 10 and 11 for MoS_2, copper and iron, respectively. A photo of the final molybdenum concentrate from 508-mm (20-in.) column is shown in Fig. 12.

Table 4

Design parameters of the flotation columns.

Flotation column parameter	Scavenger	Second cleaner	Third cleaner
Height (h), ft	32	32	25
Diameter (d), in.	30	30	20
h/d, ft/ft	12	12	15
Flow feed, gpm	220	120	35
Nitrogen, scfm	10	10	5
Nitrogen, psi	50	50	50
hold up, %	15	15	12
Feed superficial velocity, cm/s	1.5	1.5	1.2
Water superficial velocity, cm/s	0.122	0.122	0.108
Froth depth, in.	12	12	9

Conclusions

The challenges that faced molybdenum flotation during operations ramp up were the lack of experience of the operators, feed variations to the molybdenum plant due to mill throughput variations and issues in the first column cleaner and recleaners.

After implementing several improvements to resolve the above issues, the operations of the molybdenum flotation were more stable but on-specifications molybdenum concentrates still could not be produced.

Mineralogical investigations indicated that the low molybdenum concentrates grades were not due to coarse particle or interlocked sulfides but fine copper and iron sulfides were entrained into the final concentrate. Internal leaks in the recleaner cells caused high recirculation and flotation of fine material. For these reasons, it was decided to install new flotation columns to improve molybdenum concentrate grade and recovery.

The column design included a flexible flowsheet to easily operate and make changes to accommodate any variations in flow, molybdenum content in head and type of ores. The design considered the input of in-house expertise of metallurgists, process engineers, mechanics and operations. The construction of the columns was done in-house by skilled welders and boilers makers.

After commissioning of the new columns, the molybdenum concentrates quality reached the required spec on MoS_2 content and low concentrations of copper and iron. ■

Acknowledgments

The authors acknowledge the Pinto Valley management for funding this project and special recognitions are given to our in-house craftsmen for building the columns and to our operations, technical services, maintenance and engineers personnel for the design and installation of the new column circuit. The guidance and expertise of Mike Yu (internal consultant, BHP Billiton) and Ted Cook (external consultant) are greatly appreciated. Our recognition is extended to Western Industrial for the on-time installation of the columns and services.

5th Annual Elko Roundtable discussion: Strides toward sustainability in mining

by Brian Ulrich and Rick Frechette



Pebble Project, Alaska. Photo by Louise Shannon.

The majority of individuals involved in the mining industry can appreciate and understand that mining is an activity that is necessary to satisfy the very basic needs of society, and to assist in accommodating our ever-changing world. As the expression goes, "if it can't be grown, it has to be mined." And at this point in time, society has granted the mining industry the right to go about the business of mining, with the general anticipation that the work will be carried out without causing undue harm to the environment or populations in and around the mining operation. The term "sustainable development" is gaining momentum as a popular concept, and indeed it has become something of a catch-all phrase, but it is important that the idea behind the term is not cast aside as a nonsense buzz word, as it simply is an indication that development (e.g. mining) can be satisfactorily carried out with an eye toward stewardship of the environment and society.

B. Ulrich, and R. Frechette, members SME, are senior vice president, Nevada operations and Arizona operations manager, Knight Piésold and Co. e-mail bulrich@knightpiesold.com.

On Feb. 19, 2010, a roundtable discussion (Roundtable 2010) on "Strides Toward Sustainability in Mining" was hosted by Knight Piésold and Co. (Knight Piésold) at the Red Lion Inn and Casino in Elko, NV. Knight Piésold had local representatives (Bryan Ulrich and Steve Boyce), as well as representatives from other office locations (Cynthia Parnow and Rick Damiani from Denver, CO, and Rick Frechette from Tucson, AZ) to help facilitate the discussion. The meeting played host to 30 attendees from five states. Attendees included personnel from nine mining properties and various corporate offices. The majority of participants were people who are directly involved with environmental work on a day-to-day basis. Others were project managers whose jobs involve some level of environmental focus.

The purpose of the roundtable is to exchange ideas and information pertaining to sustainability efforts and issues associated with almost any aspect of a mining operation. This type of forum tends to provide a much less inhibited format for discussion, when compared with traditional conferences and symposia. In the roundtable format, lively discussions are encouraged.

This was the fifth in the series of Elko Roundtable events. Previous roundtables pertained to heap leach pad design, construction and operation; design, construction and operation of tailings

storage facilities; site-wide water considerations and mine closure and cover design.

The initial subtopics for Roundtable 2010 included:

Sustainability
- Defining Sustainability.
- Baby steps vs. giant steps.
- Using hammers – the catalytic converter approach.

Key drivers for a sustainable mining industry
- Risk
  - Political
  - Permitting
- Environmental
  - Prevention
  - Legacies
- Regulations
  - Stability
  - Clarity
  - Reasonableness
- Public image
  - Media
  - Passive/active
- Community/social
  - Relations
  - Sustainable operations
  - Power and renewable energy
- Employment
  - Education
  - Health/safety
  - Recruiting
  - Work force
- Financial
  - Operating costs
  - Commodity prices
  - Materials
  - Fuel
- Others

Evidence that the importance of sustainable development is being recognized
- University engineering departments.
- University strategic alliances and secondary degree programs.
- Spin-off companies.
- Consulting arms.

Examples of recent strides at the mines
- Project permitting strategies.
- Operating project alliances.
- Reclamation and closure strategies and opportunities.
- Forming of partnerships.

The roundtable created a good environment to discuss the current practice and challenges of sustainable development. Since there is considerable overlap between the roundtable's subtopics, the conversations frequently wandered from topic to topic and back again. The following is partly a tangential discussion and partly the proceedings of the roundtable.



Settlement near the Ingula Pumped Storage Scheme, KwaZulu-Natal, South Africa. Photo by Dawid Mouton.

First, it should be recognized that the notion of environmental protection as a collective concept is relatively young, as may be inferred by the formation of the U.S. Environmental Protection Agency (EPA), which occurred in 1970. Indeed, the term "smog" was not popularized until the 20th century, although there had been a campaign against air pollution in London for 700 years prior. The roles and responsibilities of engineers and scientists have evolved very rapidly during the past few decades. In Samuel Florman's otherwise insightful 1976 book, "The Existential Pleasures of Engineering," caution is advised against "slogans" such as an "abstraction called 'social responsibility,'" although Florman also acknowledges that the "towers of arrogance [that had led up to the new concept of environmental protection] were demolished by the environmental crisis" that had developed in the absence of regulations. Florman's dismissal of the term "social responsibility" seems almost bewildering by today's standards, yet the existence of the phrase apparently was foreign only a few decades ago. Just as mining and other industries now recognize that social responsibility is a necessity, so to has it recognized that sustainable development efforts are needed.

Since the concept of sustainable development is relatively new, its meaning has different connotations to stakeholders of various industries, including the mining industry. It can simply mean being able to operate a mine for a long period of time, or it can mean rehabilitating the post-mined land into an ecosystem that is viable, useful and fitting for its setting. Or it can imply providing, in some way, for the population around a mine property, possibly even after mining ceases. It does not seem to suggest that the post-mine land use must



Geotechnical drilling at Mestersvig Fjord, Eastern Greenland. Photo by Ryan Veenstra.

be equal to the pre-mining land use.

The United Kingdom government defines sustainable development as a process that leads to a better quality of life for everyone, now and in the future. This seems overly broad, overly ambitious, and emplaces almost unreasonably high expectations, after all, how can any one effort improve everybody's quality of life? There are a few examples that seem applicable, such as having cleaner air. But since every significant technological development involves a process, sometimes complex, it becomes difficult to 'weed through' the direct and indirect costs and benefits of any endeavor.

There are specific activities that are undoubtedly sustainable, such as a well regulated and performed hunting, fishing and trapping industry, which helps nature to balance animal populations, especially in the absence of other natural predators. There are also scientific applications and developments that are significant examples of benefiting populations, such as the eradication of the pull tab from aluminum beverage containers. It is now practically unheard of to observe a pull tab carelessly discarded on the ground, while it was all too common of a sight before the invention of the current pop top.

Written procedures, step-by-step recipes, if you will, aimed at achieving sustainable development, are notably unavailable for the practitioner, even though some of the sustainable development initiatives (such as MMSD, or Mining, Metals and Sustainable Development, which ran from 1998 until 2002) produced enormous amounts of documents and discussion. The preponderance of literature on the topic, rather, is aimed at providing thought-provoking illustrations, examples, and sets of guiding principles to assist in formulating plans and approaches for achieving sustainable development. An amalgamated definition of sustainable development, as it pertains to the mining industry, indicates that "sustainable development is an asymptotically approached ideal where positive strides are necessarily engaged, appropriate solutions are employed at appropriate scales, while considering the concept of diminishing returns, to formulate a project that is financially viable and socially responsible, from cradle to grave, while avoiding post closure legacy issues."

But still, the concept of sustainable development is somewhat nebulous since, as the description above suggests, it can be approached, but never achieved, similar to the theory of the "frog on a log," where the frog makes an endless series of jumps, with each jump putting the frog half way to the end. It can be generally accepted that at some point the frog is close enough to the end of the log to declare it to have essentially reached its goal, for all intents and purpose. Perhaps the attainment of sustainable development should be viewed similarly, that is, that significant advances are sustainable development accomplishments.



Heap leach facility at Fort Knox, Alaska. Photo by Shaun Persaud.

At the core of the sustainable development concept is the desire to balance social, economic, and environmental impacts. Perhaps a term such as "agreeable development," or "conscientious development" would be easier to get our

arms around. Or, perhaps it is better simply to revert back to the doctrines of "best practices." Nevertheless, with or without concrete definitions for the term sustainable development, there are many positive attributes of the notion that should be embraced.

One of the most provocative activities for the roundtable attendees was to describe what the term sustainable development means to them individually, either in part, or in full. In addition to the discussion above, participants indicated that aspects of sustainable development, as it pertains to the mining industry, should include:

- Being very site specific, and tailored to each individual project independently of, but not without consideration of, successes and failures of other operation;
- Employing best-practices that are economically viable, both for short-term and long-term outcomes;
- Close consideration of post-mining land use;
- Considering ways of prolonging the mining operation, such as re-processing previously processed materials;
- Considering post-mining employment possibilities;
- Recognizing that the mining operation is also a member of the community;
- Considering how populations and communities may evolve in mining areas, and consider the impact of those communities during the post-mining era;
- Considering partnering with the neighboring communities;
- Considering remaining adaptable as circumstances evolve; and
- Considering leaving behind a positive legacy.

On top of all these considerations, it was recognized that sustainable development should not indicate an open checkbook. There are also aspects such as recycling and the reduction of energy requirements that work well with the concept of sustainable development in mining. Applications of renewable energy were also discussed. Since many mining operations are situated in areas prone to wind, wind energy is one interesting application that may help satisfy some energy needs of mining operations, and also provide for the post-mining communities. Like other concepts, such as paste tailings, renewable energy should not be seen as a panacea, but it should be considered sensibly when and where it may be appropriate.

It may be surmised from the plethora of far-reaching definitions provided by the group, that a single definition is elusive, but most attendees would agree that even though it is difficult to define the term, one would likely know a successful illustration of sustainable development if one was provided with a good example, much in the way that good art is hard to define, but easy to recognize.



Local women pounding palm fruits to make palm oil, Sinthiourou Tiouladi, Guinea. Photo by Bryon Boyle.

Mining has made some significant strides toward sustainable development along several avenues, including prolonging the lives of current mining operations, and working with neighboring communities to help stabilize the necessary growth of those population centers. Very few mining operations would desire to leave behind ghost towns upon their closure. Many mines have been in operation for decades, and have been at the helm of community growth efforts. Mines with initial design lives of 10 years have gone on to continue to operate for several decades, becoming intimate partners with the community. While it is quite common to revert post-mining lands to grazing and wildlife habitat areas, there are other opportunities being met by mining companies too, such as donating portions of operations, especially operations with historical significance, as "living" museums and donating unused buildings to communities for their own use.

This year's subject offered far more challenges with respect to generating conversation than previous topics, but by the end of the afternoon, an impressive amount of information had been shared and it was generally agreed that the time was spent productively. By all accounts, this year's roundtable was seen as being highly successful. Next year, Knight Piésold will once again be hosting a roundtable discussion in Elko, where the topic will return to more traditional engineering and scientific subject matter. ■

Pinnacle Mine in West Virginia

to receive first modern automated plow system in the US



The use of plow systems fell out of favor in the U.S. in the 1970s, but recent advancements have made the technology safer and more efficent.

Bucyrus International unveiled the first modern automated plow system that was delivered to Cliffs Natural Resources' Pinnacle Mine near Pineville, WV. When it is installed, it will usher in a new era of plow longwalls as the preferred method for medium and lowseams below 1.8 m (71 in.).

At the ceremonial unveiling on July 20, the companies demonstrated the system at the Bucyrus facility in Houston, PA. The demonstration marked the kick-off for a nationwide promotion of the highly advanced and efficient technology.

Despite the fact that Bucyrus automated plows are in service around the world, North America has been reluctant to embrace the technology, based on a performance perception dating back to the 1970s when plow systems were not automated and did not possess the cutting and conveying power of today's systems. But after exhaustive research into the most efficient mining method for low seam coal, Cliffs Natural Resources decided to opt for an automated Bucyrus plow longwall as the safest, most cost-effective and most environmentally friendly way to extract coal from low seams (less than 1.8 m or 71 in.). Shearers can operate in seams of 1.5 to 6 m (59 in. to 236 in.), but are considered less than optimal in seams of less than 2.3 m (91 in.). Plows can operate in seam thicknesses down to 0.6 m (24 in.) and up to 2.3 m (91 in.).

Bucyrus automated plow systems are used worldwide in underground coal mining.

The reinvention of plowing

Bucyrus has reinvented the plowing technology by adding numerous new features – incremental (defined cut) plowing and horizon control – as well as boosting installed power to allow faster extraction. In contrast to a shearer, which requires considerable height to operate, the compact plow can operate in seams as low as 0.6 m (24 in.). This allows extraction of coal seams previously thought to be unworkable. For any seam under 1.8 m (71 in.), the plow is generally the better proposition. Also, the plow has no problems with coal flow that is in front of the plow – as opposed to the shearer, where the machine body at times needs to pass over the coal flow creating a restriction to material conveying capacity. But even more important, the shearer operator has to travel with the shearer through the face to control it.

In low seams, this presents challenges to the operators in terms of what they are physically able to accomplish during any given production shift.

Today, the Bucyrus automated plow systems represent a reliable and well-engineered cutting technology. With installed power of up to 2 x 800 kW (2 x 1,080 hp) and traveling at up to 3.6 m/s (720 ft/min.), Bucyrus plows extract coal at rates of up to 3.5 kt/h (3,858 stph).

Safety

In contrast to shearers, which always require an operators presence, automated plow longwalls do not require operators to be located in the production face, resulting in a much higher level of operator safety.

Incremental plowing (defined cut)

Conventional plows typically only allow the plow "pushing" pressure to be set – not the cutting depth – with the result that the cutting depth varies with coal hardness. Bucyrus incremental plowing, which is precisely controlled electronically, ensures that the plow cuts to an exactly defined depth, regardless of coal hardness, seam structure and presence of rock intrusions. This results in balanced loads on conveying equipment and a steady advance of the longwall through the seam.

The plow can negotiate seam undulations more easily than a shearer. This allows selective cutting of coal without adjacent strata, reducing wear and tear on equipment and cutting energy demand as well as coal preparation and mine waste disposal costs.

Seams often rise or fall both laterally and in the direction of advance. Bucyrus horizon control ensures that the plow does not dig or climb unless required by the seam geology. This control also allows mining of seams with a face or uphill panel inclination of up to 45° and a downhill panel inclination of 20°, as compared to 20° for all inclinations for a shearer.

Maximum utilization of coal reserves

With thick-seam coal reserves dwindling worldwide, it is important that thin- and medium-seam coal is not lost through sterilization caused by mining underlying thick seams first. Plows allow the overlying thinner coal seams to be mined first, ensuring that valuable coal is not buried forever. Plowing also offers higher recovery rates than room-and-pillar mining, as no pillars need to be left behind in order to support the roof. It also expands the magnitude of reserves by adding those that were previously considered not to be recoverable based on safety or economic reasons. ■

Bucyrus has reinvented the plowing technology by adding numerous new features – incremental (defined cut) plowing and horizon control – as well as boosting installed power to allow faster extraction.

New variable frequency drive introduced by Magnetek, Inc.

Magnetek, Inc., announced the introduction of its new M-Force 240/480/575 volt general purpose ac variable frequency drives for mining applications. This drive is designed for a variety of pumps, fans and conveyors in tough mining environments.

Its dual ratings, normal and heavy duty, enable the most economical match of overload capacity and starting torque for each application. Providing the right fit to power requirements is also easy with 208/240 and 480 volt ratings, built-in BUS choke above 22 kW (30 hp), 12-pulse capability above 22 kW (30 hp), common BUS capability and regeneration options. Magnetek's high slip braking eliminates the need for dynamic braking resistors for high inertia loads. Other features include motor auto-tuning and a range of configurable options, such as breakers and fuse.

The M-Force 240/480 Control is designed for mining and can handle conventional applications of a typical industrial plant, from simple variable torque pumping to sophisticated networked material handling.

The M-Force 575 Control produces an output of adjustable voltage and frequency to control the speed of a squirrel cage induction motor. This drive addresses the higher 575 Volt requirements of some mines. Its PWM design provides low motor noise and high starting torque. The drive provides three modes of control and speed accuracy to suit application requirements.

The M-Force is factory-programmed and ready to run. If the application requires programming, the M-Force makes it easy. Parameters are grouped in easy-to-use sets – quick start and advanced. To enhance parameter and data management, DriveWizard software is available for upload/download, trending and graphing.

To provide the optimum control method, the M-Force can operate in conventional V/f, V/f with encoder feedback, open loop vector, or closed loop vector mode. Drive performance can be further enhanced for a specific application with optional software. It supports the industry's open architecture, open connectivity demands with network communications choices such as DeviceNet, Profibus-DP, and others.

www.magnetekmining.com.

Joy Global adds Optidrive
to underground mining equipment

Few innovations in mining machinery technology have been as widely adopted and enthusiastically accepted as has Joy Mining Machinery's Optidrive ac variable frequency drive (VFD). In less than two decades, Optidrive grew from inception to being universally applied to Joy's underground mining equipment. Most recently, it has been included as an option on the company's Stamler products of feederbreakers.

Optidrive integrates the electrical and mechanical systems and each unique piece of software. Where the motors and drive in the optidrive system are designed for each other, Joy controls the technology to ensure a compatible system that maximizes use of both components, as opposed to using industrial off-the-shelf components modified for underground mining.



Joy feederbreakers can now be equipped with Joy's Optidrive system.

Optidrive equipped feederbreakers are available for underground and surface applications. Interest in VFD with underground feederbreakers is on the increase and, currently, about 60 percent of the units going into surface applications are so equipped. All Stamler feeder-breakers with electro-mechanical conveyors are capable of accepting VFDs.

Worldwide, more than 1,000 Stamler feeder-breakers are currently in use making Joy the market leader for feederbreakers in the U.S. and globally.

The origin of Optidrive dates back to 1992 when Joy adapted ac variable frequency drives to two existing continuous miners, with redesign and retrofitting following in 1996 and 1997, the same year when Joy installed a similar VFD on a longwall shearing machine. The same basic unit is in use today, upgraded along the way to improve and increase overall performance.

The major advantage of ac drives is that more power can be provided to drive a machine within the same space previously occupied by dc motors. Additionally, because ac motors are brushless, the time-consuming and maintenance expense of brush replacement associated with dc motors is eliminated, as is the possibility of contaminants entering the motor during replacement.

In 2001, the next generation VFD system was fitted to continuous miners and, two years later, to Joy's flexible conveyor train (FCT) continuous haulage system and shuttle cars. By 2004, Joy introduced Optidrive, the bringing together of the interchangeable hardware and the software unique to each machine under a single brand name.

The key to the effectiveness of the identical Optidrive hardware and machine-specific software is demonstrated in its application to Joy's flexible conveyor train. Optidrive matches the speed of the traction and belt systems between the outby and inby ends of the machine, enabling the operator to tailor the belt speed to match the production rate of the continuous miner. This helps reduce belt wear that, together with the system's soft-start capability, results in longer belt life and lower costs per ton of coal mined.

According to Joy, the Optidrive system programming controls the conveyor by two means. Either the conveyor speed can be varied manually through the VFD or the breaker motor amperage readings can slow the conveyor automatically to facilitate breaking of the material being conveyed to the discharge end of the unit. Prior to Optidrive, electro-mechanical conveyors were the only way this could be accomplished would be to physically install retarding chains or to change sprockets or electric motor RPM, neither of which is really feasible unless the change is to be permanent.

Optidrive allows an operator to control 25 to 100 percent of the feederbreakers rated conveyor throughput capacity, which is particularly important in handling hard materials. By slowing down the flow of material through the breaker, there is less impact and shock load on the breaker components, prolonging life and reducing maintenance. In one instance, in converting from an electro-mechanical conveyor machine to an Optidrive ac-VFD unit, an operator reported reducing the number of shear pin failures by more than 50 percent. ■

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Evaluation of the wet head continuous miner to reduce respirable dust

by J.M. Listak, G.V.R. Goodman, T.W. Beck

Abstract ■ The National Institute for Occupational Safety and Health (NIOSH) conducted field tests to evaluate the effectiveness of a wet head continuous mining machine for reducing dust exposure for continuous miner operators. Wet head technology delivers water via sprays to the continuous miner's cutter head as opposed to traditional standard sprays located on the boom and body of the mining machine. The sprays, positioned directly behind each bit on the cutterhead, deliver water at the point of attack, serving to cool the bits during mining to reduce the potential for frictional ignitions. The sprays also flood the coal with water to potentially suppress dust generation. Dust surveys were conducted at several mines to evaluate the wet head's effectiveness to control respirable dust exposure at the continuous miner operator location and in the immediate return. Results show that the wet head miner generally improved air quality at both sampling locations to varying degrees in some, but not all, mines when compared to a continuous miner with a standard spray system.

Introduction

Under the National Institute for Occupational Safety and Health (NIOSH)'s Coal Workers' X-Ray Surveillance Program, over 90,000 chest X-rays have been examined from underground coal workers from 1980 to 2008 to track and document the incidence of pneumoconiosis. From these X-rays it can be shown that, after years of decline, pneumoconiosis has been increasing among underground coal miners since 2000. There is also evidence in these X-rays to suggest that the recent increase in pneumoconiosis cases is associated with coal workers' exposure to excessive amounts of respirable crystalline silica (Laney et al., 2009). Many operations cut rock along with coal to create a more favorable working height for machinery and personnel. However, this rock is typically a source of silica, which often requires mines to be placed on a reduced dust standard lower than the current 2.0 mg/m^3 regulatory standard. Mine operations are placed on a reduced standard when the amount of silica on the dust filters exceeds 5% by weight. The dust standard is reduced using the expression, 10 divided by % silica (e.g., 10/10% silica equals a 1 mg/m^{3}reduced standard). The Mine Safety and Health Administration (MSHA) dust samples collected by inspectors from 2004 to 2008 show that 7.3% of the samples from the continuous miner operator exceed the permissible exposure limit (PEL) of 2.0 mg/m^3. However, when mines are placed on a reduced dust standard for silica content in respirable dust samples, nearly 20% of the inspector samples are exceeded (US Department of Labor, 2009).

Typically, respirable dust is controlled by water sprays mounted on the continuous miner (CM). This method has been an effective means of controlling respirable dust for CM operators for many years, but the increase in the incidence of overexposure suggests that the use of water sprays is no longer consistently providing protection to operators. As new methods of controlling face hazards are developed and adopted by the mining industry, their potential for controlling respirable dust will continue to be evaluated.

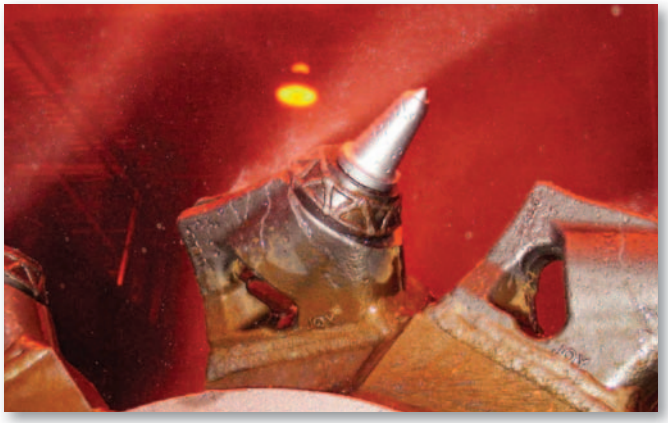
Typical mining machines place water sprays on the cutting boom approximately 30-40 cm (12-16 in.) away from cutting bits to protect the spray manifolds. The wet head continuous miner introduces water via sprays located directly behind each cutting bit on the cutting drum (Fig. 1a and b). The spray angle of the nozzles over the bits keeps the bits cool during the cutting process, increasing bit longevity and lessening the potential for frictional ignitions. In addition, these water sprays wet coal surfaces and have the potential to prevent airborne respirable dust generation by placing the water sprays as close as possible to the coal surfaces. It has been shown that the closer the water sprays are to the surface being cut, the more effective they become (Foster-Miller, Inc., 1986).

The wet head continuous miner introduces water in close proximity to the point of attack of each bit and, therefore, has the potential for limiting dust generation while mining. Wet head cutter technology was developed under a US Bureau of Mines contract in the 1970s (Kost et al., 1976). Although

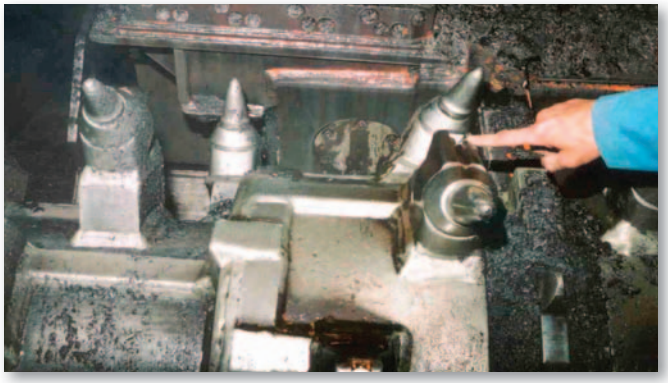
J.M. Listak, member SME, is a mining engineer, G.V.R. Goodman, member SME, is a team leader and T.W. Beck, member SME, is a general engineer at the National Institute for Occupational Safety and Health, Pittsburgh, PA. Paper number TP-09-065. Original manuscript submitted December 2009. Revised manuscript accepted for publication March 2009. Discussion of this peer-reviewed and approved paper is invited and must be submitted to SME Publications by December 2010.

Figure 1

a. Wet head bit block showing water spray behind the bit.



b. Wet head sprays on a continuous miner cutterhead.



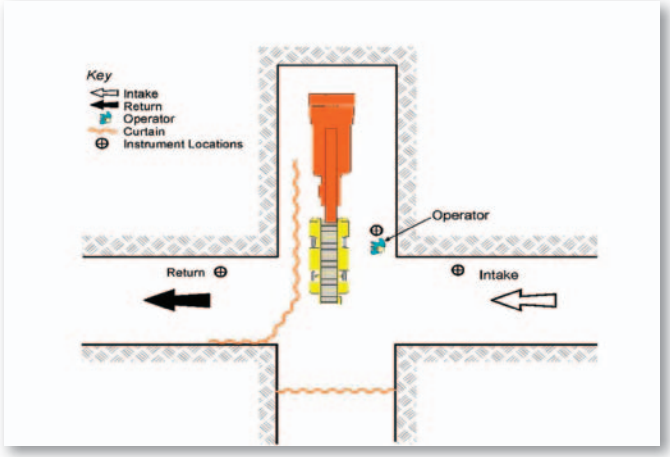
the first developed wet head continuous miners showed dust reduction potential (Strebig, 1975), the prototype units were plagued with maintenance problems. It was not until the mid-1990s that the first reliable units became commercially available. A South African study by Belle and Clapham (2002) showed 60 to 65% reductions in respirable dust at the continuous miner location. However, several US studies of wet head sprays versus standard machine-mounted sprays have either not shown or could not prove a significant difference in dust reduction from one system to the other (Chugh et al., 2006; Goodman et al., 2006; Fields et al., 2005). In an attempt to clarify the effectiveness of the wet head miner to limit coal and silica dust exposure of the CM operator and downwind personnel, NIOSH conducted five in-mine dust studies to measure respirable dust levels at the CM operator location and in the immediate return.

Mine site investigations

These studies took place in five mines located in four states: Virginia, West Virginia, Kentucky and Illinois. The five mines will be identified by letters A through E to ensure anonymity of the mines that cooperated for this study. In three of the mines, sampling took place on the same continuous miner, configured with either a wet head spray system or a regular system of boom sprays. When running the wet head, for example, most of the boom sprays were plugged and a valve thrown to send water to the wet head sprays. Two studies took place on a "super section" that utilized two CM machines, one with standard boom sprays and one with a wet head. Dust samples were taken concurrently; as each miner unit was ventilated with its own air split. Of the five mines, three used blowing ventilation schemes and two had

Figure 2

Sampling package locations for a typical cut on an exhausting ventilation scheme.



exhausting ventilation. All but one mine took extended cuts and all but one used a scrubber. The mine that did not take extended cuts used exhausting ventilation with a system of directional sprays called a sprayfan. No scrubber was used at this operation.

When possible, the ventilation and dust control plans were reviewed. Air velocity readings were taken before each cut and production was recorded at the end of the shift. Spray pressure, spray type and number of sprays were noted on both standard and wet head spray systems.

Test design

The sampling strategy for these studies consisted of both area and personal sampling to evaluate the different spray systems' affect on respirable dust levels at the miner operator location and in the immediate return of each cut (Fig. 2). These samples were not collected for a full shift and, therefore, the results cannot be correlated to compliance sampling.

For area sampling, dust sampling packages were hung in the immediate intake and return of the individual continuous miner cuts. Dust generated in the cut and in the return can be directly related to the mining of that particular cut, by subtracting the intake dust measurement from that at the operator and return. The sampling packages were repositioned at the start of each new cut (place change).

For personal sampling of dust exposure at the operator location, the CM operator wore a personal dust monitor (PDM). The PDM provided data that allows for time periods to be extracted during the shift to calculate dust concentrations for individual cuts during the shift. The PDM data was downloaded at the end of the shift, then reset for the next sampling day.

Area sampling packages for the sections consisted of two gravimetric samplers and a personal data RAM (pDR) (Thermo-Fisher) hung in the immediate intake and return entries. Gravimetric samplers use a cyclone, filter and vacuum pump to collect respirable dust particles. The permissible sampling pumps were calibrated at 2 L/min before the study. These pumps draw dust-laden air through 10-mm (0.4-in.) nylon cyclones to deposit the respirable dust fraction onto preweighed 37-mm PVC filters. All filters were pre- and postweighed at the Pittsburgh Research Laboratory and respirable dust concentrations calculated for the total shift dust concentration. The filters were then sent to a third party laboratory to determine the silica content of the dust. The

MSHA P-7 method was used to measure the silica content in the samples.

The pDRs measure respirable dust particles by light scattering techniques and provide a relative dust concentration. However, the pDRs sample every 10 seconds and give a real-time reading of the relative dust concentrations over the entire shift. The pDRs are used in conjunction with the gravimetric samplers to monitor dust levels instantaneously. The instantaneous readings can account for variations in dust levels during mining that the gravimetric samplers cannot provide. NIOSH researchers conducted time studies during the mining operations in order to relate gravimetric and pDR data to the operations at that particular time. The calculated concentrations from the gravimetric samplers are compared to the associated total shift pDR concentration. The pDR total shift dust concentration is a relative measurement (based on a calibration dust) and will vary from the true measured dust concentration given by the gravimetric samplers. To correct for this difference, the total pDR dust concentration measurements are adjusted based on the total gravimetric concentration. The adjustment factor is determined by dividing the concentrations from the gravimetric samplers by the pDR total average concentration. After the adjustments are made, the adjustment factors can then be applied to the instantaneous readings from the pDRs to determine the true concentrations during individual time periods (e.g., time in cut). Figures 3a and 3b show the samplers used for the dust surveys.

Dust survey data

Dust measurements from each of the mines were analyzed at the machine operator location and in the immediate return to determine dust levels of each spray system at each location. Ultimately, the miner operator location is the where the protection is most important. However, dust levels at this location can be affected by many variables. Therefore, measurements in the return were necessary to determine whether one system was more effective than the other. All of the intake air and dust generated during mining must go into the return and therefore the return measurements were used to compare the two spray systems over all the mines surveyed. The other variable that directly affects dust generation is production. For all surveys, the dust levels were normalized for production.

Table 1 shows the specific parameters for each machine at operation A through E. Mining heights were fairly consistent between operations. However, each operation mined roof rock for added clearance for equipment and personnel. Roof rock thicknesses varied from negligible to nearly 1 m (3.3 ft). NIOSH researchers noted little variation in scrubber capacities between studies.

Thirty-two shifts were sampled over the course of the study, accounting for a total of 156 production cuts. The individual cuts were compared within each mine to determine the consistency of collected data. The many confounding variables within a single mine setting are difficult to limit; therefore, comparing individual cuts from mine to mine was not deemed significant and will not be presented. Dust concentrations measured during standard boom spray system operation were compared to those obtained during wet head spray operation at the miner operator and return airway sampling locations.

Figure 3

a. Gravimetric/pDR samplers used for area samples.



b. Personal dust monitor used for personal samples.



Table 2 shows the combined shifts for all mines surveyed. The table is segregated by mine designation and shows the shifts surveyed at each, according to the type of spray system and the operator and return locations. The table shows the range of dust levels measured at each location for each spray system. Within-mine concentrations were consistent for both spray systems at each location. However, Mine E showed much higher return concentrations, due to the lack of a scrubber on the continuous miner. Mines A through D utilized scrubbers. As seen in the table, on most of the shifts, there were reduced concentrations on both operator and return locations using the wet head. However, most improvements were small and some shifts showed the wet head concentrations higher. Mine C showed poor performance at the operator location when using the wet head system. This super section operation used a standard spray miner on one side and a wet head miner on the other. Blowing ventilation was used on both sides of the section. However, the miner operator on the wet head machine maintained a large curtain setback distance, claiming that dust conditions were improved by this action. This practice kept him out of the mouth of the curtain and, as can be seen by the dust concentrations, exposed to higher levels of dust than the operator on the standard spray section.

To further illustrate the results, dust concentrations were

Table 1

Operating parameters for study mines.

Mine designation		A	B	C	D	E
Average mining height (m)		1.8	2.0	2.1	1.7	1.8
Average rock thickness cut (m)		0.4	<1.0[1]	0	0.2	0.3
Scrubber capacity (m^3/s)		3.1	3.4	3.2	3.2	[2]See note
Wet head operation	No. of wet head sprays	63	73	73	73	76
	Avg. wet head pressure (kPa)	621	550	620	660	620
	Avg. tonnage (t)	610	620	1590	1347	930
Standard spray operation	No. of boom sprays	25	27	36	36	15
	Avg. boom spray pressure (kPa)	1030	1160	620	690	760
	Ave. tonnage (t)	680	500	1400	1239	930

Notes: [1]Rock thickness ranged from 0.1 to nearly 1 m (0.33 to 3.3 ft) during sampling.
[2]Continuous miner at Mine E did not use scrubber; but used 15 directional sprayfan sprays on cutting boom.

Table 2

Gravimetric and PDM dust concentrations from all mines participating in the study.

		Operator		Return	
	Shifts	Standard	Wet head	Standard	Wet head
Mine A: Scrubber, blowing ventilation, super section	1	0.79	0.31	2.89	1.69
	2	n/s	n/s	4.66	1.14
	3	0.79	0.39	3.96	2.22
	4	0.65	0.89	2.88	2.37
Mine B: Scrubber, exhausting ventilation, same continuous miner	1	3.17	2.03	2.47	6.86
	2	2.68	1.76	4.84	1.57
	3	2.21	1.47	2.40	1.89
	4	3.12	2.31	3.96	3.66
	5	2.72	5.92	2.90	4.28
Mine C: Scrubber, blowing ventilation, super section	1	0.33	1.31	1.00	1.02
	2	0.74	2.42	1.80	1.37
	3	0.39	1.83	1.04	1.20
Mine D: Scrubber, blowing ventilation, same continuous miner	1	1.24	0.45	1.92	1.32
	2	1.40	0.91	1.06	0.95
Mine E: No scrubber, exhausting ventilation, same continuous miner	1	0.95	0.83	12.62	7.22
	2	1.55	1.51	11.74	10.53

Note: n/s = not sampled

averaged from each shift for each of the mines surveyed. Figure 4 shows the dust levels of each spray system in the return. The chart shows that of the five mines sampled, Mines A and E show reductions of 33% and 27%, respectively, in the return when the wet head sprays are used, but little or no improvement at the other mines. Figure 5 shows the dust levels at the operator location. It is obvious that Mine C showed elevated dust levels at the operator, but, as noted, this condition was due to the curtain setback during sampling. Mine D showed an improvement of 48% at the operator when the wet head was used.

Respirable silica levels, in the form of quartz dust, varied between the wet head and standard spray machines at Mine A (Table 3). On the wet head, measurable levels were not detected on the operator sample and only low quartz levels were present on the return samples. With the standard spray system, quartz levels were higher at the operator and return sampling locations. At Mine B, much higher quartz levels were present in the operator and return samples. This was likely due to the significant amount of rock being cut during operation of the wet head and standard sprays. Again, higher respirable quartz levels were measured on the standard spray machine. This trend continued to be seen, to a lesser degree, in Mines C and D. At Mine E, the higher quartz measurement occurred on the wet head sprays.

Summary

There are mixed results from the study as to the effectiveness of the wet head spray system to reduce respirable dust. The dust data reveals that some mines show improvements, some do not. Respirable silica levels were less on the wet head miners in all but Mine E. However, all of the mines, other than Mine E, used scrubbers.

Over the course of surveying the mine, some observations were made that may have affected the results. At the onset of the study, super sections were preferred, because both spray systems could be monitored during the same shift in the same section with the assumption that variables such as production and air quantities would be similar between each CM unit on the section. These assumptions were correct for these operations. However, it

became apparent that other factors influenced dust measurements between the two sections. For example, the CM's scrubber flow and efficiency were not the same, mine conditions differed between and within mines and the CM operators' mining habits were different, as was evident by the curtain setbacks at Mine C. It appears that the operators' habits (position, curtain settings, etc.) influenced dust measurements at the operator location. The data can be normalized for some but not all variables. In addition, the scrubbers are very efficient dust eliminators and could influence the dust concentration in the return. Four of the five mines (A, B, C and D) used scrubbers. In addition, three of these mines used blowing ventilation. On a properly maintained blowing ventilation system, an argument can be made that the operator should be in fresh air all the time and, therefore, would not be subjected to dust exposure no matter what control technology is being used for dust control.

Mine E did not use a scrubber, was not a super section and used exhausting ventilation. The same CM unit was used for each spray system. These were the most favorable parameters for consistent dust measurements. Other than Mine A, Mine E was the only mine that showed reduction of respirable dust in the return entry when comparing the two spray systems. However, silica levels were higher.

From visual observations and interviews with mine personnel, there were very favorable responses to wet head use at the face. All operators found that the wet head system greatly increased visibility while mining. Also, the dust cloud created at the miner's boom while loading shuttle cars was eliminated with the wet head system. This cloud often infiltrates the cab area of the shuttle car operators during loading. The increased visibility may be attributed to the close proximity of the sprays to the face, thus decreasing misting over the cutterhead or the wet head sprays may be eliminating some of the nonrespirable (visible) dust fraction. ■

Figure 4

Dust measurements in the return for all mines surveyed.

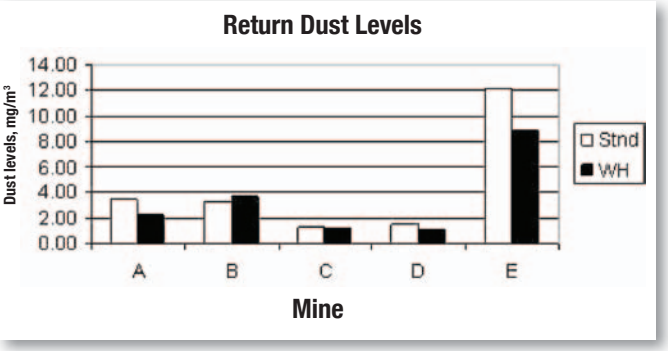


Figure 5

Dust measurements at the CM operator for all mines surveyed.

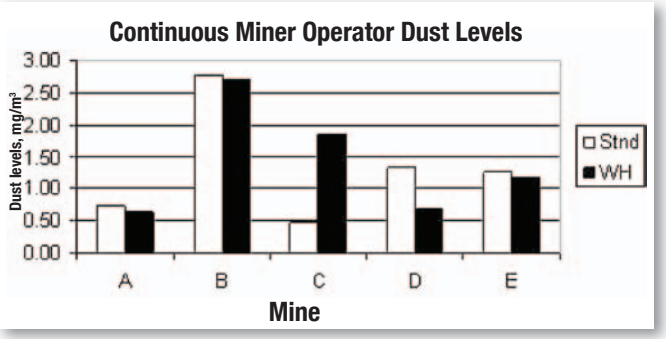


Table 3

Average respirable quartz levels, µg/m³.

Mine ID	Wet head sprays operating		Standard sprays operating	
	Operator	Return	Operator	Return
A	ND	27	70	143
B	311	359	356	413
C	n/s	0	n/s	29
D	35	21	34	29
E	n/s	742	n/s	694

Notes: ND = not detected; n/s = not sampled

References

Belle, B. K., and Clapham, S., 2002, "An improved wet head system: prevention of incentive ignitions and dust control," E. DeSouza (ed.), *Proceedings, 9th US Mine Ventilation Symposium*, Kingston, ON, pp. 479-486.

Chugh, Y. P., Patwardhan, A., Gurley, H., Moharana, A., and Saha, R., 2006, "A field demonstration of the Joy wet head miner technology," Eds. Mutmansky J. M. and Ramani, R. V., *Proc. 11th U.S./North American Mine Ventilation Symposium*, The Pennsylvania State University, University Park, PA, pp. 233-240.

Fields, K. G., Schultz, M. J., Rude, R. L., Tomko, D. M., Atchison, D. J., and Gerbec, E. J., 2005, *Respirable Dust Survey Conducted at the Big Ridge Inc., Willow Lake Portal (Mine ID No. 11-03054), Saline County, Illinois,* US Dept of Labor, Mine Safety and Health Administration, Pittsburgh Safety and Health Technology Center, Dust Division, obtained from Mark Schultz.

Foster-Miller, Inc., 1986, *Development of Optimal Water Spray Systems for Ventilation of Coal Mine Working Faces*, Contract Report No. J0113010, U.S. Bureau of Mines, 292 pp.

Goodman, G.V.R., Beck T.W., Pollock, D.E., Colinet, J.F., and Organiscak, J.A., 2006, "Emerging technologies control respirable dust exposures for continuous mining and roof bolting personnel," Eds. Mutmansky, J. M., and Ramani, R. V., *Proceedings of 11th U.S./North American Mine Ventilation Symposium*, The Pennsylvania State University, University Park, PA, pp. 211-216.

Kost, J. A., Du Breuil, F., and Saltsman, D., 1976, *Design, Development, and Demonstration of a Technique to Water-Flush the Bits on a Fixed Drum Continuous Mining Machine*, Final Report H0210050, US Bureau of Mines, Open File Report: 105-76.

Laney, A. S., Petsonk, E.L., and Attfield, M.D., 2009, "Pneumoconiosis among underground bituminous coal miners in the United States: is silicosis becoming more frequent?" *Occup. Environ. Med.* (http://oem.bmj.com/content/early/2009/09/22/oem.2009.047126.long).

Strebig, K.C., 1975, "'Wet head' tests on miners concluded," *Coal Mining and Processing*, Vol. 12, No. 4, pp.78-80, 88.

US Department of Labor, 2009, *Mine Safety and Health Administration, Program Evaluation and Information Resources*, MSHA Standardized Information System, Arlington, VA.

Solution mining
mass balance calculations

by J. S. McEwan and M. Ramey

Abstract ■ This paper describes the derivation of a set of simultaneous algebraic equations that can be solved to produce a rigorous theoretical mass balance around solution mining wells. This mass balance can then be compared with a mass balance calculated from field measurements to provide the percentage of mass balance closure. Significant deviations from the closure can be an indication that the wells are either gaining or losing circulation fluids. The equations also provide calculations for the amount of water and dissolved mineral that accumulates in the well during the mining process, as well as the net mining rate. Equations for both single mineral mining and multiple mineral mining are discussed. They can easily be formatted into spread sheets for rapid calculation of field measurement data.

Introduction

For production efficiency calculations and environmental compliance, the solution mining of minerals using hot water as the solvent requires a determination of the overall mineral mining rate and the amount of solvent water and dissolved mineral that stays in the mine well caverns as the mineral is mined. This remaining water solution is typically referred to as "accumulation water." However, to establish the accumulation water rate requires knowing the mining rate, which is in turn a function of the amount of accumulation of water. This seeming conundrum can be solved by the derivation of a system of simultaneous algebraic equations.

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Paper number TP-09-055. Original manuscript submitted November 2009. Revised manuscript accepted for publication March 2010. Discussion of this peer-reviewed and approved paper is invited and must be submitted to SME Publications by December 2010.

Equation derivation

Described below is the development of a system of simultaneous equations to solve for these two variables and also to produce a theoretical mass balance around a solution mining well. This theoretical mass balance can then be compared with the mass balance as measured by instrumentation to establish the percent closure. Closure rates within 5 to 10% can be required by governmental regulatory agencies to maintain solution mining operation. Closure rates exceeding these values can be an indication of well failure due to underground leaking from the well and possible ground water contamination.

To begin, we can establish the following known inlet and outlet variables using instrumentation or periodic laboratory measurements as follows:

Well inlet

M_1 = mass flow rate, kg/h or lbs/min, for example.
V_1 = volume flow rate, m^3/h or gal/min, for example.
ρ_1 = density, kg/m^3 or lbs/ft^3, for example.
C_1 = product mineral concentration, wt%/100 (note: this is usually zero when there is no mining solvent recycle).

Well outlet

ρ_2 = density, kg/m^3 or lbs/ft^3, for example.
C_2 = product mineral concentration, wt%/100.

Unknown variables required to establish a theoretical mass balance are:

M_2 = mass flow rate, kg/h or lbs/min, for example.
V_2 = theoretical outlet flow rate, m^3/h or gal/min, for example.
Z = product mining rate, kg/h or lbs/min, for example.

As the solid mineral being mined goes into solution in the well, the volume left by the mineral is replaced by the accumulation water. The amount of accumulation corresponds to the mining rate as follows:

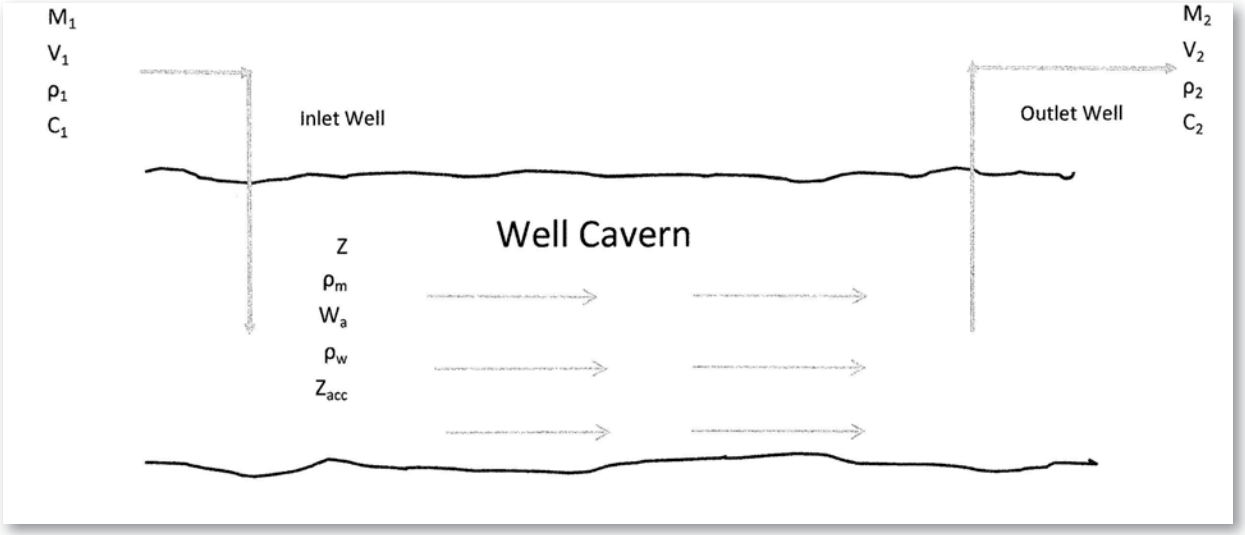
$$W_a = (Z/\rho_m)\rho_w \quad (1)$$

where W_a is the accumulation water mass and has units of kg/h or lbs/min, for example, ρ_m is the density of solid mineral being mined, and ρ_w is the density of the accumulation water.

The described variables and their physical relationship in a typical solution mining operation can be seen in Fig. 1.

Figure 1

Solution mining system.



A total mass balance can be written around a solution mining well as follows:

(mass out) = (mass in) + (mass mined) – (accumulation water mass)

or,

$$M_2 = M_1 + Z - (Z/\rho_m)\,\rho_w \qquad (2)$$

The product mineral mass balance around the well gives

$$C_2M_2 = C_1M_1 + Z - C_2\,(Z/\rho_m)\,\rho_w \qquad (3)$$

Here, it has been assumed that the mineral concentration in the accumulated water is the same as the mineral concentration in the well outlet stream C_2. Note also that Eq.(3) assumes that only one mineral is being mined. Equation modifications for multiple mined minerals that form a single well cavern will be discussed later.

Mass flow rates can be written in terms of volumetric flow rates as follows:

$$M_1 = V_1\rho_1 \qquad (4)$$

$$M_2 = V_2\rho_2 \qquad (5)$$

Substitution of Eqs. (4) and (5) into Eqs. (2) and (3) gives

$$V_2\rho_2 = V_1\rho_1 + Z - (Z/\rho_m)\,\rho_w \qquad (6)$$

$$C_2V_2\rho_2 = C_1V_1\rho_1 + Z - C_2(Z/\rho_m)\rho_w \qquad (7)$$

Solving Eq.(6) for V_2 gives

$$V_2 = [V_1\rho_1 + Z - (Z/\rho_m)\rho_w]/\rho_2 \qquad (8)$$

Substituting Eq.(8) for V_2 in Eq.(7) gives

$$C_2\{[V_1\rho_1 + Z - (Z/\rho_m)\rho_w]/\rho_2\}\rho_2 = C_1V_1\rho_1 + Z - C_2(Z/\rho_m)\rho_w \qquad (9)$$

Equation (9) can be solved for the mining rate Z in terms of inlet and outlet mineral concentrations as follows:

$$C_2V_1\rho_1 + C_2Z - C_2(Z/\rho_m)\rho_w = C_1V_1\rho_1 + Z - C_2(Z/\rho_m)\rho_w$$

$$C_2V_1\rho_1 + C_2Z = C_1V_1\rho_1 + Z$$

$$(C_2 - 1)Z = C_1V_1\rho_1 - C_2V_1\rho_1$$

$$(C_2 - 1)Z = (C_1 - C_2)V_1\rho_1$$

$$Z = [(C_1 - C_2)/(C_2 - 1)]V_1\rho_1$$

or,

$$Z = [(C_1 - C_2)/(C_2 - 1)]M_1 \qquad (10)$$

Equation (10) gives the mining rate based on the inlet and outlet mineral concentrations and the inlet volumetric flow rate, or the inlet mass flow rate.

The theoretical outlet flow rate can be found by substituting Eq.(10) into Eq.(8) and solving for V_2 as follows:

$$V_2 = [V_1\rho_1 + V_1\rho_1(C_1 - C2)/(C_2 - 1) - (V_1\rho_1(C_1 - C_2)/(C_2 - 1)\rho_m)\rho_w]/\rho_2$$

$$V_2 = V_1\rho_1/\rho_2[1 + (C_1 - C_2)/(C_2 - 1) - (C_1 - C_2)/(C_2 - 1)\rho_w/\rho_m] \qquad (11)$$

A simplifying assumption that can be made at this point is that the density of the accumulation water left in the well ρ_w is essentially equal to the well outlet density ρ_2. Note that it could also be assumed that ρ_w is equivalent to the well inlet density ρ_1, but it has been found during actual operations that accumulation water density is actually closer to the outlet density. With the assumption that ρ_w equals ρ_2, Eq. (10) can then be written as

$$V_2 = V_1\rho_1/\rho_2\,[1 + (C_1 - C_2)/\,(C_2 - 1) - (C_1 - C_2)/\,(C_2 - 1)\,\rho_2/\rho_m]$$

Rearrangement gives

$$V_2 = V_1\rho_1/\rho_2\{1 + [(C_1 - C_2)/(C_2 - 1)(1 - \rho_2/\rho_m)]\} \quad (12)$$

Equation (12) gives the theoretical outlet flow rate in terms of the inlet flow rate and the inlet and outlet mineral concentrations. Because the density terms are grouped as ratios, specific gravities can be substituted for densities.

The net mining rate, defined as the mineral mass leaving the well minus the mass going in, can be calculated from Eq. (13).

$$Z_{net} = C_2V_2\rho_2 - C_1V_1\rho_1 \quad (13)$$

The rate at which mined mineral is accumulating in the well is the difference between the mining rate and the net mining rate.

$$Z_{acc} = Z - Z_{net} \quad (14)$$

Multiple mineral mining

The equations derived above apply for solution mining of a single mineral, which is the case for most solution mining operations. An example of an important exception is the solution mining of sylvinite for the production of potash (KCl). Since sylvinite is a varying mixture of KCl and halite salt (NaCl), salt is also mined in substantial amounts when solution mining for potash. The total amount of mineral mined (Z) is the summation of the KCl and NaCl amounts mined. This can be written in the general form as:

$$Z = \sum_{i=1}^{n} Z_i \quad (15)$$

A mass balance equation for each mineral can be written around the well, similar to Eq. (3), as follows:

$$C_{2i}M_2 = C_{1i}M_1 + Z_i - C_{2i}\,(Z/\rho_m)\rho_w \quad (16)$$

Here ρ_m has been taken as the weighted average density of the individual soluble mineral densities (ρ_{mi}) present in the ore.

Rearrangement and substitution similar to the development of the single mining equations results in:

$$Z_i = C_{2i}Z - V_1\rho_1(C_{1i} - C_{2i}) \quad (17)$$

$$V_2 = [V_1\rho_1 + Z - (Z/\rho_m)\rho_w)]/\rho_2 \quad (18)$$

$$Z_{net\,i} = C_{2i}V_2\rho_2 - C_{1i}V_1\rho_1 \quad (19)$$

$$Z_{acc\,i} = Z_i - Z_{net\,i} \quad (20)$$

Equations (15) and (17) can be solved by a trial-and-error procedure as follows:

Step 1: Assume Z.
Step 2: Calculate each Z_i using Eq. (17).
Step 3: Calculate Z from Eq. (15).
Step 4: Repeat steps 1 through 3 until the desired maximum error is reached.

Once Z is known, other values can be calculated using Eqs. (18) through (20).

Note that Eqs. (15) and (20) can also be used to determine the amount of trace minerals being mined, if the inlet and outlet well concentrations are measured.

Although the equations derived above have assumed a single well, they can also be applied to an entire wellfield if the same properties for the total injection stream and production stream are known (see Example 2).

Example 1 – single mineral mining

Solution mining of nahcolite ($NaHCO_3$) at a well inlet flow rate of 100 gpm, equivalent to 22.7 m^3/h (13.37 ft^3/min), containing 3 wt% of recycled $NaHCO_3$, produces an outlet concentration of 20 wt% $NaHCO_3$. The inlet temperature is 204° C (400° F) with a density of 872.36 kg/m^3 (54.46 lbs/ft^3). The outlet density is 1,082.68 kg/m^3 (67.59 lbs/ft^3). Solid nahcolite has a specific gravity of 2.2, which is equivalent to a density of 2,199.3 kg/m^3 (137.3 lbs/ft^3). The measured outlet flow rate is 82.5 gpm, equivalent to 18.7 m^3/h (11.0 ft^3/min). The government regulating authority requires a mass balance closure of within 10% to meet the well nonfailure criteria.

From Eq. (10), the mining rate is

$$Z = (22.7\ m^3/h)/\ (60\ min/h) \times 872.36\ kg/m^3 \times (0.03 - 0.20)/\ (0.20 - 1)$$
$$Z = 70.17\ kg/min\ (154.7\ lbs/min)\ of\ nahcolite$$

From Eq. (12), the theoretical outlet flow rate is calculated as follows:

$$V_2 = 22.7\ m^3/h \times 872.36/1{,}082.68 \times \{1 + [(0.03 - 0.20)/\ (0.20 - 1)\ (1\text{-}1{,}082.68/\ 2{,}199.3)]\}$$
$$V_2 = 20.3\ m^3/h = 89.3\ gpm\ (11.93\ ft^3/min)$$

Since the measured flow rate of 82.5 gpm is within 90% of the theoretical value of 89.3 gpm, the well mass balance meets the agency criteria and the well is not considered to be in a failure mode.

From Eq. (13), the net mining rate is

$$Z_{net} = (0.20 \times 20.3\ m^3/h\ \times 1{,}082.68\ kg/m^3 - 0.03 \times 22.7\ m^3/h \times 872.36\ kg/m^3)/\ (60\ min/hr)$$
$$Z_{net} = 63.2\ kg/min\ (139.4\ lbs/min)\ of\ nahcolite$$

From Eq. (14), the rate at which mined mineral is being accumulated in the well as dissolved solution is

$$Z_{acc} = 70.17\ kg/min - 63.2\ kg/min$$
$$Z_{acc} = 6.9\ kg/min\ (15.3\ lbs/min)\ of\ nahcolite$$

The amount of pure water being accumulated in the well equals 6.9 kg/min × 0.8/0.2
= 27.8 kg/min (61.2 lbs/min)

Example 2 – multiple mineral mining

Solution mining of sylvinite with a total wellfield inlet

flow rate of 2,000 m^3/h (70,629 ft^3/h)feeding 20 wells produces the following concentrations in the total wellfield outlet flow:

KCl:	12 wt%
NaCl:	20 wt%
$MgCl_2$:	2 wt% (trace mineral)
H_2O:	66 wt%

Assuming, for this example, the absence of solution recycle, the inlet concentration for each of the above minerals is zero. The inlet and outlet specific gravities are 0.98 and 1.25, respectively. The sylvinite ore has a weighted average specific gravity of 2.0. The measured total wellfield outlet flow is 1,590 m^3/h (56,150 ft^3/h).

From Eq. (17), the mineral mining rate calculations are:

$$Z_i = C_{2i}Z - V_1\rho_1(C_{1i} - C_{2i})$$

$$Z_{KCl} = 0.12 \times Z - 2{,}000 \times 0.98 \times 10^3 \times (0.0 - 0.12)$$

$$Z_{NaCl} = 0.20 \times Z - 2{,}000 \times 0.98 \times 10^3 \times (0.0 - 0.20)$$

$$Z_{MgCl2} = 0.02 \times Z - 2{,}000 \times 0.98 \times 10^3 \times (0.0 - 0.02)$$

From Eq. (15), the total mining rate is:

$$Z = Z_{KCl} + Z_{NaCl} + Z_{MgCl2}$$

Using Microsoft Excel's "Solver" function to solve the above equations by trial and error produces

Z	=	1,009,697 kg/h
Z_{KCl}	=	356,364 kg/h
Z_{NaCl}	=	593,940 kg/h
Z_{MgCl2}	=	59,394 kg/h

From Eq. (18) the mass balance outlet flow rate is calculated as

$$V_2 = (2{,}000\ m^3/h \times 0.98 \times 10^3 + 1{,}009{,}697\ kg/h - 1{,}009{,}697\ kg/h/2.0 \times 1.25)/(1.25 \times 10^3)$$

$$V_2 = 1{,}871\ m^3/h\ (66{,}073\ ft^3/h)$$

Since the mass balance flow rate of 1,871 m^3/h (66,073 ft^3/h)is 85% of the measured rate of 1,590 m^3/h (56,150 ft^3/h), the wellfield can be considered to be not in balance, and leakage from the wells may be occurring.

From Eq. (19), the net mining rate for each mineral can be found as follows:

$$Z_{net\ KCl} = 0.12 \times 1{,}871\ m^3/h \times 1.25 \times 10^3 - 0.0 \times 2{,}000\ m^3/h \times 0.98 \times 10^3$$

$$Z_{net\ KCl} = 280{,}650\ kg/h$$

Similarly,

$$Z_{net\ NaCl} = 467{,}750\ kg/h$$

$$Z_{net\ MgCl2} = 46{,}775\ kg/h$$

From Eq. (20), the mineral accumulation in the wellfield as dissolved solution is

$$Z_{acc\ KCl} = 356{,}364\ kg/h - 280{,}650\ kg/h = 75{,}714\ kg/h$$

$$Z_{acc\ NaCl} = 593{,}940\ kg/h - 467{,}750\ kg/h = 126{,}190\ kg/h$$

$$Z_{acc\ MgCl2} = 59{,}394\ kg/h - 46{,}775\ kg/h = 12{,}619\ kg/h$$

Total mineral accumulation = 75,714 kg/h + 126,190 kg/h + 12,619 kg/h = 214,523 kg/h.

Pure water is accumulating in the wellfield at the rate of

$$214{,}523 \times 0.66/0.34 = 416{,}427\ kg/h\ H_2O$$

Conclusions

This paper has described the derivation and calculation of a system of equations that can be used to monitor the performance of an existing solution mining operation. Environmental considerations, as well as mining efficiency, can be determined. In addition, the equations can be used during the design of a new solution mining process to solve mass balance calculations and establish flow rates and mine water requirements. ■

SME seeks nominations for Distinguished Members

The SME Distinguished Member award was initiated in 1975. It honors those members who achieve distinction worthy of special recognition by SME. No more than four Distinguished Members may be elected each year, excluding the automatic election of the SME past president.

Nominations must be made by Dec. 1 of each year. The Distinguished Member Award Nominating Committee meets during the SME Annual Meeting to select up to four nominees, and the SME Board of Directors formally approves the awards. The biographies and photos of the chosen Distinguished Members are published in *Mining Engineering* and the awards are presented at the following SME Annual Meeting. A nomination is active for three years.

Eligibility requirements

A candidate for Distinguished Member must have been a full-member of SME for at least 15 years. A candidate must have demonstrated significant and sustained contributions to the minerals industry and to SME. There must be some contributions to both the industry and SME, though significant and sustained contributions can be to either one.

Outstanding service to SME may be to a section, a region, a technical division, committees or as a representative of SME and the industry to the public. Outstanding contributions to the industry may be as a leader in exploration, production, manufacturing, environment, basic sciences, engineering applications, education, management or public relations. This may be evidenced by patents, technical papers, educational activities or managerial contributions.

Other contributions may be in the development of exploration techniques, mineral properties, mineral processes, major engineering projects, mineral-related equipment and environmental solutions.

Members receiving this award must attend the annual meeting to accept the honor at the SME dinner.

Candidates may be nominated by any two SME Distinguished Members (each knowing the member under different circumstances), any two local section executives (must include a chair or past chair) or five members of SME.

Nomination procedure

All nominations for the Distinguished Member class of 2012 must be received by SME by Dec. 1, 2010. The nomination form for a Distinguished Member must include the following information: nominee's full name, biography and a concise statement that demonstrates the nominee's sustained contributions to SME and to the minerals industry. List examples such as patents, technical papers, educational activities and managerial contributions.

Only printed nomination forms will be accepted. And nominations should not exceed four printed pages. A paper or electronic version of the nomination form may be obtained from the Member Services Department, SME, 8307 Shaffer Pkwy., Littleton, CO 80127, phone 800-763-3132 or 303-948-4208, e-mail baxter@smenet.org. ■

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SME announces a

Membership challenge for student chapters

Attention all SME student chapter faculty sponsors and officers — the SME Membership Challenge of 2010 is about to begin.

The SME Membership Challenge is a recruitment contest among SME student chapters intended to challenge students to recruit new chapter and SME members. The Membership Challenge will run from Sept. 1, 2010 through Oct. 15, 2010. The winning student chapters will be recognized with a monetary award, will be mentioned in an article in *Mining Engineering* magazine and an will have an honorable mention at the SME Foundation Dinner at the 2011 SME Annual Meeting in Denver, CO.

The SME Young Leaders Committee, which is comprised of young professionals throughout the minerals industries, will travel to universities to assist in these important recruiting efforts.

Membership Challenge details

Questions — If you have questions regarding the SME Student Chapter Membership Challenge, contact Mona Vandervoort by phone at 303-948-4227 or by e-mail at vandervoort@smenet.org.

Cash awards — The prizes to be given are: $300 for the most new members recruited, $200 for the second most new members recruited and $100 for the third most new members recruited. A grand prize of $400 will be awarded to the SME student chapter with the highest total renewals and new members signed up during the Sept. 1, 2010 through Oct. 15, 2010 period.

Any student chapter that recruits more than 25 new members will be awarded a bonus of $250 for its efforts.

Rules and procedures

The winning SME student chapter will be determined by the percentage increase in membership for each chapter. The application process takes up to two weeks, so students should be encouraged to apply early. It is also important that students complete the membership application completely and correctly. Only new member recruits will count toward the chapter growth.

A chapter must have 10 active members and recruit 10 new members to be eligible for the Membership Challenge competition, but a chapter cannot win in more than one category. The SME student chapter can submit the applications to SME each week of the competition and payments must be submitted with applications. Applications and payments received after Oct. 15, 2010 will not be eligible for the contest. ■

Peng Ground Control in Mining scholarship issues a call for applications

The primary objective of the new Syd S. Peng scholarship is to promote the science of ground control. Recent trends in mining engineering education indicate a possible shortage of competent ground control engineers. To remedy this situation, undergraduate or graduate scholarships will be awarded annually to encourage the development of ground control engineers and promote the ground control engineering discipline. View the complete guidelines and submit an application online at: http://www.smenet.org/scholarships. All applications are due by Oct. 25, 2010. If you have any questions, please call Membership Services at 303-948-4208 or e-mail baxter@smenet.org. ■

Personal News

Metso has appointed **SCOTT SNYDER** as product manager, vibrating product line North America, based in Metso's York, PA office. He will introduce new global product lines to the North American construction and mining markets and develop the manufacturing operations at Metso's Columbia, SC facility. Prior to joining Metso, Snyder was a director of Schenk Mining North America and was president and founder of International Precision Controls.



SNYDER

RICHARD M. LiCONTI (SME) has joined Eickhoff Corp. as vice president with responsibilities for company sales and service operations in the United States. He has more than 30 years of experience in the coal, utility and energy services industries and has served in executive, operations and engineering positions. He has been a member of the boards of the National Coal Association, the Center for Energy and

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LiCONTI

GEM booth a favorite at the Boy Scout Jamboree

by AnnMarie Estrada, SMEF Development Associate

The Boy Scouts of America (BSA) celebrated its 100th anniversary this year at the National BSA Jamboree at Fort A.P. Hill, VA, and SME was fortunate enough to be a part of it. As part of a large GEM outreach project, the SME Foundation had a booth as a national exhibitor at the Jamboree.

SME volunteers and staff spent 10 days braving the heat and humidity to educate the BSA community about the importance of mining. "Why do we mine?" is the question that our volunteers and staff at the booth set out to answer. The simple and often quoted answer is, "Because if it can't be grown, it must be mined." We wanted to delve a little deeper than that, though, so the booth offered scouts, leaders and day visitors videos and hands-on activities demonstrating the minerals that are mined and processed and what products are created from them. Booth visitors also learned about the different phases of a mining operation, from exploration to reclamation, and about careers in the mining and minerals industries.

During the past year, the foundation has been working with the BSA on a proposal for a future mining merit badge. Visitors to the booth were largely in support of this idea. We estimated that more than 15,000 attendees stopped by, and we urged them to impress upon the BSA the importance of learning about mining and its direct impact on all the items that we, as a society, use every day. Although the mining merit badge is currently under discussion, SME graphic designer and Eagle Scout Nate Hurianek created a patch commemorating the 100th Anniversary. Scouts lined up along the entire length of the road during daily patch-trading sessions, and the SME commemorative patch was one of the hot-ticket items during these sessions. Scouts eagerly snapped them up at every opportunity. We handed out an average of 1,500 patches each day — a total of nearly 15,000 patches.



What was especially exciting about this outreach event was the inclusion of the entire SME membership through Facebook. Daily posts were made by SME staff so that members were able to stay up-to-date on all the Jamboree happenings. We will continue to update the membership on the progress pertaining to the proposed mining merit badge. It is our hope that the mining merit badge will be approved and available for the scouts to earn at the next Jamboree in 2013.

The foundation would like to thank its wonderful Jamboree volunteers for their assistance, support and good humor — Bill and Lee Ann Beck, Richard Katz, Christopher Carroll, Joe Hirschi, Brian Shaffer, Dermot Winters, Mark Ellis, Pam Wilkinson, Lee Bray, Gary Buchan, Lisa Corathers, James Hedrick and Steve Richards. Our participation in the Jamboree was a fantastic success, and we couldn't have done it without all of you. We truly appreciate your help.

We would also like to send a big thank you to the companies who sponsored this event: Alpha Resources, Rio Tinto Exploration, Rio Tinto Kennecott Utah Copper and Vulcan Materials.

(continued on page 76)

Pam Wilkinson, education curator with the Arizona Department of Mines and Minerals, helps a young scout do an experiment in minerals conductivity. Which one will make the buzzer sound?



Richard Katz, a project engineer with Jim Walter Resources, taught scouts from Minnesota and Puerto Rico how minerals are processed in the products that they use every day.



SME divisions award 2009-2010 scholarships

Each year, five SME divisions offer up to 25 undergraduate scholarships to SME student members. Scholarship announcements are sent to universities with departments that offer eligible programs of study. Furthermore, SME contacts all of its student members and directs them to the guidelines and applications link on the SME website www.smenet.org. Each division has a separate application form that can be obtained and filled out online by visiting each applicable division page. Oct. 25, 2010 is the deadline for the submission of all scholarship applications.

Coal & Energy Division

Robert R. Burns is a junior majoring in mining engineering at The Pennsylvania State University. He is a member of the SME student chapter at Penn State, the Penn State mine rescue team and is president of the student chapter of the International Society of Explosives Engineers. He is pursing minors in global business and geosciences. In the summer of 2009, Burns worked for Consol Energy at its Enlow Fork operation in West Finley, PA. During his 14-week rotation, he reviewed the West Virginia miner's apprentice test material, then rotated among positions in the mining operation. He worked with the safety department, the engineering group surveyors, the shift and assistant shift foreman, the electrical foreman, the F-18 longwall section and foreman, the continuous miner section and foreman, the mains foreman and at the processing plant and the communications center.

Andrew M. Calhoun recently received his degree in mining engineering from Virginia Tech. While a student, he was a member of the Burkhart Mining Society (the SME student chapter) and was part of its new tutoring program. He was also a representative of the Mining and Minerals Engineering Department to ABET and to potential incoming students. He was on the Dean's List all six semesters at Virginia Tech. Calhoun participated in two summer internships with Consol Energy's Central Appalachian division. He was assigned to the regional engineering office to aid in internal compliance audits and governmental reporting, worked underground and worked with the onsite mine engineers at Buchanan No. 1. During the second internship, he worked the entire summer as the industrial engineer.



The Coal & Energy Division awarded 10 scholarships of $2,500 each. Eight of the students received checks at the division's luncheon in Phoenix AZ. Those participating in the awards ceremony were, from l-r, Jurgen Brune, 2009 division chair, Megan Habbe, Robert Burns, Austin Vreugdenhil, Andrew Calhoun, Jacob Stephens, Michael Middleton, Sarah Milne and Matthew Hyita.

SME Division Scholarships



Martin Smay (l) received his scholarship check from Christopher Bise (r), head of the Mining Engineering Department at WVU.

He used AutoCAD to update mine maps. He earned Mine Safety and Health Administration certification to sample respirable coal mine dust and took air and dust samples for safety and environmental compliance.

Megan A. Habbe graduated from Southern Illinois University-Carbondale with a degree in mining engineering. She was the top student in the department with a 3.8 GPA and served as the secretary and vice president of the Saluki Miners student chapter of SME. During the school year, she worked as an assistant to the equipment manager at SIU's Intercollegiate Athletic Department, tutored math classes and was a teaching assistant in the mining department. She was a member of the university honors program. Habbe worked for Peabody Energy for two summers as an intern. First she worked with AutoCAD and in production at the Wild Cat Hills complex in Harrisburg, IL. Her second summer internship was at Lee Ranch/El Segundo Coal in Grants, NM where she worked as a surveyor and on a major reclamation project. She then worked for Barrick Gold at an openpit operation in Elko, NV as a blast technician.

Matthew J. Hyita graduated from the University of Utah with a degree in mining engineering. He was a student member of SME and a member of the Rocky Mountain Coal Mining Institute. During the school year, he was involved in a geochemical research project focused on a coal-dust suppression application that has the potential to reduce hydrogen sulfide emissions from freshly mined coal. He researched compounds for reagent solutions and did bench testing. Hyita spent three summers as an intern for Consol Energy, first at the Emery Mine in Utah, then at the Bailey/Enlow Fork mines in Pennsylvania and finally at the Bailey/Enlow Fork preparation plant. At the Bailey plant, he worked on a project to determine the outcome of screening using two different coal qualities, one from the Bailey Mine and one from Enlow Fork. He will make a technical presentation to the university with his results.

Michael B. Middleton is a graduate of the Colorado School of Mines with a degree in mining engineering. He served the SME student chapter as social chair, organizing social events and networking industry with fellow students. He worked as a mining engineering intern for two summers with the Kiewit Mining Group at the Buckskin Mine, a surface coal operation in Gillette, WY. There, he did surveying with a Trimble GPS and designed a re-grade of backfill to permitted post-mining topography using AutoCAD software. He also worked two summers in Gillette, WY at the surface coal operation. Middleton was a nontraditional student who worked in the airline industry and attended junior college before beginning his studies at CSM. He was on the Dean's List at CSM and was a member of the Phi Theta Kappa honor society. He also received a Mining & Exploration Division scholarship.

Sarah K. Milne is a senior majoring in mining engineering at the University of Alaska Fairbanks (UAF). She is a current member and was secretary of the SME student chapter at UAF. With some professional help, the chapter is currently rehabilitating the UAF Silver Fox Mine. She is also a member of the Society of Women Engineers, the Alaska Miner's Association and Alaska Women in Mining. While working for the Usibelli Coal Mine as an intern mining engineer, she became proficient at GPS surveying, using AutoCAD and she assisted the staff on permitting, logging holes and supervising drillers. She has also been involved in coaching kids in the Math Counts program and leading Young Life. Milne also received a $1,500 scholarship from the Environmental Division.

Michael J. Shuman is a junior at the Missouri University of Science and Technology (MS&T) majoring in mining engineering. He is a member of the SME student chapter, the MS&T mine rescue team and the mucking team. He also participated in the benchman's competition. Shuman worked as a summer intern at the Dotiki underground coal mine in Kentucky and at Jim Walter Resources' Blue Creek #4 coal mine. At Blue Creek, he worked underground with production foremen on longwall and continuous miner sections, and he job-shadowed the surface foreman. At Dotiki, he trained on underground mining equipment, built ventilation controls, belt headers and secondary roof support and earned Kentucky's experienced miner certification. During school, Shuman participated in the Mining Simulation Augmented Reality System, training underground miners in the basics of using a jackleg drill to install rock bolts.

SME Division Scholarships

Martin J. Smay is a senior majoring in mining engineering at West Virginia University (WVU). He is a member of the SME student chapter and participated in the local GEM show to explain the importance of the mining industry to children and adults. He also helps run the campus ministry outreach for his church. Smay served two summers as an intern with Consol Energy and attended the West Virginia apprentice miner certification program. Consol then sent him to the safety department at the McElroy Mine as the company escort for many mine inspectors. He also worked with the longwall supervisors, a track crew laying track and an electrician. His long-term goal is to remain in West Virginia and eventually work in underground coal-mine management.

Jacob L. Stephens is a senior at the University of Kentucky (UK) majoring in mining engineering. He is a member of the SME student chapter and plays in an intramural flag football league and a softball league. He is currently a mentor to a freshman studying to be a mining engineer. For three summers, Stephens has been an intern at Massey Energy's Logan County Mine Services, primarily focused on surface mining. The first summer he received his apprentice miner's card in the states of Kentucky and West Virginia. The second summer, he shadowed mine employees on a weekly rotation system. During the third summer, he worked with production engineers on budget maps, coal preparation, project management, annual appraisal of taxes and determining the feasibility of projects. He plans to get further experience in underground coal mining. He will work full time for Massey after graduation.

Austin L. Vreugdenhil is a senior at the South Dakota School of Mines and Technology (SDSM&T) majoring in mining engineering and management. He is member of the SME student chapter, Triangle and an SDSM&T orientation leader. Vreugdenhil worked as a summer intern for Peabody Energy's Rawhide and North Antelope Rochelle Mine in Gillette, WY. He completed an analysis detailing the reasons the mine was having coal-quality issues. He also worked with engineers and pit managers to design and assess the feasibility of a land bridge that would minimize the overburden haul length in the northwest pit. Vreugdenhil also led and managed a team of interns who mapped sediment pond bottoms. In a previous summer, he constructed a networked coal-pillar recovery library using I-Site, Vulcan and AutoCAD software. He operated light-duty vehicles on a regular basis in the active openpit. This summer, he was an intern with Solvay Chemicals, which mines trona in Green River, WY.

Environmental Division

Allan K. Hepworth, a senior majoring in mining engineering at the University of Utah, received a $1,500 scholarship from the Environmental Division. Before starting at Utah, Hepworth received an associate's degree from Salt Lake Community College. During the school year, he has served as a laboratory assistant in a surveying course. He recently completed a summer intern assignment for Monsanto near Soda Springs, ID, an area of environmental challenges. Hepworth had responsibility for monitoring slopes and the highwall monitoring stations. He added new stations and updated the database. He used mining software to digitize pit cross sections and made a 3D model of the historic pit. From the model, he calculated the volume of material that will be used in future reclamation projects. He has a 3.7 GPA.

Sarah K. Milne, a senior majoring in mining engineering at the University of Alaska Fairbanks, also received a $1,500 Environmental Division scholarship. See pages four and five for her photo and biography.



Allan Hepworth (l) accepts an Environmental Division Scholarship check from Anne Williamson (r), 2009 division chair.

Industrial Minerals & Aggregates Division

Stephenie L. Mirka, a senior at the University of Arizona majoring in mining engineering, received the $2,500 Gerald Henderson Scholarship from the Industrial Minerals & Aggregates Division. Mirka completed two summer internships with Rinker Materials (now Cemex), a producer of construction aggregates and portland cement. Her field assignments included mapping, sediment drilling exploration, claim sampling and materials testing. Her office

duties included plotting GPS data, calculating in situ and salable reserve quantities and mapping from aerial photos. Mirka is active in the student chapter of SME where she is on the fundraising and recruiting committees. Mirka is in charge of contacting potential donors for prizes for the annual golf tournament during the SME Arizona Conference. She is consistently on the Deans List and maintains a 4.0 GPA in all her mining classes.



Srinivas Veeramasuneni (l) presented the scholarship check to Stephenie Mirka (r) during the division luncheon in Phoenix, AZ.

Mining & Exploration Division

Alison E. Sears, a senior at West Virginia University, received a $1,500 Mining & Exploration Division scholarship. Sears is pursuing a dual major in civil and mining engineering and is at the top of her class. She is a member of the SME student chapter and serves as its GEM coordinator. She has also organized community service activities for the student chapter, including many recruiting opportunities. She is a member of the Society of Women Engineers. Due to a serious illness in her freshman year, she was unable to accept a planned summer internship for a mining firm.



Allison Sears (l) received a scholarship check from Christopher Bise head of the Mining Engineering Department at West Virginia University.

Lewis Aaron Burton, a senior in the Mining Engineering Department at the University of Kentucky, received a $1,500 Mining & Exploration Division scholarship. Burton has served as the Norwood (SME) student chapter secretary and as the chapter president. He led the chapter in several community outreach projects, including assisting a troop of Cub Scouts as they worked on their engineering badge. Burton worked for Newmont Mining during the summers of 2009 and 2010. In 2009, he worked at Newmont's Gold Quarry operation on a drill-and-blast fragmentation study that he organized, researched and completed. As a member of the leach team, he provided valuable insight and data on the fragmentation attainable by drill-and-blast and worked closely with the mine operation foremen, shovel operators and dispatchers. Newmont sponsored Burton to write a paper on his research to be presented at the Northwest Mining Association meeting.



Aaron Burton (r) received his scholarship check from Dayan Anderson (l), M&E Division chair, at the division luncheon during the SME Annual Meeting in Phoenix, AZ.

Michael B. Middleton is a graduate of the Colorado School of Mines with a degree in mining engineering. Dayan Anderson, division chair, presented him with a $1,500 scholarship from the Mining & Exploration Division at the division's luncheon during the 2010 SME Annual Meeting in Phoenix, AZ. Middleton also received a Coal & Energy Division scholarship. See pages four and five for his photo and biography.

SME Division Scholarships

Mineral & Metallurgical Processing Division

Ryan Morrison, a senior in the Metallurgical Engineering Department at the University of Utah, received a $2,000 Mineral & Metallurgical Processing Division (MPD) scholarship. Morrsion, a top student in the department at Utah, has received merit-based scholarships each year and received the department's outstanding freshman award. He has a 3.86 GPA. Morrison speaks fluent Spanish, and one of his goals is to travel to or live in South America while working in the minerals processing industry. During the school year, he worked on several metallurgical research projects within the department. He is president of Tau Beta Pi fraternity and the SME student chapter. He uses his Spanish fluency as an interpreter at Primary's Children Hospital.



Ryan Morrison (l) received his scholarship check from Jan Miller (r), head of the Metallurgical Engineering Department at Utah.

Brooke O'Bryan, a senior at the South Dakota School of Mines and Technology majoring in metallurgical engineering, received the $3,000 MPD Richard Klimpel Scholarship. O'Bryan interned with Newmont Mining in the summer of 2009. Her first project was to conduct a grinding-circuit survey. This included sampling and testing ore and compiling the results. These results were then sent to an engineering firm for analysis. She also was able to see different aspects of mineral processing including flotation, roasting and leaching and conducted tests used for a variety of processes.

O'Bryan found that she was most interested in flotation and accepted a second internship with Newmont Mining this summer working with the flotation circuit. This will provide hands-on experience with trouble shooting and improving processes. ■



Rick Gilbert (r), MPD division chair, presented a scholarship check to Brooke O'Bryan (l) at the MPD luncheon in Phoenix, AZ.

BSA Jamboree

(continued from page 71)

SME would like to continue saluting the BSA's 100 year anniversary by sending commemorative patches to all SME members who are involved with a BSA troop or council. Please contact AnnMarie Estrada, Foundation Development Associate, at 303-948-4224 or by e-mail at estrada@smenet.org to request your patches. ■



(l-r) Jim Hedrick, AnnMarie Estrada and Mark Ellis staffed the SME booth at the Jamboree.



Trading patches was a daily pastime for scouts, and the SME patch was a favorite.

SME and PCMIA will hold 2010 annual joint meeting

SME and the Pittsburgh Coal Mining Institute of America (PCMIA) will hold their annual joint meeting Oct. 28-29, 2010 at the Hilton Garden Inn-Southpointe in Canonsburg, PA. Featured technical sessions include mine emergency operations, communications and tracking, respirable dust and international coal mining.

Thursday's keynote speakers will be Tim Murphy, representative for the18th District of Pennsylvania and SME young leaders Ryan T. Desko, Richard C. Kim, Ryan M. Murray and Heather Trexler. Nikhil C. Trivedi, SME President and senior partner with Idekin International, will be Friday's keynote speaker.

On Thursday Oct. 28, following the student luncheon, there will be a student tour of the Mine Safety and Health Administration's (MSHA) Approval and Certification Center in Triadelphia, WV. Fifty university students will have the opportunity to tour MSHA's electrical explosion test gallery, the intrinsic safety test lab and the diesel explosion test gallery.

The fee for two-day registration is $125; one-day registration is $70. For registration information, contact Mary DelRosso at 412-835-7387 or e-mail mary412d@comcast.net.

To maintain, improve and expand the skills and knowledge relevant to engineering, particularly mineral/mining engineering, meeting attendees will receive professional development hours (PDH) for their attendance at this event. Two-day attendees will be awarded 10 PDH, and one-day attendees will receive 5 PDH.

On Friday evening, Oct. 29, SME/PCMIA will host a musical tribute to the American coal miner at the IceoPlex located in Southpointe, Canonsburg, PA. International award-winning, Grammy nominated recording artist Stella Parton and her band, Underground, will perform a selection of heart-warming and passionate coal mining songs that trace the history of coal and its importance to the nation.

The IceoPlex doors will open at 6:15 p.m., and Stella Parton will take the stage at 7:30 p.m. Tickets are $12 each and can be purchased through Mary DelRosso (see above). ■

Membership

Baikuntha Adhikari, Claypool, AZ
Ryan Arp, Washington, PA
Taner Aydogmus, Fairfax, VA
Alireza Ayoubian, Newark, NJ
Saleh Behbahani, Tehran, Iran
Wynard Bender, Windhoek, Namibia
Mark Benson, Folsom, CA
Raymond Brady, Indianapolis, IN
Cass Bruneau, Sequim, WA
Rafael Castro, Burlington, MA
Brad Cavitt, Clackamas, OR
Cheryl Christian, Olympia, WA
Greg Colzani, Vancouver, WA
Richard Conte, Bellevue, WA
William Dean, Pelham, NY
Michael DeSafey, Roseville, CA
Deborah Dickson, Sumner, WA
Chris Diener, Fort Worth, TX
Gerald East, Bainbridge Island, WA
Alessandra Eliseo, Jandira-SP, Brazil
Jon Felton, Puyallup, WA
Ignacio Garcia, Grande Cache, AB, Canada
Chuck Gardner, Sacramento, CA
Evan Garich, Portland, OR
Cindy Godel, Phoenix, AZ
James Goudie, Farmington, MI
Craig Haley, Ontario, CA
Devin Harmia, Bellevue, WA
Chris Hebert, Porter Ranch, CA
Steve Heist, Olympia, WA
Cary Hirner, Kansas City, MO
Roger Ilsley, Topanga, CA
Frank Jenkins, Vienna, VA
Bruce Johnson, Salem, OR
Scott Johnston, Regina, SK, Canada
Gary Jones, Fort Wayne, IN
Maurice Jones, Aylesbury, England
Philip Kassouf, Walton Hills, OH
Galen Klein, Walnut Creek, CA
Martin Knights, Surrey, England
Doug Krebs, Fort Wayne, IN
Sebastian Kumpfmueller, Herndon, VA
Simon Law, Douglas, QLD, Australia
Patrick Liu, Gold River, CA
Robert Masbaum Jr., Indianapolis, IN
Jon Henri Mayer, New York, NY
Gary McClellan, Portland, OR
David McMahon, Larchmont, NY
Daniel Meyer, Lake Forest, IL
Tennyson Muindi, Boston, MA
Bruce Novakovich, Salem, OR
Patricia Oka, Vancouver, BC, Canada
Johnny Pappas, Kershaw, SC
Michael Pearce, Irvine, CA
Wayne Porter, Bellevue, WA
Mike Rigsby, Seattle, WA
Matt Roberts, Clackamas, OR
Phil Roppo, Portland, OR
Thomas Saczynski, Littleton, CO
Arash Sayyar, Cypress, CA
Jim Schettler, Bellevue, WA
James Schick, Salem, OR
Thomas Schwind, San Franscisco, CA
Joseph Sesil, Broomfield, CO
Mina Shinouda, Lynnwood, WA
Steve Skelhorn, Toronto, ON, Canada
Matthew Stone, Kansas City, MO
Jeffrey Swanstrom, Salem, OR
Matt Swinton, Omaha, NE
Natasha Taylor, Brooklyn, NY
Glen Thommen, Salem, OR
Luis Tisnes, Costa Mesa, CA
Matthew Trone, Peoria, IL
David Tsztoo, San Francisco, CA
Zephaniah Varley, Antioch, CA
Steven Wright, Indianapolis, IN
Xiaomin You, Austin, TX ■

Tom Everett Hearon

An appreciation by his friends at Magma Copper

Tom Everett Hearon died peacefully at his home in Oracle, AZ on June 5, 2010. He was a long-time SME member and executive with Magma Copper.

Hearon was born in Oklahoma in September 1929. His early years were remarkable. On by the death of his parents, he was sent to an orphanage in Oklahoma at age eight. By the time he was 13, he was on his own. He fudged about his age and joined the U.S. Army at 16. He served in the 82nd Airborne Division. Following his army service, he graduated from the Texas College of Mines (now the University of Texas at El Paso) in 1954 with a degree in mining engineering. He joined SME in 1952 and was a member of the Legion of Honor.

Hearon's first job was as a junior mine engineer at Climax Molybdenum. He joined San Manuel Copper in the mid-1950s, which later became Magma Copper, and served as an underground laborer, mine shift boss, mine engineer, chief plant engineer and assistant general manager. He retired in 1989 as vice president and general manager,

During his management years, Hearon was a key figure in the development and nurturing of the Magma-San Manuel operation into the world-class mining-smelting-refining complex that it became.

Hearon is survived by his wife of 57 years, Mary Ann; sons, Mark and Tom Jr., daughters, Julia and Carol; 13 grandchildren, nine great-grandchildren and a host of friends in southern Arizona and in the hard rock mining industry. He will be missed by all who knew him.

Walter Andrew Paroni Jr.

Walter Andrew Paroni Jr. died at home in Post Falls, ID on June 3, 2010. He was born Dec. 5, 1921 in Berkeley, CA to Walter and Dorthea (Roust) Paroni.

He worked with his uncle and cousin during the summers of 1937 and 1938 on mining claims near Eureka, NV and decided that mining was the career for him. At 19, he headed to Alaska to work at his grandparents' hydraulic gold operation above the Arctic Circle. During World War II, he served in the U.S. Army-Air Force, mainly as a mechanic on B-17 and B-25 airplanes.

In 1950, Paroni received a B.S. in mining engineering from the Hearst School of Mines at the University of California-Berkeley. After graduation, he went to work at the Bingham Canyon open-pit copper mine near Salt Lake City, UT. He then worked for the California Transportation Department designing the foundations for the Richmond–San Rafael Bridge for several years. He joined Eureka Corp. in 1952 working on mining projects near Bishop CA, at Cobalt, ID and at the Ruby Hill Mine near Eureka. He married Genevieve Swick in 1954. When Ruby Hill ceased operations, Paroni and the family moved to the California bay area where he worked in the water treatment business. After several years, he decided to return to mining and took a job with Hecla Mining, moving to the Silver Valley of northern Idaho. During his career, he often served as a mentor for younger mining engineers and engineering students. He retired from Hecla in 1986. He and his wife moved to Post Falls, CA in 2004 after living in Wallace, ID for 36 years.

Paroni was a Legion of Honor member of SME; a 56-year member and past master of the Eureka Masonic Lodge #16; member and past patron of Shoshone Chapter #10, Eastern Star in Wallace and a member of the York Rite Bodies of Elko, the Kerak Shrine Temple in Reno, NV and the Wallace Elks Lodge #331. He was active in the Lions Club while living in Nevada.

He enjoyed camping with his family, doing woodwork and carpentry, working as a mechanic and working in the garden. He was an avid golfer and spent many hours on his computer. He is survived by Genevieve, his wife of 55 years; his daughter, Andrea Storjohann, and a sister. ■

Necrology

date elected	name and city
1947	H.W. Ahrenholz ** Buffalo Grove, IL
1958	Douglas R. Cook Reno, NV
1952	Thomas R. Fuller ** Tulare, CA
1938	Martin K. Hannifan ** Tucson, AZ
1952	Tom E. Hearon ** Oracle, AZ
1947	John S. Holland ** Denver, CO
1978	Roger B. Humberger Pocatello, ID
1962	Roberto F. Limon El Paso, TX
1953	Walter A. Paroni ** Post Falls, ID
1974	Philip C. Walsh Peapack, NJ

** Legion of Honor ■

Personal News

(continued from page 70)

Economic Development and the Pittsburgh Coal Mining Institute.

Stillwater Mining has appointed **JOHN STARK** as executive vice president and chief commercial officer. He will be responsible for the company's recycling business and the metallurgical complex in Columbus, MT. **GREG ROSET** (SME), who has been general manager of the company's smelter operations for nine years, will report to Stark. He will direct the operation of the new recycling plant. **DAVE SCHUCK**, general manager of base-metal refinery operations and the assay laboratory, will also report to Stark. ■



2010 Professional Development Seminar Series

Strategic Risk Quantification and Management for Ore Reserves and Mine Planning

Mineral project evaluation techniques and applications: From conventional methods to real options

November 8-11, 2010, Montreal
Michel Bilodeau, McGill University, Canada

Learn the basics of economic/financial evaluation techniques, as well as the practical implementation of these techniques to mineral project assessments.

- How to gain a practical understanding of economic/financial evaluation principles.
- How to develop the skills necessary to apply these to support mineral project decisions.

Upcoming 2011 Seminars

- New - Certification in ore reserve risk and mine planning optimization. Starts May 2011, Montreal Canada.
  Roussos Dimitrakopoulos, McGill University

  For more details please visit- www.mcgill.ca/conted/prodep/ore/

- Theory and practice of sampling particulate materials - Part 1
  QA-QC, mine, and project audits - Part 2
  Dominique François-Bongarçon, AGORATEK, USA

- Strategic risk management in mine design: From life-of-mine to global optimization
  Roussos Dimitrakopoulos, McGill University, Canada; Gelson Batista, AMEC, Canada; and Gerald Whittle, Whittle Consulting Australia.

- An introduction to cutoff grade estimation: Theory and practice in open pit and underground mines
  Jean-Michel Rendu, Executive Consultant, Snowden, Australia

- Geostaistical mineral resource/ore reserve estimation and meeting the new regulatory environment: Step by step from sampling to grade control
  Michel Dagbert, Geostat Systems Int, Canada; Jean-Michel Rendu, Consultant, USA; and Roussos Dimitrakopoulos, McGill University, Canada

www.smenet.org
http://cosmo.mcgill.ca

SME Society for Mining, Metallurgy & Exploration

CIM ICM

AusIMM The Minerals Institute

The Southern African Institute of Mining and Metallurgy
Founded in 1894

McGill
COSMO Lab
Mining Engineering

For registration and information please contact:

Deborah Frankland
Dept. of Mining and Materials Engineering
McGill University
Montreal, Quebec

Email:
admcrc.mining@mcgill.ca

Phone: (514) 398-4755, ext. 089638
Fax: (514) 398-7099

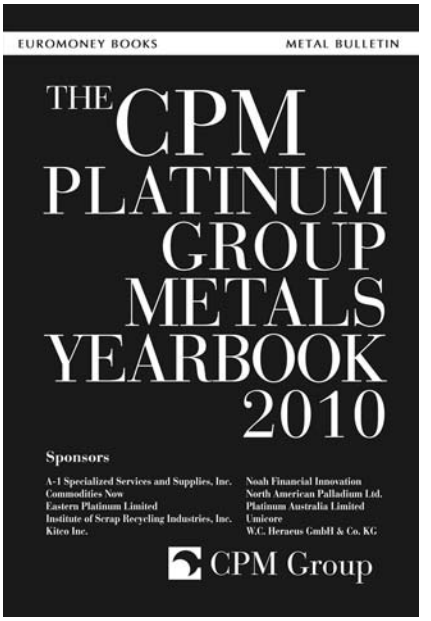
Platinum Group Metals Yearbook 2010

2010, published by Euromoney Books and the Metal Bulletin, 30 Broad St., 37th Flr., New York, NY 10004 USA, phone 212-785-8320, fax 212-785-8325, e-mail info@cpmgroup.com, website www.cpmgroup.com, $150, available in printed and PDF format.

A combination of constrained supplies, rising fabrication demand and increased investor interest in the platinum group metals has driven prices sharply higher over the past several quarters. This is also expected to drive the prices of these metals higher in the near future and is the primary theme of the *CPM Platinum Group Metals Yearbook 2010.*

South Africa, the largest producer of platinum in the world, is confronted with certain resource constraints that are not expected to be resolved in the near future. The constraints are expected to inhibit the supply from South Africa, no matter how high metals prices rise. Strength in jewelry demand was offset by weakness in demand from the auto catalyst sector.

In the case of platinum, investment demand played an extremely important role in pushing the price of palladium higher. Investment demand in exchange traded funds (ETF) rose significantly in 2009, with metal held in ETFs reaching 37.3 t (1.2 million oz) on Dec. 31, 2009. This was a net addition of 15.7 t (506,560 oz) more than 2008. Net additions to palladium ETF holdings in the first 24 weeks of 2010 already have exceeded net additions last year. Rhodium prices recovered in a similar fashion to platinum and palladium prices.



Analyzing the Major Mines of the World

2010, published by Aruvian R'search, Research and Markets, Guinness Center, Taylors Lane, Dublin 8, Ireland, fax 646-607-1907, e-mail help@researchandmarkets.net, website www.researchandmarkets.com/reports/548751, 360 pp, hard copy €963 plus shipping, also available as a CD ROM and as a PDF.

Traditional mining countries, such as the United States, Canada, Australia, South Africa and Chile, still dominate the global mining scene. But exploration and development funding has changed over the past few years, with emphasis shifting to areas that have been poorly explored or have had poor access for reasons of politics, infrastructure or legislation. Gold, base metals, diamonds and platinum-group elements are the more important commodities explored for and developed globally.

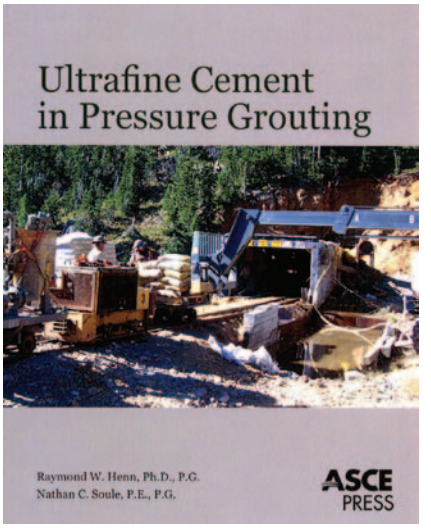
Aruvian's R'search brings in-depth coverage to 100 major mines of the world in the research report *Analyzing the Major Mines of the World*. The extensive report covers comprehensive profiles of the mines, including production data, location data and geographic data. Commodities such as copper, gold, iron, diamonds, platinum and coal are among some of the mines profiled in the report. The report also includes a brief profile of the global mining industry and the environmental legacy of the mining industry.

Ultrafine Cement in Pressure Grouting

2010, by Raymond W. Henn, Ph.D. P.G. and Nathan C. Soule, P.E. P.G., published by the American Society of Civil Engineers Press, Book Orders, P.O. Box 79404, Baltimore, MD 21279, phone 1-800-548-2723 (U.S. customers) or 703-295-6300 (international customers), fax 703-295-6211, e-mail pubsful@asce.org, website www.asce.org, ISBN 9780784410271, 82 pp., $65 soft cover.

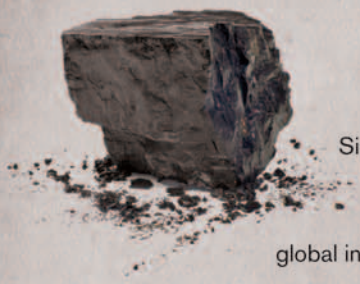
Ultrafine Cement in Pressure Grouting presents the technical and practical information required by engineers to plan and implement grouting programs that are cost effective and technically sound. As a key component of modern grouting programs, ultrafine cement is an ideal solution for geotechnical engineers and construction contractors who are grappling with the challenges of managing costs, while developing sites that may be less than ideal. Increasingly, the virtues of ultrafine cement led engineers and contractors to use it rather than the less expensive portland cements.

The authors concisely define ultrafine cement, describe its engineering properties and explain its manufacture, packaging and storage. Mixing and pumping procedures and quality control issues are covered, as well as recommendations for specifying ultrafine cement in contracts. An appendix offers 16 brief project descriptions. ■





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Atlas Copco boomer works in narrow veins

The new Atlas Copco Boomer T1D face drilling rig builds upon the proven features of the Boomer 104 in narrow vein applications. The T1D has improved productivity, more strength and more options, and the hydraulically controlled rig has a tight turning radius. With the enclosed cabin option, it stands 13 m (43 ft) wide and 27.2 m (89.2 ft) high. It comes standard with a COP 1838ME rock drill, which has a high penetration rate and excellent drill steel economy because of its double dampening. An optional long-hole feed kit is available, suitable for face drilling and long-hole drilling.

The Boomer T1D features easy access to all service points for faster diagnosis and repair. The standard protective roof and the optional enclosed cabin are approved by OSHA's "falling-object, protective structures" guidelines. The ergonomic design of the operator compartment makes this a safe, comfortable and productive machine to operate. It is equipped with improved LED tramming lights that provide better visibility with lower power consumption and HID (Xenon) work lights that provide better visibility and are less sensitive to water splash.

www.atlascopco.us



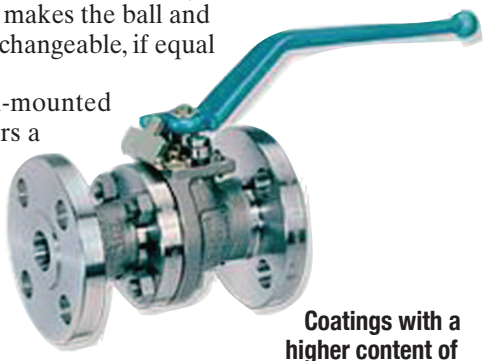
The Boomer T1D is available in Australia, Canada and the United States. It will be available worldwide in early 2011.

Krombach ball valves are made for mining

Crane ChemPharma Flow Solutions has introduced a line of Krombach metal seated ball valves (MSBV) designed for specialty chemical and mining applications.

Featuring a two-piece design with a flange connection, the ball and seat are machined to such precise tolerances that ball and seat lapping does not have to be performed individually for each valve. This makes the ball and seat freely interchangeable, if equal in nominal size.

Its trunnion-mounted ball design offers a polygon stem-to-ball connection, which reduces stress and ensures optimal torque transmission. An additional feature is its self-cleaning system, which removes excess particles, minimizes leakage and extends product life.



Coatings with a higher content of chrome/cobalt are more effective in acidic applications (pH-value 0-7). Coatings based on nickel are used with alkaline fluids (pH-value 7-14).

Other key options include a fire-safe design body gasket and a removable hand lever. Crane ChemPharma's Natural Resource segment serves the mining and minerals, desalination and oil sands markets. These markets have applications with highly corrosive media. The Krombach brand is well known for its range of special designs for demanding applications.

www.cranechempharma.com

Eriez *Orange Reports* offer industry-specific solutions

Eriez, a world authority in advanced technology for magnetic, vibratory and inspection applications, has introduced *Orange Reports*. The reports are concise case studies presented in the form of one-page, PDF documents. The reports are useful to those involved in separation, material beneficiation, detection, conveying, lifting, positioning, holding, feeding or detection.

Each report features a problem an Eriez customer has encountered, the solution they found with Eriez equipment and the result. The *Orange Reports* offer an opportunity to learn from others' experiences. Eriez created the reports to help users stay up-to-date on the latest solutions available for those facing processing challenges. *Orange Reports* can be downloaded for free from Eriez' website.

http://en-us.eriez.com/products/orangereportcasestudies

Matec water-recovery system eliminates settlement ponds

The Matec pondless washing system features a water recycling, decanter-style water clarifier to reclaim and recycle dirty water from the washing of aggregates. It also has a proprietary, high-pressure filter press that eliminates settlement ponds at mines, quarries and concrete producers. This system provides the opportunity to wash aggregates where settlement ponds and washing are prohibited. It can cut operating costs for those who wash and have to deal with water pollution and settlement pond headaches.

The Matec line of water treatment equipment cleans and recovers up to 90 percent of the wash water and eliminates settlement ponds at aggregates facilities. Wash water and settlement pond problems can include zoning, environment, fines, water restrictions, high pumping costs and and pond maintenance, including excavator and dragline issues.



The Matec System overcomes these problems using an HPT high-pressure filter press and the decanter-style clarifier. The system essentially has no moving parts. The end result is a super-dry dirt cake of more than 80 percent solids. It can easily be stockpiled and sold for landfill cover or other purposes.

http://www.matecamerica.com

Magnetek introduces M-force drives for mining applications

Magnetek, a manufacturer of severe-duty mining variable frequency drives, has introduced its new M-Force 240/480/575 volt, general purpose, ac variable frequency drives for mining applications. The rugged and reliable drive is designed for a variety of pumps, fans and conveyors. Its dual ratings, normal and heavy duty, offer an economical match of overload capacity and starting torque. The drive also provides the right fit to power requirements with 208/240 and 480 volt ratings, built-in BUS choke above 30 hp, 12-pulse capability above 30 hp, common BUS capability and regeneration options. The M-Force 240/480 control can handle conventional applications from simple variable torque pumping to sophisticated networked materials handling. The M-Force 575 control produces an output of adjustable voltage and frequency to control the speed of a squirrel-cage induction motor. This drive addresses the higher 575 volt requirements of some mines. Its design provides low motor noise and high starting torque. The drive provides three modes of control and speed accuracy to suit application requirements.



Magnetek's patented high-slip braking eliminates the need for dynamic braking resistors for high-inertia loads.

www.magnetekmining.com

Pacific Crest makes transformers for underground and openpit mines

Pacific Crest Transformers (PCT) is a manufacturer of liquid-filled distribution transformers. The company offers cost and energy-efficient station and substation transformers for mining applications that feature a greater overload capability and high thermal resistivity. PCT station transformers can be used in openpit and underground applications that range from auxiliary lighting loads to power for cranes, draglines, conveyor belts and dedicated variable speed drive applications. The liquid-filled, station-type transformers are available in ratings from 75 to 15000 kVA. Compact in size, the station-type transformers occupy a minimum amount of space, are skid-mounted and are specially designed to operate on a tilt. Customized designs are available for new applications and the replacement of existing transformers. ■

www.pacificcresttrans.com



PCT custom built transformers are constructed to withstand rough ground and a corrosive atmosphere.

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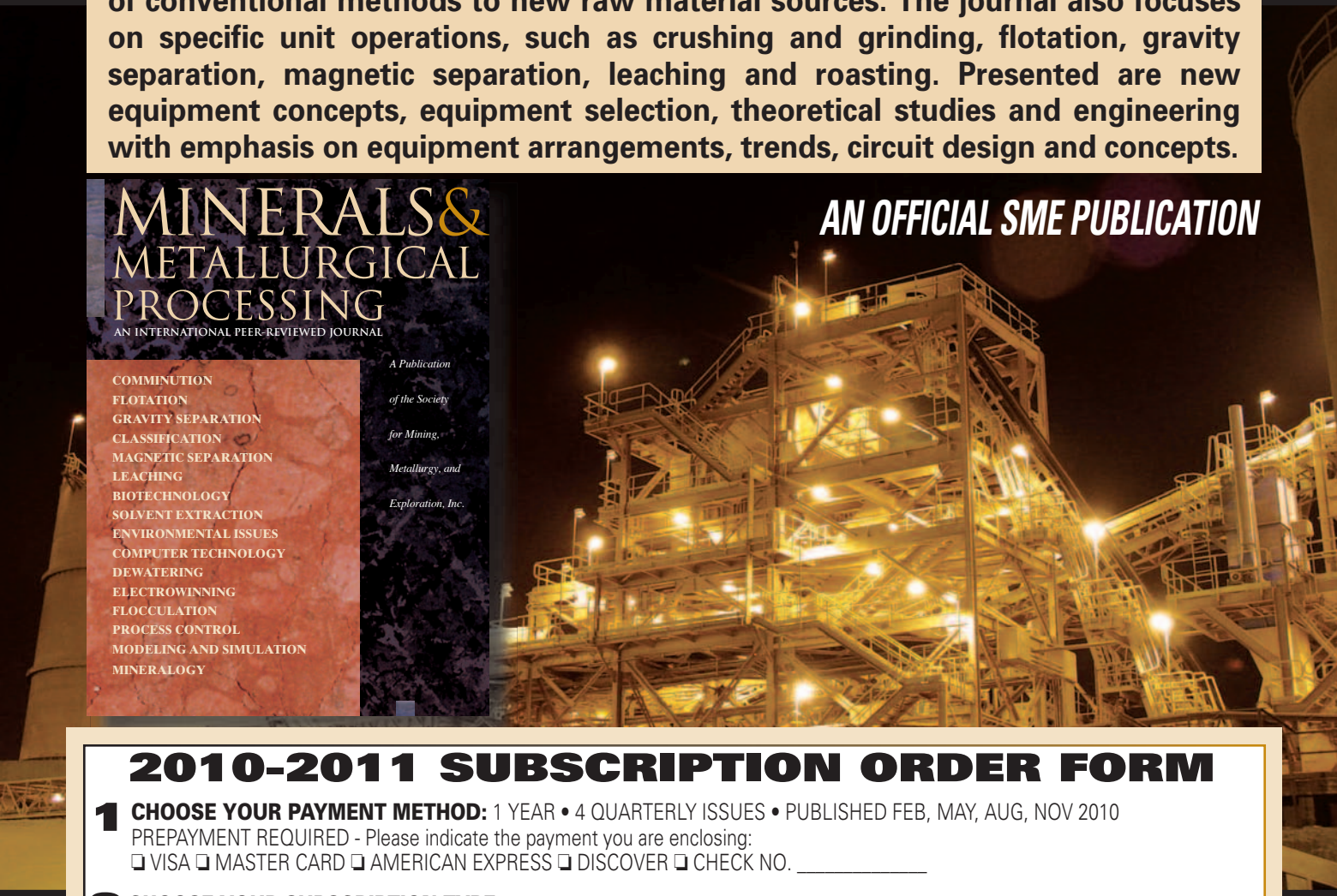
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Remarkable rescue unfolds



Steve Kral,
Editor

Chilean rescue **major challenge**

There is a remarkable story unfolding in Chile's Atacama Desert. Remarkable in several ways. To begin with, 33 miners trapped underground following a cave-in at the San Jose copper and gold mine managed to survive for 17 days before rescuers on the surface were able to make contact with them (see page 12).

The miners, who had been living on emergency supplies that were designed for a couple of days, were reportedly in reasonably good spirits. That by itself is remarkable. After 17 days of not knowing if anyone on the surface even knows where you are or if you are alive would certainly dampen anyone's spirits.

Unfortunately, their ordeal is not over and, according to Chilean authorities, probably will not be for up to four months, and that is if everything goes according to plan with no complications.

Rescuers will need to drill a new shaft, 66 cm (26 in.) in diameter, in order to bring the men to the surface. And, due to the instability of the mine, it could take through the end of the year to drill the 700 m (2,300 ft) needed, according to Jaime Manalich, Chile's health minister.

The rescue is reminiscent of the Quecreek Mine rescue in Pennsylvania in 2002, where several miners were trapped in a cave-in at the coal operation. Then, rescuers needed to drill only 74 m (240 ft) to reach the men.

But the rescue attempt at the San Jose Mine is not impossible. John Urosek was part of the rescue at Quecreek and is now chief of mine emergency operations with the U.S. Mine Safety and Health Administration (MSHA). He told the *BBC News* that it is not impossible. "I would put this at the tough end of things," he said. "It's not mission impossible, but it's a difficult mission."

Rescuers will require a raise drill to reach the trapped miners. Fortunately, Murray & Roberts, a South African mining company, has one nearby. The machine can drill up to 1,100 m (3,600 ft), depending on rock conditions. So depth is not a problem.

However, conditions at the mine will require drillers to adjust the way they operate the drill. Under normal circumstances, a narrow pilot hole would be drilled down to the area where the miners are trapped. Another larger drill bit would then be attached from inside the mine and reamed back to the surface, creating the 66 cm (26 in.) shaft in which to extract the miners.

That is not the case at San Jose. The collapse that trapped the miners blocked the access to their refuge. The drill has be directly above the exit point and it took several days of surveying to find that point.

The most delicate part of the operation will be the breakthrough, Manalich said. "When you drill a big hole through the roof, you have to be careful you don't collapse it," he said. "The last few hundred feet or so is very slow going."

One more difficulty involves the debris from reaming the pilot hole. It will all fall to where the miners are located. They may have to remove that debris, a tough task when a person is physically fit, but made even more difficult by the shape the men will be in following four months trapped underground.

Despite the difficulties that lay ahead, optimism remains. Chile's president Sebastian Pinera declared that the miners would be home by Christmas. And, as MSHA's Urosek said: "Miners are a pretty tough breed and, in the end, they are going to get these people out and these guys will do just fine."

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The world's growing population is straining the infrastructure of the world's major cities, particularly their transportation and utility lines. The increased use of tunnels to relieve congestion on the surface is requiring the use of larger tunnel boring machines (TBM). This month's *Tunneling & Underground Construction* takes a look at the development of the TBM and the direction the machine is headed.

Another feature this month discusses the advantages of building single bore transit tunnels to house light rail or subway tracks in a stacked configuration. This concept, as opposed to twin tunnel systems, allows for significant savings in construction costs and time, as well as reducing the effects on the environment. ■

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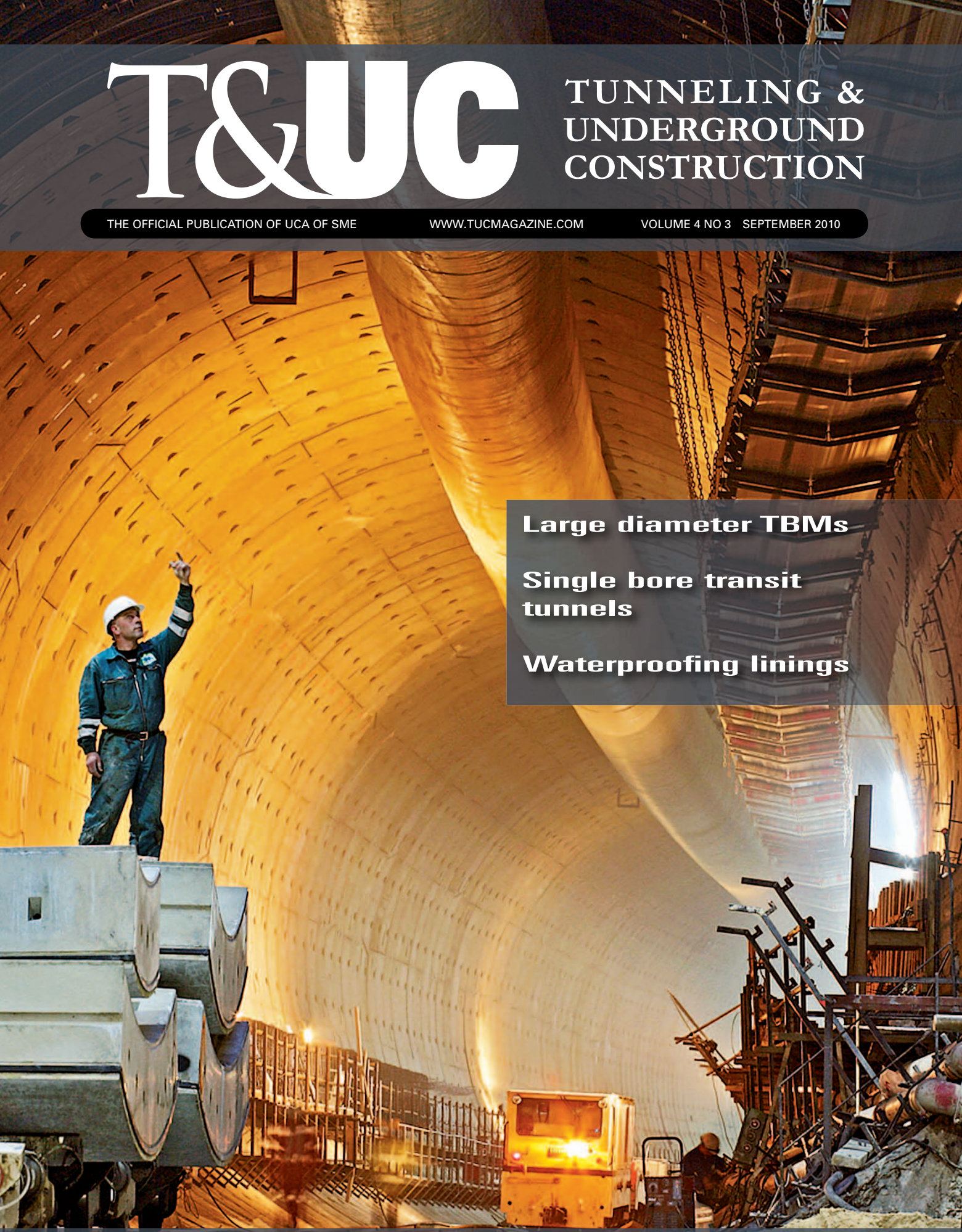
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THE OFFICIAL PUBLICATION OF UCA OF SME WWW.TUCMAGAZINE.COM VOLUME 4 NO 3 SEPTEMBER 2010



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COVER STORY



CONTENTS — A 15.2-m (50 -t) Herrenknecht earth pressure balance-shield tunnel boring machine excavated 3,650 m (12,000 ft) of ground for the M-30 highway tunnel in Madrid, Spain. The breakthrough was achieved on July 17, 2006 – 4.5 months ahead of schedule. An average of 100 lining segments were installed every day. Cover photo courtesy of Herrenknecht.

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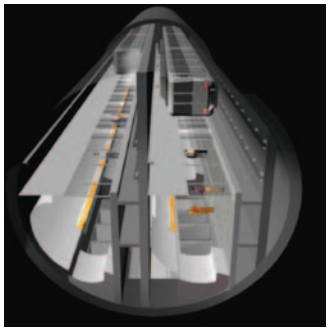
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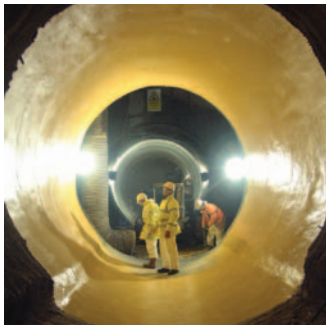
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CHAIRMAN'S COLUMN

Thanks to those who made NAT such a success

On behalf of the Executive Committee of the UCA, I would like to thank all of you that attended the North American Tunneling (NAT) conference 2010 in Portland, OR, June 20-23, 2010. Mark Ramsey, NAT 2010 conference chairman and his committee members created a very interesting and educational conference. The UCA sold 108 exhibitor spaces and had 803 registered attendees. Because of the strong attendance, the conference was a financial success for our organization and will enable us to advance some of our programs that are critical to the future of our industry — programs such as our scholarship program. I would also like to give a special note of appreciation to the staff at the SME office in Denver, CO. They worked very hard to create an event that was well organized and operated in a seamless manner.

A special note of appreciation from the executive committee to the various NAT 2010 awardees; Ed Plotkin for Lifetime Achievement, Refik Elibay for Person of the Year, Levent Ozdemir for Educator of the Year and the Metro Gold Line East Extension for Project of the Year. I was chairman of the awards dinner and it was most interesting to listen to Plotkin and Elibay as they gave their acceptance speeches. Both gentlemen have been involved in the industry for many years. But the proverbial "light at the end of the tunnel" still burns for each of them as after dedicating their lives to the tunnel industry they still have a passion to participate and to transfer their knowledge to the next generation. Due to a health problem with his father, Ozdemir was not able to give his acceptance speech, but his efforts in educating students and industry personnel at the Colorado School of Mines is nonetheless an important contribution to our industry. Ray Henn accepted the award for Ozdemir.

I would also like to extend our congratulations to all of the people involved in the planning, design and construction of the Metro Gold Line East Extension project. This was a team effort of dedicated and competent people. The Gold Line project has become a model for future projects to emulate.

There were three full-day short courses on various subjects applicable to tunnel construction and two workshops — one in the morning on obtaining better tunnel industry specifications and one in the afternoon on legal issues impacting the industry. I want to thank the people who gave up a Sunday and attended the various sessions and to the people who took the time to prepare and conduct the various short courses and workshops. This takes a lot of time and effort, frequently done on personal time, to prepare the material required to conduct such an event. I worked with Mike Bruen on the "Creating Better Specifications" workshop and would like to thank Mike for his planning and for doing most of the organizational work. This is an important industry issue that was well attended. The discussions were quite lively as we antagonized every aspect of the industry to stimulate debate. Mike and I will be creating a white paper on this subject based on the information and input received during the workshop. I hope that the other workshop and short course attendees will continue on what was gleaned from these venues as we must educate and advance as an industry.

From the attendance of NAT 2010, it is clear that our industry is still quite strong and active in all

Continued on page 18

David R. Klug,
UCA of SME Chairman

TBM sets world-record pace at Niagara project

One of the world's largest tunnel boring machines (TBM), a 14.4-m- (47.2-ft-) diameter Robbins main beam TBM, is setting world records at Canada's Niagara Tunnel project.

The TBM had excavated 6.8 km (4.2 miles) of the 10.4-km- (6.5-mile-) long conduit for Canada's Niagara Tunnel project in Queenston, Ontario in June. Geologic conditions have largely determined the project's advance, from periodic stoppages to a world-record month of 467 m (1,535 ft) in July 2009. The advance rate is a landmark achievement for TBMs in the 14 to 15 m (46 to 49 ft) diameter range, Robbins said in a statement.

"We also raised the tunnel alignment by 45 m (150 ft) to bring the tunnel out of the Queenston shale and into more competent rock, in order to reduce overbreak," said Ernst Gschnitzer, project manager for contractor Strabag AG. Much of the tunnel face is now in whirlpool sandstone and conditions are improving. "We are happy with the current rock conditions and ground support system, as we haven't been short of challenges in the past."

Conditions in the tunnel have been variable, with significant over-break occurring within the first 200 m (650 ft) of tunneling in Queenston shale. Crews scaled down the loose rock and adopted a newly redesigned ground support program consisting of 9-m- (30-ft-) long grouted spiles, 4-m- (13-ft-) long rock bolts, wire mesh, steel straps and a layer of shotcrete.

Four different processes are currently being done from the single tunnel opening. Crews are excavating the tunnel, performing repairs in sections of overbreak, laying invert concrete, and conducting arch lining for the upper two-thirds of the tunnel.

The finished 12.8-m- (42-ft-) diameter tunnel will be fully lined with 600 mm (24 in.) thick continuously poured concrete and a polyolefin waterproof membrane to prevent leakage. The tunnel is being lined behind the TBM using separate invert and arch lining systems as well as a membrane laying machine. By May 2010, invert concreting had reached 4.8 km (3 miles) into the tunnel, while arch lining had started up recently.

The Niagara Tunnel project was initiated in June 2004 by provincially owned company Ontario Power Generation. The tunnel is the third headrace under Niagara Falls, and will add up to 500 m^3/sec (17,700 cu ft/sec) for hydroelectric generation by 2013 — enough power to service 130,000 Canadian customers

Progess at East Side Access project

The joint venture of Dragados/Judlau completed a series of short rail tunnels as part of East Side Access project in New York City. A Robbins main beam TBM was the first of two machines to finish the rail tunnels below Grand Central Station in Manhattan.

The Robbins main beam was the first ever TBM initially assembled at the jobsite using OFTA.



The completion, on June 2, was an important milestone for the East Side Access project, which was stalled in the 1970s due to lack of funding. Altogether, the Robbins machine excavated 5.2 km (3.2 miles) of tunnel since its 2007 launch, averaging 16 m/d (52 ft/day) in the final month of boring.

A second double shield TBM was preparing to embark on its third of four tunnels. The short tunnels, four to each TBM, will ultimately lead to the upper and lower departure and arrival platforms of two main stations currently under construction.

The Robbins machine was retracted at the end of each tunnel heading using specially designed, hydraulic side and roof supports to move past installed ring beams and rock bolts. "The bolted cutterhead, in five sections, was the best possible design for boring multiple tunnels and retracting back through the ring steel," said Kerry Clark, Robbins field service superintendent. The hydraulic extensions, combined with the removable cutterhead pieces, allowed the entire machine diameter to be reduced from 6.7 m (22 ft) to just 6 m (20 ft).

Crews maintained good advance rates despite difficult project conditions. At one point, the parallel TBM excavations were separated by a slim 1.5 m (5 ft) thick pillar of rock, requiring the Robbins machine to operate at 45 to 50 percent gripper and thrust pressure. Much of the drive was also done with a live subway tunnel 1.5 m (5 ft) overhead. ■

Construction on Port of Miami tunnel begins

Contstruction work has begun on the Port of Miami Tunnel project to prepare the area for tunneling.

A $45-million Herrenknecht tunnel boring machine (TBM) that will be constructed underground is expected to begin digging in September, *MiamiTodayNews.com* reported.

The tunnel is one of three transportation megaprojects under way in South Florida. The others are the $1.7 billion Miami Intermodal Center near Miami International Airport and the $1.8 billion reconstruction of Interstate 595 in Broward County.

The tunnel will link the port for the first time to area expressways in a bid to speed cargo traffic and ease traffic congestion in downtown Miami.

Currently, trucks headed to or from the port meander through surface streets just north of downtown Miami as they make their way between the seaport and Interstates 395 and 95.

The Herrenknecht TBM will be built during the next year and shipped in parts to Miami where it will be reassembled at Watson Island to begin boring the tunnel said Christopher Hodgkins, vice president of Miami Access Tunnel, the team in charge of designing, building, financing, operating and maintaining the port tunnels.

Dirt from the boring will be shipped elsewhere on barges.

The tunnel entrance will be at Watson Island on the median of the MacArthur Causeway, which connects to Interstate 395.

The project is a public-private partnership with the Florida Department of Transportation, covering $457 million; Miami-Dade County, contributing $402.5 million and Miami, set to put in $50 million.

Herrenknecht is custom designing the machine with Miami's geology in mind and aims to minimize noise and vibrations, Hodgkins said.

Once the port tunnels are dug — completion is expected May 15, 2014 — the machine is to be disassembled, barged out and shipped back to Germany for Herrenknecht to use as parts. ■





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Compaction Grouting – Highway 85 Sinkhole above Utility Tunnel, Brighton, CO

Politicians choose sides on Alaskan Way viaduct

Changing soil conditions, the reminder of what can go wrong at a project just 19 km (12 miles) away, fears of cost overruns and a clause in the contract has Seattle, WA Mayor Mike McGinn raising caution flags about the proposed tunnel project that would replace the Alaskan Way viaduct with a 2.7-km (1.7-mile) long tunnel.

A clause in state legislation states that cost overruns from the project will be paid by "Seattle property owners who benefit" from the tunnel. McGinn, who has spoken often about cost overruns, said he would sign off on agreements dealing with utility access, schedules and other planning issues that would get the work done by 2016 if the language is changed.

The Seattle Times reported that Washington Gov. Chris Gregoire, a tunnel supporter was adamant in saying, "we have no cost overruns on this project at all, zero."

The 2.7 km (1.7 miles) long tunnel will be bored with a Herrenknecht tunnel boring machine (TBM) with a 17-m (56-ft) diameter cutter face has been estimated to cost $2 billion.

Two international teams will bid in October for the six-year contract. A third team, led by Kiewit Pacific, dropped out of the bid process.

The budget includes a $415-million cushion for risk, contingencies and inflation. The project also includes $500 million in surety bonds, a department of transportation (DOT) study said.

However, there is still concern.

In King County, WA, 19 km (12 miles) northwest of Seattle, soil conditions similar to those of the Seattle area where the tunnel will be built caused a TBM to stall, delaying the project and creating massive overruns. Tunnel detractors have also talked about the problems at Boston's Big Dig Project.

Tunnel supporters say the tunnel is needed to replace the Alaskan Way viaduct that was built in 1953 and could cause catastrophic harm if it were to collapse in an earthquake.

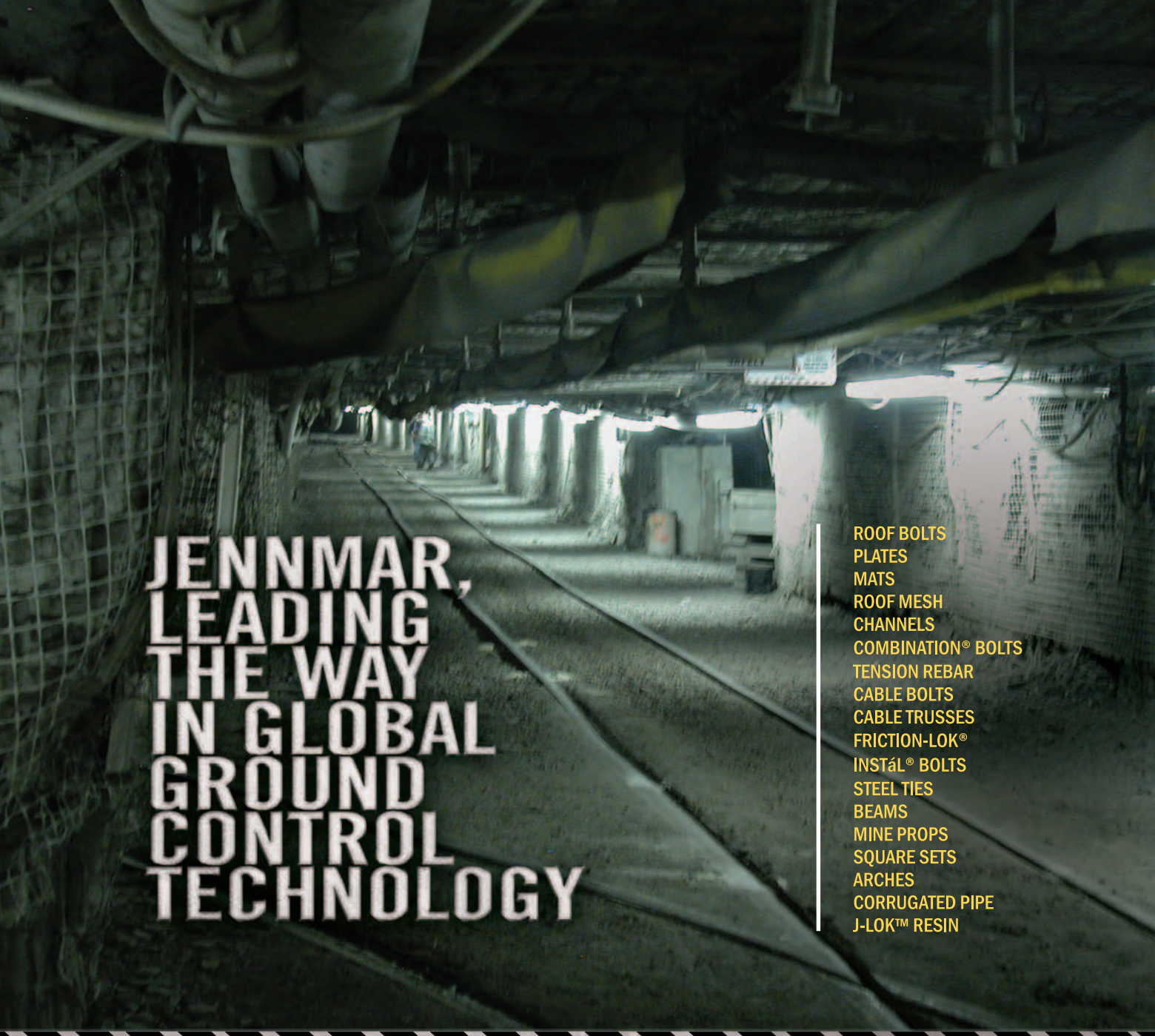
Each side has recently brought in their own experts to evaluate the project.

John Newby, a consultant hired

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Four Lovat machines ordered for Eglington Crosstown project

Lovat Inc. will build four custom tunnel boring machines (TBM) that will be put to work on Toronto's new Eglington Crosstown Light Rail Transit (LRT) project that will incorporate both above and below ground travel.

Metrolinx, Ontario's regional transportation agency for the Greater Toronto and Hamilton area, placed the $54 million contract with Lovat.

The Eglinton Crosstown LRT project aims to take more cars off the road, improve air quality, create approximately 46,000 jobs, reduce travel times and support a stronger regional transit system in the greater Toronto area. The project is estimated to cost $4.6 billion and will be completed by 2020.

About 12 km (7.4 miles) of the Eglinton LRT will run underground.

Lovat Inc. is also supplying the Toronto Transit City (TTC) projects with four other TBMs.

The TTC's $58 million order for machines last year will be used to extend the subway into York Region.

The same machines could not be used for both projects because the tunnel on Eglinton will be about 6 m (19-ft) wide, compared with the 5.4-m (18-ft) tunnel on Spadina.

Light rail vehicles require pantographs (overhead structures) for their power supply, unlike the subway, which uses a third rail, Metrolinx head Rob Prichard said.

The ridership on Eglinton will be adequately served by light rail rather than subway, Prichard told *The Toronto Star*.

The first of the tunneling machines, will take about 18 months to build,

Most of the tunneling will take place between 2012 and 2014, with the entire first phase of the line complete by 2020.

The current Metrolinx plan calls for all four Transit City projects and a $1.5-billion express bus lane system in York Region to be completed over 10 years. ■

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Tunnel boring machine arrives at New York's 2nd Avenue Subway project

A tunnel boring machine (TBM) originally built by The Robbins Company to dig New York Metro Transit Authority's (MTA) 63rd Street tunnel in the late 1970s is back underground and ready to bore another tunnel in New York.

The 181-t (200-st) cutterhead was lowered into the launch box of the Second Avenue Subway tunnel. The majority of the parts for the machine are now in place to begin mining the western tunnel for the new two-track line that will reduce overcrowding and delays on the Lexington Avenue line and provide better access to mass transit for residents of the far east side of Manhattan. The line is being built in phases. Mining for the first phase was scheduled to begin in May.

Construction of Phase I of the Second Avenue Subway began in April 2007. When complete in December 2016, Phase I will serve 213,000 daily riders who are currently using other subways, buses, taxis or cars. It will decrease crowding on the adjacent Lexington Avenue Line by as much as 13 percent, or 23,500 fewer riders on an average weekday. It will also reduce travel times by up to 10 minutes or more (up to 27 percent) for those on the far east side or those traveling from the east side to west midtown.

The Second Avenue Subway TBM was originally manufactured about 30 years ago and has been used on at least four other projects. The machine has been reconditioned and was rebuilt in Newark, NJ at contractor Schiavone's yard where it was assembled, tested and then disassembled for shipment to the site. The TBM was most recently used on the Fall River CSO project in Fall River, MA.

The total length of the TBM plus the trailing gear that contains the

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mechanical and electrical equipment that powers the cutterhead is 137-m- (450-ft-) long. The cutterhead has 44 rotating discs and is the vital piece of the TBM that will drill and excavate the approximately 2,300-m- (7,700-ft-) long tunnels.

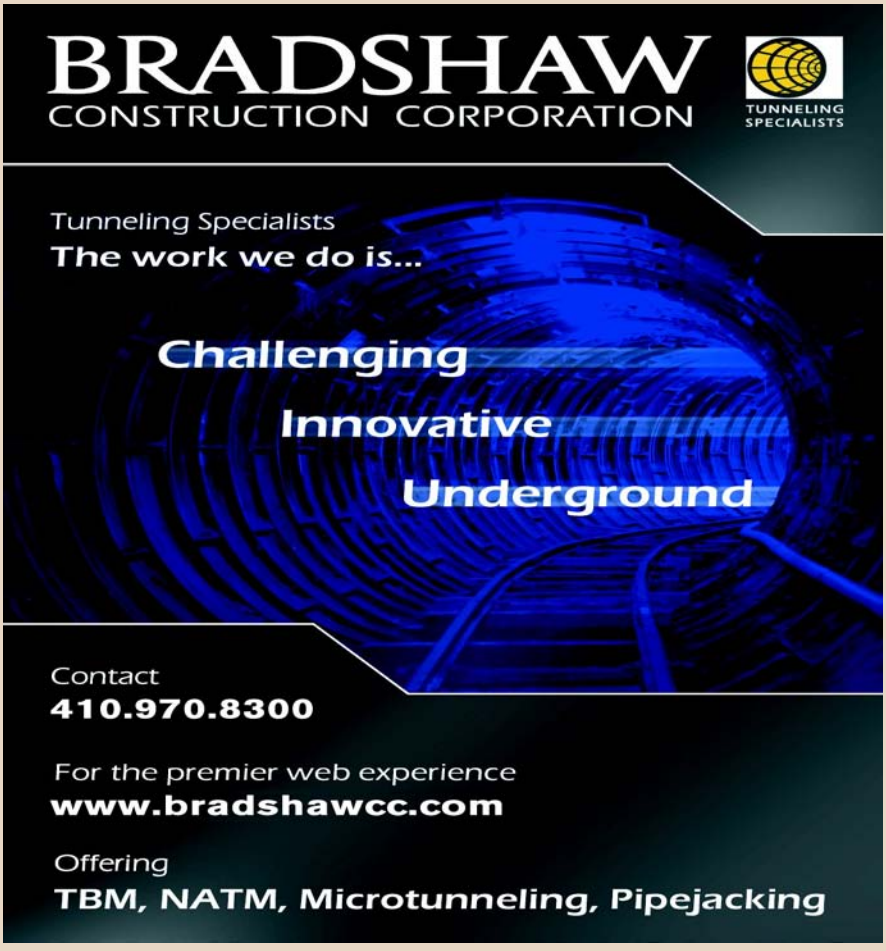
"The arrival of the TBM at Second Avenue is a clear indicator that the MTA is delivering on a major expansion project that will have a dramatic impact on Manhattan's East Side, easing overcrowding within our transit system and serving as an economic driver for the region as a whole," said MTA Capital Construction President Michael Horodniceanu.

The launch box, which extends from just south of 92nd Street to 96th Street along Second Avenue and is approximately 250-m- (815-ft-) long by an average of 20-m- (63-ft-) wide and 17-m- (56-ft-) deep, forms the shell of the new 96th Street Station. This is also where the machine will be assembled and launched from one of two starter tunnels in May. Excavation of the launch box began in June 2009 using a combination of controlled blasting and mechanical methods. In total, 89,000 m^3 (117,000 cu yd) of rock and soil were removed.

"The arrival of the TBM at Second Avenue is a clear indicator that the MTA is delivering on a major expansion project that will have a dramatic impact on Manhattan's East Side easing overcrowding within our transit system and serving as an economic driver for the region as a whole."

Michael Horodniceanu, MTA president

The Second Avenue Subway will reduce overcrowding and delays on the Lexington Avenue line and provide better access to mass transit for residents of the far east side of Manhattan. The line is being built in phases, with the Phase I of the Second Avenue Subway providing service from 96th Street to 63rd Street as an extension of the Q train, three new ADA-accessible stations along Second Avenue at 96th, 86th and 72nd Streets, and new entrances to the existing Lexington Avenue/63 Street Station at 63rd Street and Third Avenue. ■





Caltrans begins tunneling for the Caldecott fourth bore

Tunneling on the fourth bore of the Caldecott Tunnel began on Aug. 9 when one of the world's largest roadheaders, a 118 t (130 st), 16-m- (54-ft-) long, 4.2-m- (14-ft-) tall machine that was built in Germany and assembled on site, began boring on the tunnel to widen Highway 24 between Orinda, CA and Oakland, CA.

The $5.2 million project will ease traffic congestion at the choke point by adding two freeway lanes. The roadheader will dig a 1,032-m- (3,389-ft-) long bore in the mountain. The project is expected to be complete in 2013.

Contractor Tutor-Saliba will use the roadheader to excavate about two-thirds of the tunnel from the Orinda side. A subcontractor with a smaller roadheader will swing into action later to dig one-third of the tunnel from the Oakland side.

Excavated dirt and rock will be moved by a conveyor belt into trucks. The trucks will haul most of the dirt to San Francisco construction sites on Treasure Island and Hunters Point, although some may go to landfills at the Altamont Pass near Livermore.

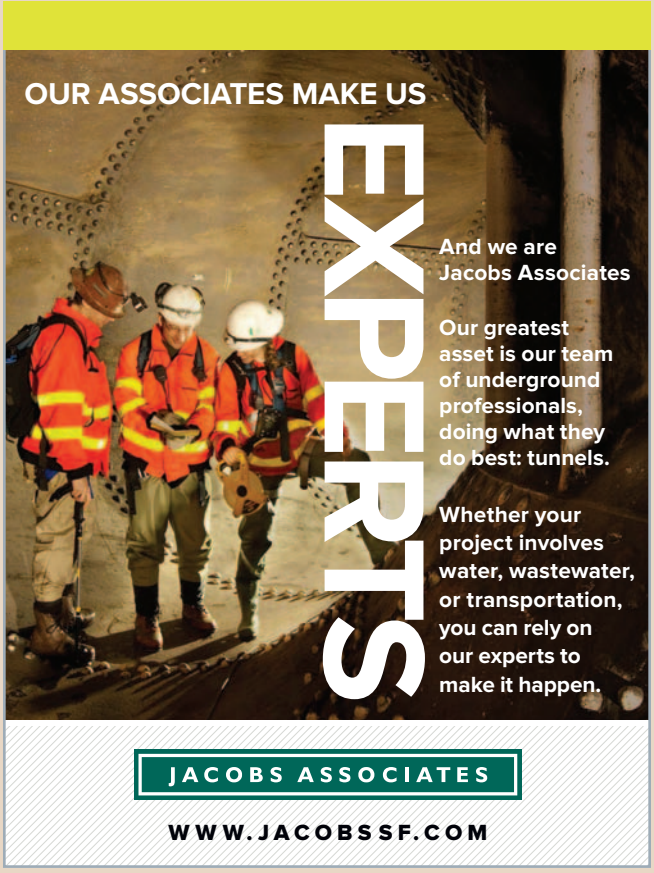
Any dirt found to have hazardous levels of naturally occurring or man-made impurities will be shipped out of the area to hazardous waste landfills, *The San Jose Mercury News* reported.

A maximum of 50 truckloads a day of dirt and rock will be hauled out of the two sides of the tunnel, Caltrans said.

Federal economic stimulus dollars will cover $197.5 million of the construction cost, while Contra Costa County sales tax will pay for $122.8 million. The rest will come from bridge tolls, and other state, local and regional sources. The original Caldecott Tunnel opened with two bores in 1937. The third bore opened in 1967 nad has since become a major point of traffic congestion.

"The new tunnel will reduce congestion for those living in the East Bay and put people to

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work," said U.S. Transportation Secretary Ray LaHood. "This is what the Recovery Act is all about."

The $420 million project relies on $197.5 million from the Recovery Act, making it the nation's second-largest investment of Recovery Act highway funds. Of the more than 12,000 highway projects, it is the largest tunnel excavation funded by the Recovery Act. The fourth bore will be the first on the route since 1964.

SR 24's existing three tunnels, which give drivers a total of six lanes, are inadequate for the heavy volume of Bay Area traffic each day. The route serves an estimated 160,000 drivers daily. When completed in 2013, the new tunnel will have 3.6-m (12-ft) lanes, shoulders and emergency walkways.

Located less than a half mile from the Hayward fault, the tunnel will be built to withstand an earthquake - as are the existing tunnels - and will include numerous safety features, including seven emergency escape passages to the adjacent tunnel.

"The new tunnel will reduce congestion for those living in the East Bay and put people to work. This is what the Recovery Act is all about."

Ray LaHood, U.S. Transportation Secretary

Of the more than $26.6 billion in ARRA highway funds available nationwide, California received nearly $2.6 billion for highways – and more than $4 billion in ARRA funding for all transportation projects, which supplements billions more in local and state spending.

As of July 30, the state had funded 946 projects, with 455 projects under way and 122 completed. ■





World's largest earth pressure TBM will be ready to begin work in Italy in 2011

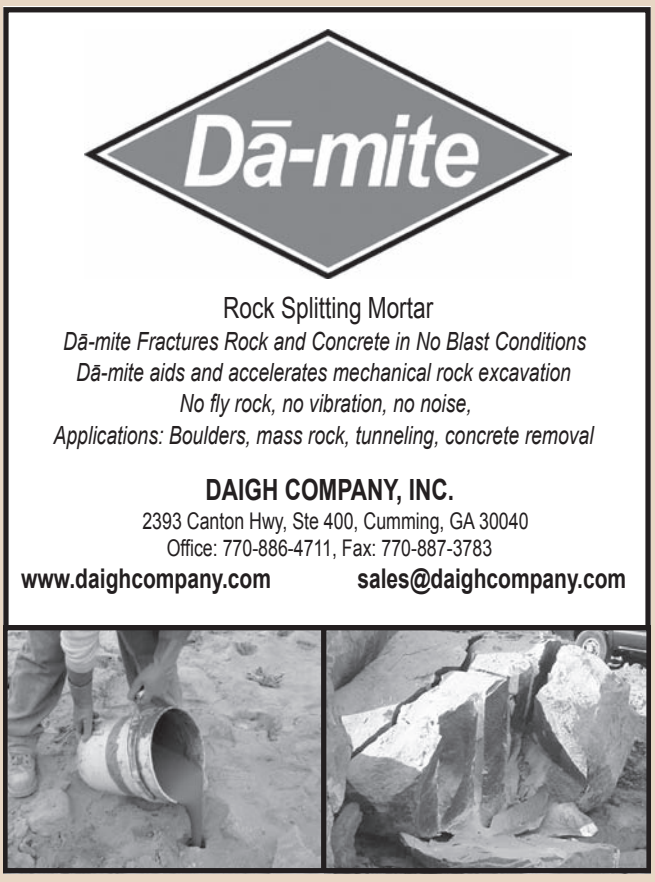
A 15.55-m (51-ft-) Herrenknecht earth pressure balance shield tunnel boring machine (TBM) will be ready to begin construction of the Sparvo Tunnel, a project that will extend the A1 highway between Bologna and Florence.

The machine will be the largest TBM ever built and will set a record in diameter in mechanized tunneling. The tunnel will consist of two parallel-running tubes with a length of 2.5 km (1.5 miles) each. The tubes will each accommodate a three-lane road. Because of the size and the geological conditions, the construction of the tunnel is considered to be the most challenging part of the overall project. The Italian contractor, Toto Costruzioni Generali S.p.A, decided to use mechanized tunneling technology to improve work safety and to accelerate the work. Toto will carry out the tunneling work in loose soils with local presence of gas using earth pressure balance (EPB) technology on a total length of 5 km (3.2 miles). The Sparvo Tunnel is part of the project awarded by Autostrade per l'Italia S.p.A.to a joint venture comprising Vianini Lavori S.p.A., Toto Costruzioni Generali S.p.A. and Profacta S.p.A.

In order to produce the two 2.5-km- (1.5-mile-) long tubes of the Sparvo Tunnel, Herrenknecht developed and built an EPB shield with an exterior diameter of 15.55 m (51 ft), a weight of 4.3 kt (4,700 st), a cutterhead power of 12,000 kW (16,100 hp) and an overall length of 120 m (393 ft). After completion at the Schwanau plant, the TBM will begin its work in Italy.

Preparations for the assembly of the record-breaking TBM have begun in Schwanau. A tight time schedule has been set for the construction of the Sparvo Tunnel. In line with the current planning, the machine is expected to begin tunneling near Florence toward the north as early as in the first half of 2011. The 6-7 lot is the last section of the Variante di Valico project that will considerably reduce the traveling time between Bologna and Florence for up to 90,000 vehicles per day after the alternate route is opened according to schedule at the end of 2013. ■





Milestone hit at No. 7 Subway Extension project

New York City's No. 7 Subway Extension project reached another milestone this summer when, on July 15, the second of two 907-t (1,000-st) tunnel boring machines (TBM) reached the chamber adjacent to the current terminus for the No. 7 train underneath 42nd Street. The breakthrough by the second TBM marked a major milestone in the $2.1-billion project that will extend the No. 7 line to 34th Street and will support the growth of an emerging community on the west side. The project is funded by the city of New York and managed by the Metropolitan Transportation Authority (MTA).

The TBM broke through into 61-m- x 15-m- x 12-m-(200-ft- x 50-ft- x 40-ft-) deep receiving chamber just below the Port Authority bus terminal in close proximity to the bus terminal foundation and utilities, as well as the 8th Avenue Subway Line. This is where the new tunnels will connect with the existing No. 7 Line terminus at Times Square.

"This marks the final leg of the second of two, 907-t (1,000-st) tunnel boring machines that have mined more than a combined 2,800 m (9,300 ft) to reach this point," MTA chairman and chief executive officer Jay H. Walder said. "It's a major milestone working toward the completion of a project that will increase capacity within our transit system and help redevelop a vital part of our city that will spur future growth."

The two TBMs will be partially disassembled and backed up to where they began tunneling at 26th Street and 11th Avenue where they will be lifted out of the shaft.

The receiving chamber under the bus terminal was excavated by controlled drill-and-blast in 2009. Through coordination and cooperation with the Port Authority, the 24-hour construction operation was completed in six months instead of two to three years as originally planned. There was not a single complaint from the public.

The TBMs were launched in the summer of 2009. As the machines mined, they placed precast concrete lining rings along the excavated tunnel, making up the permanent liner of the finished tunnel.

Tunneling north from 34th Street presented unique challenges, as the tunnels run under Amtrak/NJ Transit tunnels, tunnels to the former New York Central Line, the Lincoln Tunnel and the Port Authority Bus Terminal and ramps.

Work will now commence on station entrances and finishes, as well as support facilities such as ventilation and traction power substations. Customers will be able to take advantage of the new service in December 2013 as scheduled. ■

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Kenny/Obayashi low bidder for OARS project

The joint venture team of Kenny/Obayashi presented the lowest of three bids for Phase 1 of the Olentangy-Scioto Intercepting Sewer Augmentation Relief Sewer (OARS) in Columbus, OH.

The project includes 7,100 m (23,300 ft) of 6.1-m (20-ft) internal diameter tunneled sewer as well as a 16-m (52-ft) internal diameter pump station shaft (Shaft 1), a 13-m (42-ft) internal diameter screen shaft (Shaft 2) and a 14-m (48-ft) internal diameter shaft (Shaft 6) with an internal surge chamber and hydraulic drop pipe. The depth to tunnel invert ranges from approximately 40 to 56 m (130 to 185 ft). Depth to bedrock varies from 9 to 37 m (30 to 120 ft). The tunnel will collect combined sewer overflows through the downtown area and will be constructed through limestone bedrock containing Karst features. Ground water pressure at the tunnel elevation is anticipated to vary and require a pressurized face tunnel boring machine.

Kenny/Obayashi was the lowest of three bidders at $264,506,000. Other bidders to the City of Columbus, Department of Public Utilities opened bids for Phase 1 of the OARS, were Jay Dee/Traylor Brothers/J.F. Shea with a bid of $290,499,392 and Kiewit/McNally at $306,956,100. Pending approval by the city council, notice to proceed was expected to be given in September.

Phase 2, which is expected to be advertised for bids in early 2011, will include off-line Shafts 3, 4 and 5. Both projects are being designed by DLZ Ohio and Jenny Engineering Corp. ■

Continued from page 6

by the pro-tunnel city council said "Clearly there is inherent risk in anything you do in the subsurface. You're dealing in ground you can't see."

However, Newby said that while risk can be particularly great beneath a dense urban area, most risks can be mitigated with close management and careful maintenance, and that the chance of a TBM completely breaking down is extremely rare.

"WSDOT is doing the right things to address and manage these risks. WSDOT has assembled a strong team, combining their experienced staff with external tunnel and risk experts, and the design-build process provides the opportunity for this team to work together with the selected...contractor team giving the project the best chance for success.

Thom Neff, a longtime project manager and soil expert in Boston, New York and Portland, OR, warned of tricky soils below downtown, which he called worse than in Boston's Big Dig. In particular, there is no place in the route where the soil is all of the same type, he said.

"They're definitely worse than Boston. We didn't have abrasive soil, we didn't have boulders eight feet in diameter, we're not in a seismic zone, and we didn't have water pressure," he said, referring to Boston's extensive, problem-plagued project. ■



New Irvington Tunnel contract awarded

The joint venture of Southland Contracting Inc. from Ft. Worth, TX and Tutor Perini Corp. of Sylmar, CA was awarded the contract for the New Irvington Tunnel Project by the San Francisco, CA Public Utilities Commission (SFPUC).

Southland/Tutor Perini JV submitted the lowest qualified bid at $226.6 million, which is $26.6 million below the commission's estimate.

The 5.6-km (3.5-mile) New Irvington Tunnel will have an internal diameter of approximately 2.6 to 3.2 m (8.5 to 10.5 ft). It will lay parallel to the existing tunnel between the Sunol Valley south of Highway I-680 and Fremont, CA.

Construction is expected to begin in September 2010 with final completion by April 2014.

Located between the Calaveras and Hayward fault zones, the mixed-face tunnel is made up of interbedded layers of sandstone and shale, with several smaller fault zones. Adding more complications, the tunnel offers 213 m (700 ft) of cover and high hydrostatic head with potential water inflows up to 63 L/s (1,000 gpm).

The new tunnel will provide a seismically designed connection between water supplies from the Sierra Nevada Mountains and the Alameda Watershed to Bay Area water distribution systems. Not only does it provide a seismically sound alternative to the existing tunnel, the new tunnel will allow the SFPUC to take the existing tunnel out of service for much needed maintenance and repair. ■

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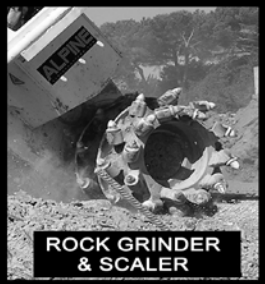
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Chairman's column

Continued from page 2

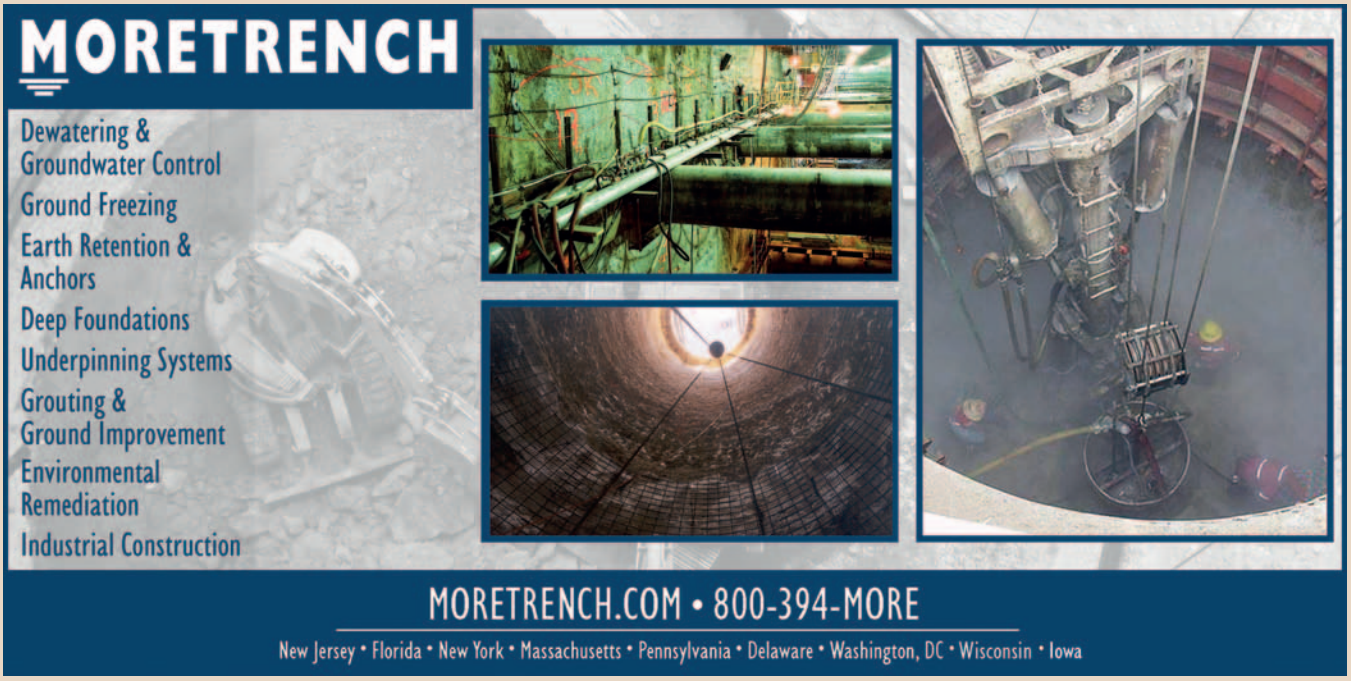
sectors. The gauge of the industry is driven by large projects and programs such as the ARC Program Hudson River Tunnels, Washington DOT Alaskan Way Tunnel project, the DC-WASA Blue Plains Tunnels, NEORSD Euclid Creek Tunnel project and the TTC Eglinton Subway Extension. All of these projects are advancing through the bidding stages. Other projects and programs are advancing in Austin, TX, San Francisco, CA, Atlanta, GA and Cincinnati, OH. These, and other upcoming projects, are detailed in the Tunnel Demand Forecast section of this magazine (page 40).

During the past month, I was underground on two interesting projects that are important to our industry that I am sure will be evaluated very closely in upcoming conferences. First, I was underground at the MTA No. 7 Subway Line Extension project in New York City. The construction of the station cavern is awe-inspiring due to its complexity and size. It was there that I observed a situation that will impact our industry — the successful tunnel boring machine (TBM) construction of hard rock tunnels with the use of one-pass precast segmental tunnel linings. Most people think that these are only applicable in soft ground applications. However the people at the project installed the linings with a high degree of precision and the quality appeared excellent. Congratulations to Jim Marquardt and the people of S3 II JV for demonstrating that complex projects can be constructed with quality in a major urban environment.

The second project was the Devil's Slide Tunnel project south of San Francisco, CA. The project is interesting as the contractor is casting the final lining while continuing to excavate the two north and southbound tunnels from the south portal. A section of the tunnel is completed, with the final lining in place and with architectural reliefs cast into the final lining concrete at eye level of the motorists that will be using the tunnel. Plus the arch is now painted. The project will hole through at the north portal in October of this year. I want to thank Paul Madsen for taking me on the "walkabout" and to Dan Griffin, project manager, as well as the people of Kiewit Pacific Co. for demonstrating that quality work can be performed in difficult conditions.

On a final note, I am advising that, in the June UCA Executive Committee meeting, changes were made in the structure of the UCA Education and Training Committee as outlined by committee chairman Bill Edgerton, and agreed to by the executive committee. The UCA and the committee members do not have the resources and/or time to develop, publish and implement education and training programs at this time. This is best left to academic institutions, organizations and companies that have the expertise and resources to perform such work. The new role of the committee will be one of an advisory capacity that will review and consult, providing industry comments and assistance were feasible. The current committee is non-active and at my request (e-mail: dklug@drklug.com) and Bill Edgerton (e-mail: edgerton@jacobssf.com) direct an expression of interest complete with your full contact information to Bill or I if you are interested in serving on this committee .

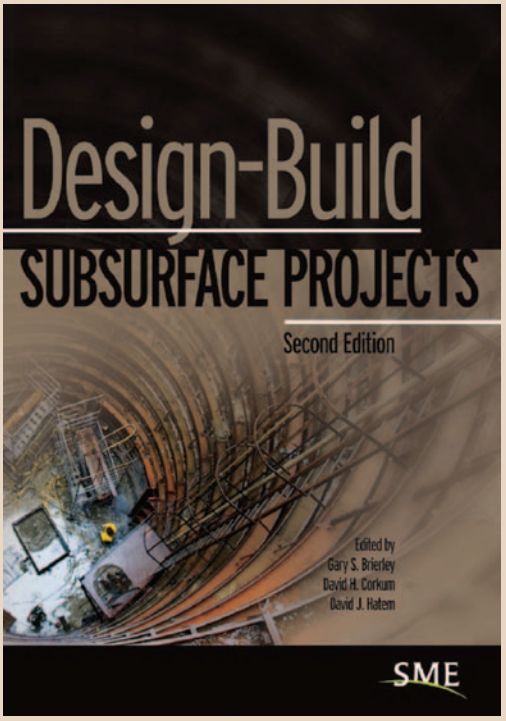
We are looking for "working committee members" and not "resume committee members" to assist Edgerton in this important industry endeavor. ■



NEW MEDIA

Design-Build Subsurface Projects, Second Editon

2010, Edited by Gary S. Brierley, David H. Corkum, David J. Hatem, published by SME, 8307 Shaffer Parkway, Littleton, CO 80127, phone 800-763-3132 ext. 225, e-mail books@smenet.org, website www.smenet.org/store, ISBN-13: 978-0-87335-321-2. Book Order No. 321-2, 228 pp., $89 SME member, $69 student member, $109 non-member.



Design-build construction has become so widely accepted that owners and their advisors must seriously consider this approach when making decisions about project delivery. With its opportunities for cost containment and substantial risk transfer, design-build is increasingly becoming the delivery method of choice for owners with challenging funding limitations.

But deciding to use the design-build system for underground projects is one thing; successfully implementing it is quite another.

Design-Build Subsurface Projects, Second Edition, can help bridge that gap. This cutting-edge book provides a straightforward, comprehensive look at how to make design-build work on complicated projects involving tunnels, highways, dams and deep foundations.

The authors are a "who's who" of subsurface construction experts, many of whom are key players in the most high-profile and challenging projects in the world. Drawing upon their wealth of practical experience, they spell out a list of common sense best practices that can be used by today's project owners and designers.

Be advised: these authors do not shy away from the many thorny issues of design-build. Nor are they unabashed cheerleaders. They dispassionately explore both the advantages and disadvantages of this system, which must be carefully weighed and evaluated so planners can decide what is best for their projects based on all of the important variables, including third-party impacts and environmental/community concerns.

The reader will find extensive information about procurement, as well as risk allocation issues, which are significantly different from the design-bid-build approach. Team structure, agreements, design development, subsurface exploration, geotechnical reports, construction phase issues and insurance are also examined in great detail.

Design-build Subsurface Projects is an indispensable resource for owners, engineers, construction managers, contractors and others involved in the design and construction of subsurface projects. You will gain a thorough understanding of how and why the system works and where the pitfalls can arise. The authors' years of experience will benefit even the most seasoned of practitioners. ■



FEATURE ARTICLE

Large diameter tunnel boring machine development

Martin Herrenknecht and Karin Bäppler

Dr.-Ing. E.h. Martin Herrenknecht is chairman of the board of management and **Dr.-Ing. Karin Bäppler** is with the sales department, respectively, with Herrenknecht AG, Germany, e-mail bappler.karin@herrenknecht.de.

The world's growing population and rapidly proceeding urbanization are boosting an enormous demand for new and high-capacity infrastructures to secure the mobility of goods and people.

Densely populated areas face the challenge to provide efficient traffic infrastructure, such as a modern public transportation system. At the same time, the maintenance and modernization of supply and disposal structures for water, sewage, energy and communication are also essential. Additionally, supra-regional transportation routes such as long distance water diversion schemes are the challenges for the future. All these projects are as demanding as they are characterized by a tight time schedule.

In this context, the demand for efficient tunnels for traffic and utility lines is increasing as the way of new infrastructures leads, in most cases, underground because of limited space above ground. Also, tunnels are the obvious choice to cross natural barriers like mountain ranges.

The tendency of the upcoming traffic tunnel projects shows the demand for large to very large profiles. The increasing need for high-performance infrastructure in the sector of transport and utility tunneling favors tunnel solutions and, thus mechanized tunneling. With the manufacturing of one of the first of the largest type of tunnel boring machine (TBM) (mixshield, 14.2 m or 47 ft in diameter) for the fourth tube of the Elbe road tunnel in Hamburg, Germany and the largest TBM to date for the inner-city tunneling (earth pressure balance (EPB)-shield, 15.2 m or 50 ft) for the M30 highway project in Madrid, Spain, as well as the two (15.43-m- or 51-ft- mixshields), TBMs for the Changjiang Under River Tunnel Project in Shanghai, China, the feasibility of large diameter tunnels, and the outstanding examples for applied technical engineering, are given (Fig. 1).

The 15.43 m (50.6 ft) mixshield TBM, built by Herrenknecht, is the largest in the world. It was built for the Changhai Changxing Under River Tunnel.



The SMART tunnel project in Kuala Lumpur, where two mixshields with a diameter of 13.21 m (43 ft) have been used, is one of the first pioneering examples to show that the tunnels can take over more complex service functions. With its dual-usage, such as preventing flooding and alleviating traffic congestion, the project presents the tendency of extending the utilization ratio of the future tunnels.

Trend of very large diameter tunnel profiles

More than 70 machines with diameters larger than 10 m (33 ft) had been delivered by the end of 2009. However, tunnel projects are often planned with diameters exceeding the 10 m (33 ft) diameter limit. The large diameter TBMs are not restricted to special ground types as they are applied for both soft and hard rock or mixed face conditions. Mechanized tunneling with diameters larger than 15 m (49 ft) are now state-of-the-art and can be operated safely. Compared to conventional

construction methods, the mechanized shield tunneling with larger diameters is considerably faster and its limits are set by logistical issues such as removal of excavated material, rather than by construction safety or financial questions. Large tunnel profiles allow contractors and planners the possible installation of additional service and safety facilities for the operation of the tunnel. Herrenknecht's large diameter TBMs operating worldwide show that extremely large tunnel diameters can be safely and efficiently produced with the chosen tunneling technology. Examples include the machines used for the Fourth Elbe tunnel in Hamburg, the Lefortovo and Silberwald tunnels in Russia, the SMART tunnel in Kuala Lumpur, the M30 highway project in Spain and the two 15.43-m- (51-ft-) diameter machines that excavated parallel tunnels near Shanghai.

Challenge in Spain

At the M30 Highway North tunnel in Madrid, an EPB-shield 15.2 m (50-ft) excavated and lined the three-lane, 3.65-km- (2.3-mile-) long highway tunnel in the center of Madrid with an extremely tight time schedule. The target construction time of 12 months could be reduced, and the eight-month tunnel construction time equalled an excellent TBM performance of more than 450 m/month (1,476 ft/month). The unique TBM with two concentrically arranged cutting wheels and three screw conveyors for material discharge out of the working chamber achieved top performances of up to 36 m/d (118 ft/day) of excavated and lined tunnel.

The tunnel profile was not a challenge on this project, but the logistics were. During the construction of the 3.65-km- (2.3-mile-) long highway tunnel, an average of 60 trucks a day went to the inner-city construction site for the delivery of the segments used to line the tunnel. At peak times, 720 trucks passed the construction site on one day to remove the excavated material.

World's largest TBMs to date applied in Shanghai

The largest current machines, two mixshields 15.43 m (51 ft) for the Changjiang Under River Tunnel Project in Shanghai, excavated parallel 7.47-km (4.6-mile) long, three-lane highway tunnels. They excavated at a depth of up to 65 m (213 ft). The tunnels connect the Changxing River Island with the mainland of Pudong/Shanghai.

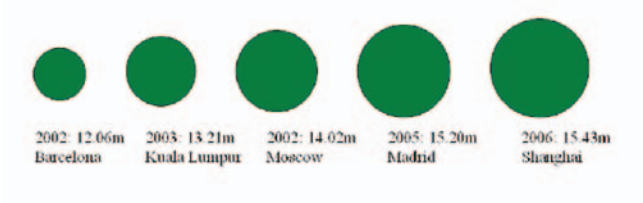
The innovative features of the shields are the cutting wheels that are accessible in free air for the replacement of the cutting tools.

Two other large diameter mixshields with diameters of 14.93 m (49 ft) excavated and lined 2.9 km (1.8 miles) of road tunnel each. Both machines crossed parallel beneath the Yangtze River in Nanjing (Jiangsu Province, eastern China). The machines were also equipped with the feature of cutting wheel arms that are accessible under atmospheric conditions.

In November 2006 and January 2007, respectively, the TBMs began the construction of the Shanghai Changxing Under River Tunnel" in China.

FIG. 1

Largest TBM by year (Herrenknecht AG).



Parallel 7,170-m- (23,525-ft-) long motorway tunnels were built between the mainland of Pudong and the island of Changxing. The waterway in between is a busy main shipping route. The connection between Changxing and the island of Chongming was achieved by a bridge construction.

The parallel motorway tunnels have two levels. The upper level contains three lanes for road traffic and the lower level is planned to integrate a rescue lane in the center and a safety passage.

The main challenges of this project were the large shield diameter of 15.43 m (51 ft) and the predicted geological and hydrological conditions with high ground water pressures of up to 6.5 bar.

The tunnels were built in clayey formations below the ground water table. At the deepest point, the tunnels run about 65 m (213 ft) below the surface.

Therefore, both mixshields were designed for a maximum working pressure of 6.5 bar. To avoid adhesion of sticky clay at the cutting wheel, its center area was equipped with its own slurry circuit. Large openings in the cutting wheel optimize the material flow and reduce the risk of blockage of material in the center.

A special feature of the soft ground cutting wheel is six accessible main spokes, sealed against the water pressure. The design of the cutting wheel was conceived in order to allow man access to its interior space in free air, sealed from the ground water pressure outside.

To handle the clayey soil conditions the cutting wheel was equipped with soft ground tools and buckets. Tool change devices integrated in the cutting wheel allow workers to replace tools under atmospheric conditions from the interior of the cutting wheel.

The tunnel is lined with reinforced concrete segments. The heavy segments that weigh up to 16.7 t (18.4 st) each were delivered by two special trucks from the segment fabrication yard, about 1.5 km (1 mile) away from the jobsite. The tunnel lining has an inside diameter of 13.7 m (45 ft). Each tunnel ring consists of 9+1 segments and has a length of 2 m (6.5 ft).

The breakthrough of each 7,170 m (23,525 ft) tunnel was in May 2008 and September 2008, 12 and 10 months earlier than scheduled, respectively. The commissioning of the BOT tunnels was planned for 2010. The structural

Workers at the Gottahard Base Tunnel project celebrate the breakthrough of the 9.58-m- (31-ft-) Herrenknecht tunnel boring machine, which had been given the name Gabi 1. The breakthrough came six months ahead of schedule. In the meantime, Gabi II reached its target in Amsteg. On the southern side of the Gotthard, there are still two Herrenknecht Gripper-TBMs on their way. The first breakthrough on the south is expected in October 2010.



steelwork for the two new 15.43-m- (51-ft-) diameter mixshields was manufactured in China. The assembly time of only four months displayed a high technical standard in the field of tunneling technology. And this was for projects with huge demands, like the excavation of the parallel motorway tunnels below the Yangtze River with high ground water pressures.

Two mixshields for the rail tunnel access route to the Brenner Base tunnel

Two mixshields with diameters of 13 m (42.6 ft) were used for the construction of the northern rail access to the future Brenner base tunnel in Austria. The tunnel will form a key link between Germany, Austria and Italy. This project is also characteristic of the demanding conditions of tunneling with large diameter TBMs in extremely heterogeneous geological formations.

The sections concerned are situated in the Lower Inn Valley where the existing 40-km (25-mile) doubletrack railway had to handle north-south traffic as well as the east-west traffic between Vienna and western Austria. It is an important junction, especially taking an increase in traffic both for freight and passenger capacity into consideration, which cannot be handled with the existing infrastructure.

One mixshield excavated a section of 5,835 m (19,144 ft) for a double-track railway tunnel on Lot 3 – 4 (Münster-Wiesing). The second mixshield, which was used before in the SMART tunnel project in Kuala Lumpur, was used for the 3,470-m- (11,385-ft-) long Lot 8 (Jenbach). Along this section, the 13-m- (42.6-ft-) diameter shield passed under the Jenbach Station, a power station channel and the motorway.

The machine had to be adapted from 13.21 m (43.3 ft) to a shield diameter of 13 m (42.6 ft) to fit the demands for the railway tunnel project Lot 8. The shield was equipped with a 4,400-kW (5,900-hp) hydraulic cutterhead drive system.

The mixshield used for the lot H3-4 excavated the 5.8-km- (3.6-mile-) long main tunnel, the longest tunnel section of the new Lower Inn Valley rail. This shield was equipped with 20 electric motors generating a power of 3,200 kW (4,300 hp). The shield started from a 30-m- (98-ft-) deep shaft. Over a length of approximately 250 m (820 ft) it passed beneath the River Inn with minimal distance between the tunnel crown and the river bottom. Also, the motorway, A 12, and the existing railway line was undercut. The shield drive ended in a cavern. The shield skin remained in the tunnel and the rest of the TBM was dismantled through the already built tunnel.

The extremely heterogeneous geological formations in the bottom of the valley of the Lower Inn, comprising alluvial sands, clays, gravels and boulders with the ground water level just below the surface, was a particular structural challenge. The 13-m (42.6-ft) mixshields are among the largest TBMs ever used in Europe.

Concerning the design of the tunnel profile, a system with two independent sealing levels was demanded for reasons of operational-technical requirements, whereby one seal level must maintain the pressure. As a standard profile, a double shell lining in the form of a circular cross-section with segmental lining and an additional fire protection shell of in situ concrete was preferred.

The TBM was designed and manufactured according to the predicted geological conditions. The mixshield technology presented the best solution for the handling of the prevailing changing geological conditions with permeability of 10–5 m/s in the gravel formations.

The tunnel face was stabilized with a bentonite suspension, which functions, not only as a support medium but also as a transport medium. In a conventional mixshield, as used for Lot H3-4 (Münster-Wiesing), a submerged wall separates the working chamber from the bulkhead, enabling the regulation of the quantity and pressure of the supporting medium separately from each other. The substantial advantage of the divided working chamber with air cushion in the rear chamber for the regulation of the support pressure at the tunnel face is the decoupling of the support pressure regulation from the total circulating quantity of the suspension in the slurry circuit.

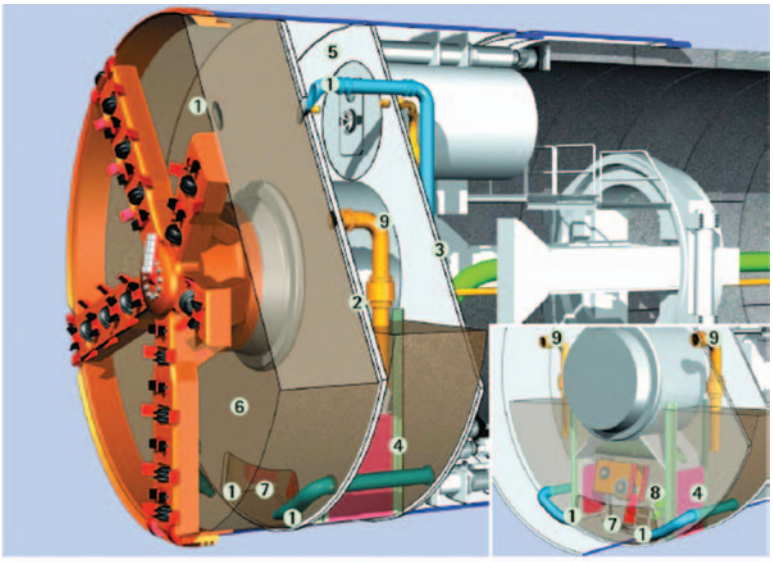
The mixshield for Lot 8 (Jenbach) was designed with an isolated invert segment. This innovative patent protected version of the mixshield is predominantly used in cohesive soils. This technology was used for the first time in the mixshield 11.67 m (38.3-ft) for the Weser Road Tunnel Project near Bremen, Germany.

With an isolated invert segment, the function of support pressure control is separated from the soil conveying. Due to the isolation of the invert area, the prepared bentonite suspension is injected directly into the working chamber. The slurry circulates towards the suction nozzle by the isolated invert through the working chamber. The pressure control at the tunnel face is no longer exercised by the submerged wall opening as is usual, but through two pressure compensation pipes (see 9 in Fig. 2) situated between the working chamber and the excavation chamber. The connecting pipes ensure that the support pressure control is still guaranteed by the air cushion and secondary compressed air equipment.

The isolation of the invert area of a TBM ensures the safe and controlled transportation of the excavated material even in cohesive and sticky ground. This makes a continuously high excavation speed possible, no matter the quality of the ground.

FIG. 2

Isolated invert. Increasing tunneling performance through controlled flow.



The excavated soil that is mixed with the suspension is pumped by slurry line to a separation plant outside the tunnel. There, the excavated soil is separated from the transport medium. It is planned to recycle the material as far as possible and to dump the unusable material.

Except for the planned downtime for maintenance, the mixshield for the double-track railway tunnel advanced 24 hours, including the weekends and holidays. The 13-m (42.6-ft) mixshield for the Lot 3-4 (Münster-Wiesing) of the Lower Inn Valley finished its 5,835-m-(19,143-ft-) long drive after approximately 19 months of excavation, six months faster than schedule.

Double-shielded, hard rock TBMs for the Brisbane North South Bypass tunnel (NSBT)

The NSBT project is a public private partnership (PPP) project. The main benefit of the PPP is that the RiverCity Motorway Co. is responsible for delivering the project on time and on budget, reducing the overall cost and construction risk to the city council. The RiverCity Motorway has contracted the design and construction of the NSBT to the Leighton Contractors and Baulderstone Hornibrook Bilfinger Berger Joint Venture (LBB JV).

The project includes parallel bored twin-lane tunnels that were excavated and lined in rock below the city of Brisbane and under the Brisbane River.

The tunnel provides a link between the Inner City Bypass and Lutwyche Road in the north with Ipswich Road and the South-East Freeway in the south. And it provides an additional Brisbane River crossing. The northbound and southbound tunnels bypass 18 existing sets of traffic lights. Moreover, they take a significant number of vehicles underneath the city each day, reducing surface congestion and, thus, enabling a series of urban enhancements to be completed in adjacent suburbs.

The geological conditions at tunnel level comprise Brisbane Tuff and Neranleigh Fervale (NF) beds. The NF beds are characterized by arenites and phyllites with quartz veins. Both the tuff and the rocks of the NF beds are generally of high to very high strength.

Due to the predicted local geological conditions along the excavation of the tunnels, a combination of tunnel excavation methods were used. They included cut-and-cover sections and sections driven by two TBM's and six roadheaders.

The overall excavated tunnel length by the TBMs is 8.4 km (5.3 miles). Two 12.34-m (40.5-ft) double-shielded, hard rock TBMs of identical design were used for the parallel bored tunnel sections of 4,067 m and 4,348 m (13,343 ft and 14,265 ft), respectively. They excavated about 70 percent of the tunnel sections.

Double-shielded TBMs are among the most sophisticated TBM types in tunneling because two applications — shield TBM and gripper TBM — are combined in the same machine. Changing ground conditions can be handled with this type of machine because the shield can

be adapted to the geological conditions relatively easily and without any major setbacks affecting its progress, even if poorer rock zones are encountered. This excavation method is characterized by safe working conditions.

Moreover high and continuous production rates can be achieved in good rock conditions because the tunnel support can be placed while excavating.

The two double shields were ordered in July 2006. The cutterhead with a diameter of 12.4 m (41 ft) was fitted with 74, 482 mm (19-in.) back-loading disc cutters and 12 buckets. The double shields were fitted with an electrical 6-m- (20-ft-) diameter main drive and installed with a power of 4,200 kW (5,632 hp).

The geological condition, the inner-city location of the tunnel and the undercut of the Brisbane River required the TBMs to be equipped with drillings for probing ahead and taking core samples from the TBM. A full preexcavation grouting pattern as well as two probing ports were arranged in an angle of 8° through the gripper shield skin between approximately 11 and 1 o'clock in the crown. The machine was equipped with a percussive drill rig mounted on top of the first trailer. This drilling unit was installed on a moveable (180°) ring carrier to drill on a length of 22 m (72 ft) ahead of the TBM.

Mucking out of the tunnel was done by a conveyor belt that was equipped with a weight-measuring system and a volume-measuring system (scanner device). The excavated material was taken to a purpose-built, loadout facility and transported primarily by the arterial road network.

The tunnel is lined with a sealed segmental lining that consists of 8+1 reinforced concrete elements, each having a length of 2 m (6.5 ft). Each segment is provided with an all-round seal that prevents ground water from entering the tunnel. The tunnel lining has an outer diameter of 12 m (39 ft) and an inner diameter of 11.2 m (36.7 ft).

The machine was equipped with a segment storage magazine that holds one complete tunnel ring (8+1) to avoid downtimes due to a delay in segment delivery. The segments were manufactured in a segment factory installed 10 km (6.2 miles) from the jobsite. The equipment was supplied by Herrenknecht Formwork Technology GmbH, a 100-percent subsidiary of Herrenknecht AG, which delivered a turnkey lining segment production facility for the NSBT project. In addition, Herrenknecht Formwork provided and installed all of the associated facilities and equipment. This included handling equipment to turn, orientate, remove, deliver and store the segments, as well as equipment to install seals and produce the surface finish of the segments.

The segment factory included a carousel system capable of carrying five sets of molds (45 molds), a curing tunnel, a concreting station, a reinforcement assembly area and a mold preparation line. The segment plant produced 10 complete rings in two, 10-hour shifts using the five sets of molds in production.

The design of the Herrenknecht Tunneling Systems for the NSBT in Brisbane was based on the contract specifications of the client that defined the technical basis and requirements for the double-shielded, hard rock TBM, the backup systems and peripheral equipment such as tunnel belt conveyor and segment plant.

Hard rock tunneling for Switzerland's - the Gotthard Base tunnel

The Gotthard base rail tunnel is currently under construction. The project is a future-oriented flat railway through the Alps and will be the longest rail tunnel in the world with its two tunnels of 57 km (35 miles) each. The tunnel will be put into service at the end of 2017. This pioneer work of the 21st century will lead to a prominent improvement of travel and transport possibilities in the heart of Europe.

The concept for the Gotthard Base tunnel provides a simultaneous advance in five parts of different lengths comprised of TBMs and drill-and-blast.

The mechanized tunnel sections excavated by means of gripper TBMs comprise in total following four subsections:

- Erstfeld (two at 7,178 m or 23,550 ft).
- Amsteg (two at 11,350 m or 37,240 ft).
- Faido (one at 12.4 km or 7.7 miles, one at 11.9 km or 7.4 miles).
- Bodio (two at 14 km or 8.7 miles).

The first mechanized tunnel of the subsection Amsteg was completed in June 2006. The parallel section was excavated by the beginning of October 2006 about half a year ahead of schedule.

The approximately 14-km- (8.7-mile-) long parallel tunnels of the subsection Bodio were completed at the beginning of September 2006 and the end of October 2006, respectively.

The four gripper TBMs excavated the often demanding rock massif and fault zones finished the total of about 50 km (31 miles) on time.

For the subsection Faido to Sedrun, the two gripper TBMs used in Bodio were completely refurbished.

The geology along this section comprises two tectonic units, the Penninic Gneiss zone (approximately 5 km or 3.1 miles) and the Gotthard Massif (approximately 10 km or 6.2 miles). The Piora zone was predicted to comprise solid, compact and partially metamorphic dolomite anhydrite rocks at tunnel level. The TBMs applied for the subsection Faido have been modified. To be prepared for the greater overburden of 2,470 m (8,100 ft), up from1,200 m (3,940 ft) and rock pressure, in addition to an increase in excavation diameter along this section, 12 buckets were applied instead of eight and the 431 mm (17-in.) disc cutters were replaced by 457 mm (18-in.) cutters. To support the 9.5-m- (31-ft-)

diameter, the gripper and the walking legs were adapted. Modifications were also done on the cutterhead dust control system with an increase from 600 m^3/min (21,200 cu ft/min) to 1,100 m^3/min (38,850 cu ft/min).

For the subsection Erstfeld the geology is characterized by mainly solid and geotechnically favorable, highly metamorphic gneisses (Erstfelder gneiss). The AlpTransit Gotthard AG administrative council awarded the subsection Erstfeld to the Gotthard Base Tunnel North Joint Venture (JV). The JV consists of Murer-Strabag AG, of Erstfeld, Switzerland and Strabag AG of Spittal/Drau, Austria. The TBM section comprises the excavation of two, single-track tunnels of 7.2 km (4.5 miles) from Erstfeld to Amsteg. The tunnels are excavated and secured by the two TBMs that have driven the two 11.35-km- (7-mile-) long subsection Amsteg. This section includes an underground junction to permit a future extension of the tunnel toward the north without interrupting the operation.

In connection with the TBM drives of a long tunnel with a large overburden (>2,500 m or 8,200 ft) and in a tectonically active rock mass (folding of the Alps), one can draw the conclusions that despite extensive clarifications in the run-up to the project, there can be a great difference between geological prediction and geological finding. The rock behavior and the hazard scenarios can prove to be less favorable than expected. This could make impossible an optimal use of the drive systems designed according to the hazard scenarios dominating the service contract.

The constructional relevance can change very quickly on site. Correspondingly, the mountain only forgives faults in exceptional cases and sometimes requires quick decisions of all persons involved in the project and the prompt realization of immediate measures.

The applied TBM technology proved, however, that it is in a position to master technically essentially more critical situations than were provided in the service contract. The construction of these TBMs and trailers were subject to extensive adjustments

(among others due to the extraordinary conditions) and optimizations during the drive for more than altogether eight years and nearly 30 km (18.6 miles) each.

Extraordinary conditions can additionally aggravate the already very demanding technical and logistical challenges. A close and constructive cooperation between client, author of the project, supervisor of works and enterprise is essential for the success of the project of the structure of the century.

Outlook

The cited projects show the multitude of pioneering references in large diameter mechanized tunneling development such as Shanghai (mixshield 15.43 m of 51 ft) and M30 Madrid (EPB-Shield 15.20 m or 50 ft). They support the feasibility of the construction of very large tunnels. The performances that have been achieved by the current largest TBMs also include an excellent logistical concept, which presents a good basis for administrative authorities, project owners and contractors regarding the feasibility, reliability, safety and speed of upcoming large diameter projects.

The tendency of future large diameter tunnel projects are in direct relation to the progressing urbanization and the possible impending total gridlock especially in metropolitan areas or larger cities and also at junctions such as the access to the Brenner Base tunnel.

To summarize the current state of the art in TBM technology, the TBMs range from 100 mm (3.9 in.) to 16 m (53.5 ft). They are today reliably used for the realization of complex projects. In the future, tunnels with diameters of more than 16 m (53.5 ft) are envisaged, not only in densely populated areas, but also through natural barriers like mountain ranges or under rivers and estuaries. The market requires practical engineering skills under the toughest conditions.

Innovations, such as seismic probing ahead, cutting wheels accessible under free air, muck control, drill units for ground stabilization measures from the TBM and cutter wear detection systems, were designed and further developed. Information technology and sophisticated measuring techniques in tunneling are increasing safety as well as economic profitability. ■

Herrenknecht mixshield S-352 at Schwanau, Germany. It was used to construct the 5,768-m- (19,000-ft-) long New Tunnel for the Lower Inn Valley Railway, Austria.



FEATURE ARTICLE

Single bore solution for transit tunnels

The use of a single tunnel boring machine (TBM) tunnel of approximately 12 to 13 m (40 ft to 43 ft) diameter for transit systems to house both light rail or subway tracks in a stacked configuration is an advanced concept that allows significant savings in construction cost and time while reducing, to a large extent, the negative effects on the environment.

This solution, similar to the recently completed Barcelona Metro Line 9, integrates station platforms, train storages, crossovers, bypass tracks, ancillary areas and utility corridors inside a single tunnel. Each of the underground stations consist of a cut-and-cover entrance structure and ventilation shafts, that also serve as emergency exits. The excavations for the station structures and shafts can be done on one side of the street with nominal impact on traffic and utilities.

The North American transit agencies are familiar with the application of the twin tube tunneling approach, as most of their recent subway extensions have used this method of construction. At the same time, large bore tunneling has been used as the preferred method on multiple projects during the last two decades all over the world.

The primary feature of the single tube tunnel configuration for a transit line is that station platforms, crossovers and tail tracks are all accommodated within the tunnel cross section. As such, the location of each of these major elements can be adjusted along the entire corridor to maximize design efficiency and minimize construction impacts. Another key feature is that station structures can be located on either side of the street. This allows for structures that are constructed using cut-and-cover method, to be built with minimal impact on traffic along the street. This is critical to residents, businesses and the general public.

The new transit lines are often introduced as a means of alleviating traffic congestion and the associated noise and air pollution. However, the traffic impacts, noise, dust and business disruption that would be generated by cut-and-cover construction along a highly dense corridor may be counterproductive to the objectives of these projects. Part of this disruption would also affect existing public transportation services during several years construction phase of the underground structures.

Verya Nasri

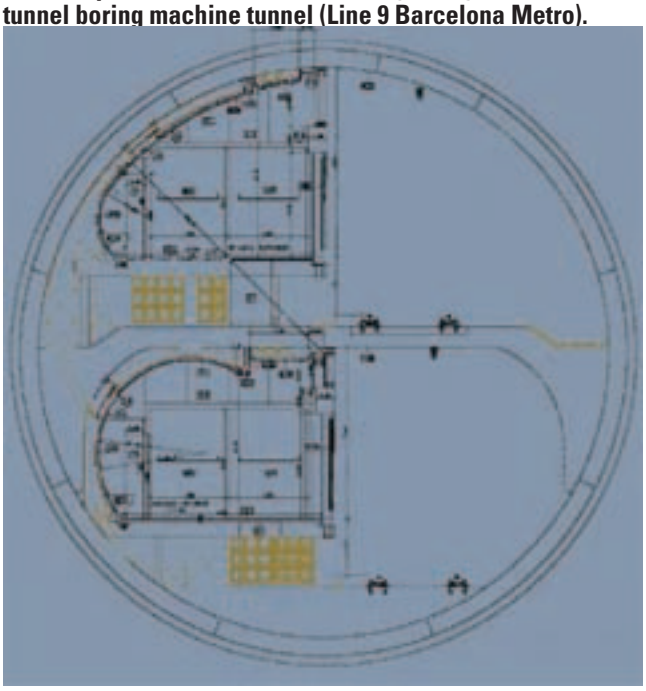
Verya Nasri, member UCA of SME, is chief tunnel engineer, AECOM, New York, NY, e-mial verya.nasri@aecom.com.

Placing the stations inside the running tunnel

Since the early 1990s, in many parts of the world, the design of new transit lines has generally followed a typical configuration: excavation of cut-and-cover stations as rectangular boxes using slurry walls as support of excavation is followed by connecting these boxes by a single tube tunnel boring machine tunnel

FIG. 1

Stacked platform station within a single large diameter tunnel boring machine tunnel (Line 9 Barcelona Metro).



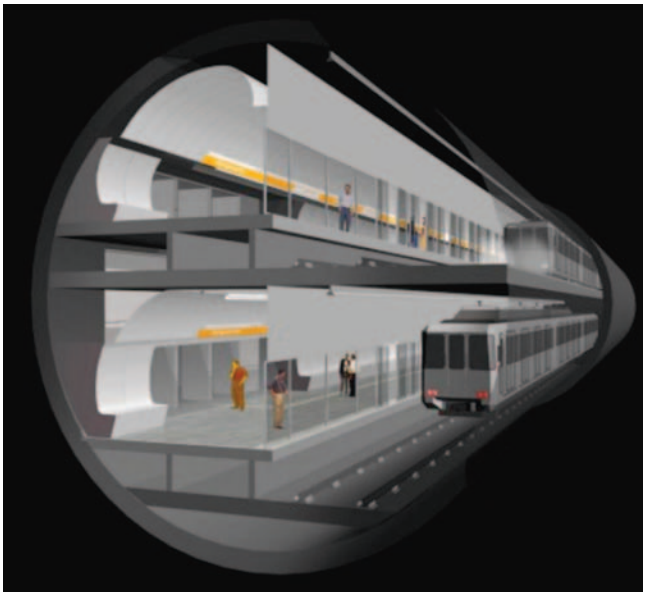
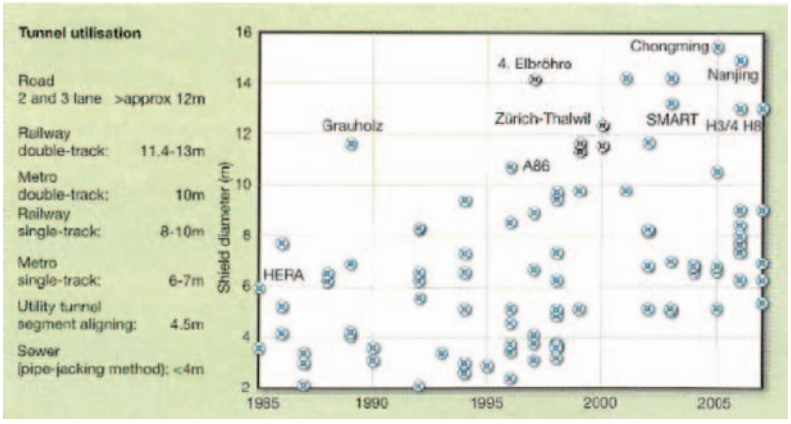


FIG. 2

Increase in Mixshield diameter manufactured by Herrenknecht in the past two decades.



housing two side-by-side tracks.

The twin tube system was preferred during the 1980s. It was considered to be easier to build and to generate less settlement, but has since been abandoned. Aside from major geometrical constraints, the experience shows that the twin tube is clearly more expensive than the single tube. It should be noted that a TBM with a diameter large enough to place two, side-by-side subway tracks within it (external diameter of about 9.5 m or 31 ft) can be well controlled. The conventional mining method for subway tunnel construction is now almost abandoned because of the risks involved with the construction crews and adjacent structures that are not totally controllable.

After multiple use of large diameter TBM for building double track side-by-side transit tunnels, Spanish engineers working on the Line 9 of the Barcelona Metro decided to go farther and put the stations inside the tunnel by slightly increasing the TBM diameter. This revolutionary concept was applied to 28 km (17 miles) of tunnel using a 12-m- (40-ft-) diameter TBM housing two stacked tracks (Fig. 1) (Della Valle 2003).

The conventional twin tube tunnels with cut-and-cover stations construction is disruptive to vehicular and pedestrian traffic and requires significant construction costs to provide for temporary decking, special staging and phasing of the project and usually extends the construction duration due to the restrictiveness of the worksite below the surface.

Since the platform is integrated within the tunnel of the single tube option, the remaining underground work at the stations is limited to access shafts and short connector tunnels. Station configuration can be developed to satisfy the transit agencies' design criteria and requirements for vertical circulation, ventilation and fire/life safety. Each of the underground stations consists of a cut-and-cover entrance structure and ventilation shafts. These also serve as emergency exits. These excavations are performed on one side of the street with no impact on the traffic and utilities.

The single tube solution promotes operation safety. In fact, the internal slab seals off the two platforms that behave like two separate tubes with the possibility of closely spaced emergency stairs equipped with fireproof doors between the two tracks. Each platform acts as a refuge area for the other, with a connection possibility at a much higher frequency than the actual standard safety requirement.

The platform edge doors solution can be adopted, similar to those found in major cities like Paris, Singapore, London, Bangkok, Hong Kong and Barcelona. The doors physically separate the tracks from the platform enhancing safety in case of fire and reducing the psychological effect of the incoming train.

The access shafts can be equipped with high-capacity elevators and emergency stairs. The elevators may be synchronized with train arrival to minimize waiting time at the shaft bottom. The number of elevators per each shaft varies in function of the expected number of passengers.

Based on the studies performed by the author on several North American projects, the duration of construction

FIG. 3

Change in track configuration from side-by-side to stacked.

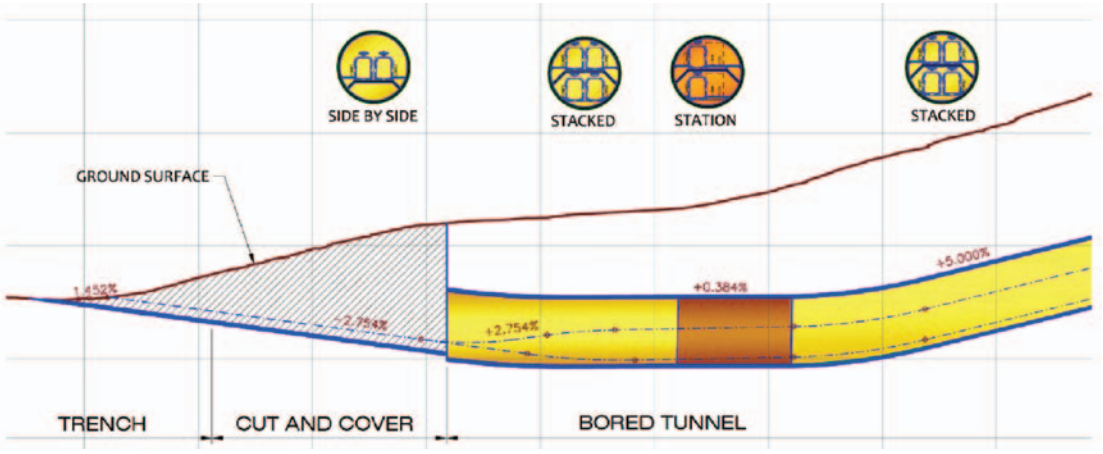
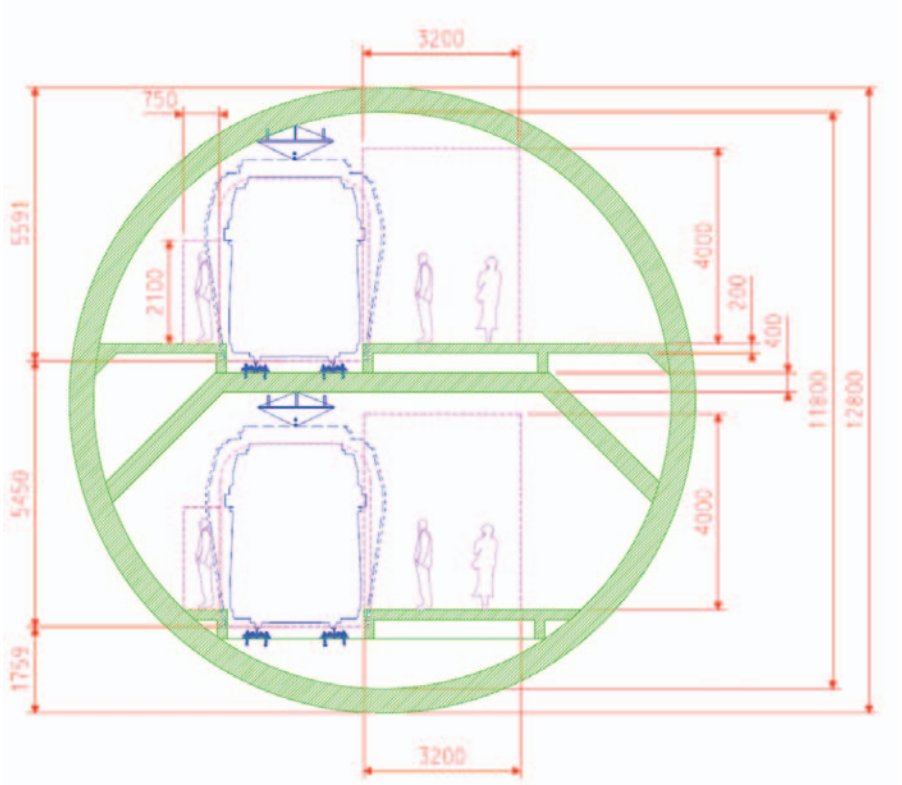


FIG. 4

Example of cross section of the single tube tunnel for a LRT project (lengths shown in mm).



is clearly shorter for the single tube option. The advance rates for both single and twin alternatives are comparable based on reported cases. In the case of single tube alternative, the platform structure can be completed just after the passage of the TBM. These studies also show that the estimated construction cost for the single tube alternative is clearly lower.

Some of the advantages of the single tube option compared to twin tube include:

- Construction disruptions are minimal on the street, as building the stations, entrances and other structures would be done outside the street right-of-way. This is true, especially considering the large construction areas and muck disposal activity that would occur at each station location, associated with the cut-and-cover that would be required for the twin tube.
- Cost of disruption to businesses as a result of construction, including muck disposal, traffic and pedestrian reductions/restrictions as well as the additional costs that would be associated with the hoarding, piling, decking, detouring, dewatering, utilities relocation and others at the stations.

TBM selection

The growing need worldwide for efficient infrastructure systems encourages tunneling solutions, particularly by mechanized methods. The mechanized tunneling process offers a safe, settlement controlled alternative to other tunnel excavation methods. Innovative solutions, such as the multipurpose use of the tunnel profiles, are increasingly demanded. This requires large diameter tunneling technology. Mechanized tunneling with diameters of up to 16 m (52 ft) is reliably controlled and, compared with conventional tunnel construction, is substantially faster.

The TBM method requires a more comprehensive and thorough geological investigation, mapping and testing during the planning stage in order to evaluate the overall TBM viability and possible machine types that could be applicable. Considerations to use the TBM method have to take place during the early planning stage to establish tunnel alignment and profile. Possibilities to reduce adits and job sites while still maintaining the overall construction deadline should also be considered in early planning stages.

Planning the tunnel projects with diameters exceeding 10 m (33 ft) is now a common practice. The large diameter TBMs can be designed for soft soil, hard rock or mixed face conditions. Mechanized tunneling with diameters even larger than 15 m (49 ft) is now the state-of-the-art and can be dealt with safely. Compared to conventional construction methods, the mechanized shield tunneling, even with larger diameters, is considerably faster and its limits are set by logistical issues, such as mucking, rather than by construction safety or financial concerns (Herrenknecht and Bäppler 2008).

It is now possible to use the TBM method for just about any purpose and ground condition including open hard rock TBMs and shielded TBM designs like single shields, double shields, mix shields, earth pressure balance (EPB) machines, and slurry shields in diameters from about 2 to 3 m (6.5 to 10 ft) and up to approximately 16 m (52.5 ft). Figure 2 shows the increase in TBM diameter in recent years of one particular machine type (Mixshield) produced by one of the main TBM manufacturers.

Typically, a TBM consists of a rotating head that excavates the material. From there, the spoil enters into a chamber from which the material is transported to the surface. The complete operation requires a crew driving and running the cutting head, an excavation handling crew, and a segmental liner installation and storage crew.

The diameter of the cutting head is selected based on the required tunnel geometry and total thickness of the assembled segmental liner ring and annular grout ring behind it.

Three types of TBM technology are predominantly used in current practice. They are referred to as open face, EPB and slurry shield.

The open face shield method cannot effectively control the inflow of water or support the face of the poorly graded sand and gravel, and water pressure anticipated at most soft ground sites.

The EPB has been traditionally used in finer grade materials such as silts and clays. But, with the development of foams and polymers, EPB can now be used in a wider range of soils and is even being used in rock tunneling. Advantages for the EPB over the slurry TBM include more flexibility in the chosen mode of operation, easier access to the face for cutter changes; potentially cheaper machine costs and a faster rate of advancement for tunnels in mixed ground conditions. Disadvantages include the difficulties associated with maintaining a good quality spoil in highly permeable, coarse-grained soils.

Advantages for the slurry TBM include operating well in sands and gravel soils and tunnel spoil is pumped to the surface, avoiding the use of mucking cars or conveyor belt system on steep grades. Disadvantages for the slurry TBM include higher operating and slurry handling equipment costs, and the potential for slurry blowout causing environmental pollution.

Recent developments in TBM technology have brought about effective methods of building tunnels in various types of soil, rock and mixed face conditions. A dedicated TBM is usually designed for the specific subsurface materials and conditions expected to be encountered on each project. The alignment is selected to provide at least one tunnel diameter of cover to the extent possible.

The development of underground technology using TBMs in recent years has reduced the potential differences between the EPB and slurry TBM systems. A pressurized face machine is often recommended for use on the project. The contractor will have the option to choose either an EPB or a slurry TBM. Figure 3 shows the change in tracks configuration from side-by-side at the portal to stacked at the station.

For transit projects, a large diameter, single tube tunnel (12 to 13 m or 40 to 42 ft TBM diameter with about 15 cm or 6 in. annular grouting) can be considered to house both light rail or subway tracks in a stacked configuration. This solution, which is similar to the recently completed Barcelona Metro Line 9, integrates station platforms, train storages, crossovers, bypass tracks and ancillary rooms inside the single tube tunnel (Fig. 4). Based on the existing experience, the construction cost and time and environmental impact of this concept is lower than the twin tube option.

Station configuration

Stations for single tube tunnel consist of three separate functional elements:

- Stacked side platforms.
- Vertical circulation (entrances and emergency exit buildings).
- Fire ventilation units (FVU).

FIG. 5

Single tube station platform.



The platforms are located within the single tube tunnel itself, one at each level, to one side of the running tunnel. Essentially, the station consists of side platforms stacked one atop each other within the tunnel structure to provide consistent access to the vertical circulation elements (Fig. 5). As such, a single point of entry or egress to and from both platforms can be located anywhere along the length of the station. In addition, the stacked side platforms can be located to the either side of the running tunnel within the tunnel depending on the preferred location of the main entrance building.

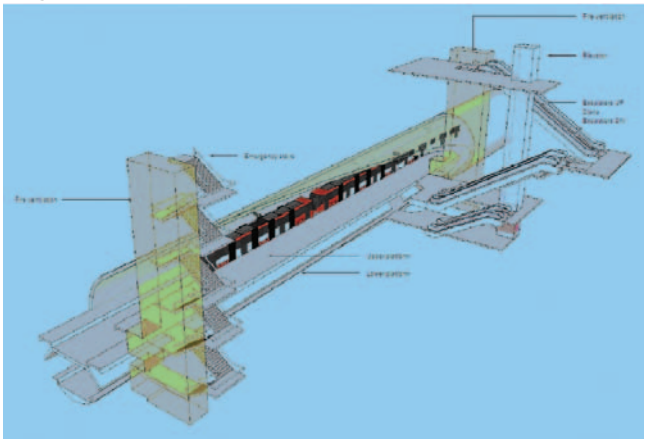
Vertical circulation structures include a main entrance building and, at minimum, one emergency exit building, each located at either end of the station. These structures are separate entities connected to the single tube tunnel and platforms by individual pedestrian adits.

The main vertical circulation can include two sets of escalators (one up, one down, 1.6 m or 5.2 ft each), stairs (2.4 m or 8 ft) and an elevator (2.5 m or 8.2 ft). Due to the depth of the station platforms, an additional escalator can be included to accommodate faster passenger access between the platforms and the street (Fig. 6).

The emergency exit building provides egress from

FIG. 6

Single tube station 3D view.



each of the platforms and would include fire doors at each platform level to secure a safe access route to the surface.

FVUs are required, one at each end of the station beyond the platforms. For the purpose of this study, standard FVUs applied in the transit systems have been used, stacked atop one another beyond either end of the platform. This allows for all vertical circulation and fire ventilation elements to be consolidated into single or adjoining structures, reducing the number of footprints required (Fig. 7). As such, ventilation shafts can be raised higher, beyond street level to avoid impacts during smoke discharge.

Station design initiatives from other single tube tunnel studies had investigated options for staggering the side platforms within the tunnel, each to opposing sides of the subway or LRT running tunnel. The staggered platform layout was intended to provide direct access from each platform to both sides of the street above. The design investigations revealed that staggered side platforms within the single tube tunnel would require a complex combination of mezzanines and pedestrian tunnels outside of the main tunnel to connect the platforms with one another and any vertical circulation to the street. This complexity would not only necessitate far more elevators and escalators but also lead to disorientation among passengers attempting to connect between the platforms and the street.

The ability to combine FVUs with vertical circulation into a single or adjoining structures reduces the number of structural components required. Albeit larger in size, ideally the station requires only two vertical structures:

- Main entrance building with adjoining FVU.
- Emergency exit building with adjoining FVU.

These structures exist independently of the single tube tunnel (horizontal structure) and can be located anywhere along the length of the station platform but must always be located on the same side of the tunnel as the platforms. The platforms also exist independent of any site constraints since they are within the single tube tunnel and can be located anywhere along the horizontal alignment, limited only by natural topography (slopes) and associated track work. Additionally, due to the larger diameter size, the stacked platforms can be located on either side of the single tube tunnel. This versatility in sitting individual elements allows the main entrance building to be located at a preferred location, typically at an intersection, allowing direct connection to surface transit routes. The location of the entrance building will determine the location of the platforms. Opportunities exist for satellite entrances to be located in the immediate vicinity (either side of the street) and connect by pedestrian tunnels to the main vertical circulation building.

Construction of the platforms occur within the tunnel structure that has no impact on adjacent properties or surface activities. In addition, the continuity and independence of the tunnel from the vertical structures allows for increased capacity with the ability to lengthen the platforms without additional impacts. As an example, the platforms could be constructed at a length of 64 m (210 ft) for a two-car train and, in the future, extended to 96 m (315 ft) for a three-car train. Should demand warrant, these platforms can be extended even farther, limited only by the vertical alignment constraints and special track work.

The combined structures of vertical circulation and fire ventilation can be constructed independently from the single tube tunnel. These structures can be constructed prior, during or after tunnel boring operations without impact on street level activities. The impacts will be similar to that of any surface building structure affecting only the immediate sidewalk or curbside lane depending on the size of setback. Once both the tunnel and vertical circulation structures have been completed, connections between the two elements can be mined.

In all situations, construction of the entrance and emergency exit buildings, along with tunneling operations, can occur with no impact on day-to-day surface activities. As such, vehicular and pedestrian traffic can flow unimpeded, especially at intersections, making it ideal for high-density areas.

The vertical circulation structure is based on local building code standards to determine minimum spatial requirements. The depth of a single tube tunnel and associated platforms may not be conducive for passengers' perception of comfort and safety when implementing engineering minimums. Passenger safety and comfort is directly associated with visibility. Visibility from the entrance building, down the vertical circulation structure and through to the platforms can be highly constrained when using engineering minimums typically applied for shallow or deep stations.

The design and functional layout of a single tube station are different from the typical center platform arrangement found at many of the subway stations. The emphasis on connectivity and accessibility in twin tube stations is on horizontality versus verticality in single tube stations.

Passenger accessibility for single tube stations should not be perceived as a drastic departure from that for twin tube, since the vertical circulation structure is more similar to that found in buildings, especially office towers or shopping centers, with multilevel atria.

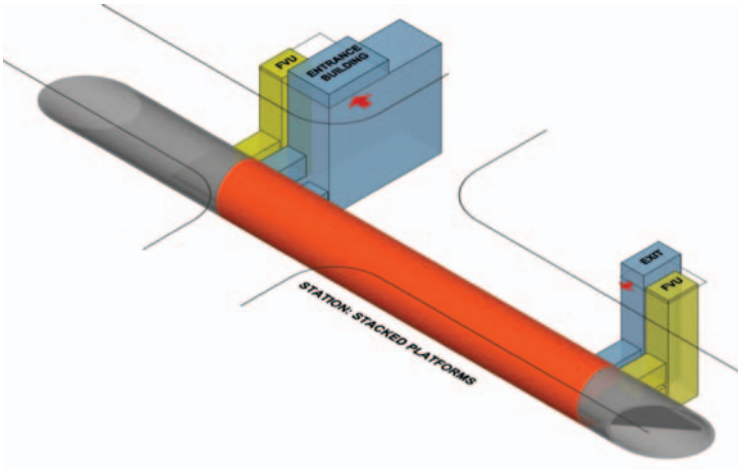
The perception of depth is a social and psychological factor that is premised upon the volumetric confines within which a person either feels forced or choosing to enter. The ability to see where one is traveling is an important criterion affecting people's perception of depth and safety. Designing the vertical circulation shaft in a single tunnel station to be spacious and open is equally as important as managing direct and well lit access from individual entrances to a mezzanine or concourse level in twin tube stations.

The introduction of an atrium-type space within the vertical structure would greatly increase visibility between levels and allow passengers to not only see where they are going, and want to go, but also assists in reducing the perception of depth and distance. Atria have been highly successful in higher density developments of all types, worldwide. The application of an atrium-type volume would allow the vertical circulation structure to function as the backbone for ancillary underground passages to adjacent properties, especially in high density downtown areas.

The single tube tunnel concept can be made compliant with all of the requirements of the latest version of NFPA 130 and other local codes. Stations are designed to be evacuated within four minutes with all passengers reaching full safety within six minutes. This is an easily achievable goal given the excellent location potential of fire separations in the structures immediately beside the platforms of the single tube tunnel. It is reasonable to consider the single tube tunnel performs more safe in this regard as fire separations can be placed anywhere along the platforms in the connections to the vertical transportation elements.

FIG. 7

Single tube station entrance and FVU configuration.



Summary

Two TBM tunneling methods for transit projects are compared. The alternatives considered in this evaluation are:

- Twin tube alternative — two conventional size TBMs for excavating two running tunnels and cut-and-cover tunneling method for the construction of under ground stations and crossovers.
- Single tube alternative — one large diameter TBM for excavating one running tunnel that includes all of the stations and crossovers.

These alternative tunneling methods were studied as part of the environmental impact studies for several North American transit projects to determine the most cost-effective method of construction.

Construction staging and maintenance of traffic is determined to be more favorable for the single tube alternative. Major cut-and-cover operations for the twin tube option will result in difficult construction conditions in congested areas along the street. Environmental impact in general is more favorable toward the single tube alternative.

Over the past 20 years, the TBM technology has evolved around the world to the point that TBMs with diameters greater than 12 m (40 ft) have become common. Conceptually, the primary feature that would make single tube the preferred configuration is that the running tracks, station platforms and ancillary spaces are all contained within a large diameter tunnel. As such, provisions for station entrances, ventilation shafts, etc. can be taken "off alignment" of the tunnels and greatly reduce the need for roadway and intersection disruptions at the surface as would be required with cut-and-cover construction.

The time savings in construction of the single tube are realized mainly from the construction of the stations. Both the time savings and minimization of roadway right-of-way disruptions, due to cut-and-cover construction, translate into significant construction cost savings and a more manageable public relations effort.

Given the significant cost savings, overall shorter project construction time, simpler station design and construction with significant less surface disruption and reduced need for complicated cut-and-cover and maintenance and protection of vehicular and pedestrian traffic, the single tube tunnel solution can be considered as a serious alternative in the study of transit projects. ■

References

Della Valle, N. 2003, "The New Line 9 of Barcelona Metro." Rapid Excavation and Tunneling Conference 2003, New Orleans, LA, June 16–18, . pp. 1280–1293.

Herrenknecht, M. and Bäppler, K. 2008, Tunnel Boring Machine Development. "North American Tunneling Conference 2008," San Francisco, CA, June 8–11, 2008, pp.52–57.

FEATURE ARTICLE

Waterproofing: Key to SCL tunnel lining design

The global tunneling industry has many challenges, both technically and financially, with the latter likely to be a significant feature over the next few years. Many industries have adopted standard practices in order to overcome specific technical challenges, from which standard outcomes are anticipated. In tunneling, however, every project is unique so standardized practice is not easy. This requires original thinking and being open to adopting new techniques and technologies as they emerge. Sprayed waterproofing is a hot industry topic and a paper recently presented at the North American Tunneling conference not only discussed this methodology for achieving a dry tunnel but also how it can reduce build costs and construction time.

Workers inspect a tunnel sprayed with a waterproofing membrane.



Despite their being relatively few "universal truths" throughout the tunneling industry, there is one opinion that appears to be shared by most in the sector, "all tunnels leak."

"Coming from the angle of a specialist waterproofing manufacturer with 25 years of experience in waterproofing all types of civil engineering structure throughout the world, the concept that leaking tunnels are acceptable seems quite odd," said Stirling Lloyd's development director, Mike Harper. "However, tunnel engineers across the world relate to their experience of what they have known up to now; that is, to a greater or lesser extent, tunnels let water, regardless of what you do. Tunnel engineers are, therefore, having to compromise on what they feel is an acceptable level of leakage rather than creating a dry tunnel. Over the last eight years, we have been asking ourselves whether it is possible to achieve a watertight tunnel and have developed a method for achieving this."

In other industries, accepting something that is nearly watertight is just not acceptable. For example in the aviation industry having an aircraft that allowed water to penetrate the outer shell would not be tolerated, neither would a submarine which had a few leaks, damp patches or running water. In an environment such as tunneling, where water penetrating into the structure can cause many problems it is not acceptable for tunnels to let in water. If an aircraft or a submarine can be made watertight, so can a tunnel. It is true that the tunnel environment presents different challenges for waterproofing than some other engineering environments, such as bridge decks or chemical tank linings. But if the requirements are clearly understood, effective waterproofing can be achieved.

Waterproofing is an exact science. A structure is either waterproof or it is not. This is a case of black and white — gray is leaking. The risks presented by water ingress include short-term maintenance issues that, in the long term, can degrade the fabric of the tunnel itself, shortening the overall life of the asset. Poorly waterproofed tunnels have serious economic and environmental impacts, which is why addressing this issue is so fundamental.

Waterproofing that works

The decision on how to waterproof a structure is much more important than the lowest initial cost per square meter of material. It is how the waterproofing will perform over the 120-year design life of the tunnel, and what the risks, costs and environmental considerations associated with failure of the waterproofing are.

There are some well established criteria for successful waterproofing systems to meet to waterproof a concrete structure, which have been implemented in the external lining of tunnels, such as cut-and-cover and immersed tube tunnels, for the last 20 years. These five key requirements can, and should, also be applied to the internal lining of a tunnel of SCL/SEM/NATM design to create a dry tunnel.

Crack bridging capability

This is fundamental to a successful long-term waterproofing membrane when the membrane is intimately and continuously bonded to the concrete substrate. Cracks in new concrete are inevitable at some level, whether from shrinkage during curing or from ground movements. A sprayed membrane needs to be able to bridge cracks that open up or the waterproofing will also crack with the concrete and leaks will appear. Consequently, the product must not only be flexible but also have a very high tensile strength.

Seamless

Where sheet systems are concerned, the problems of leaking tunnels emanates not from the middle of preformed sheets but from the seams where the sheets have been welded together on site. The more seams that are present, the more likely leaks are. Complex geometry provides the opportunity for even more seams, which gives the potential for more leaks. Therefore, the goal is minimizing, or preferably, eliminating seams.

Where sprayed membranes are concerned, seams can still be an issue. The chemistry of the system should be such that a completely seam-free installation is achieved. Much as been done to minimize the impact of seams, including double seaming, trying to test seams and installing grout pipes to try and stop leaks through seams. But these fail to address the root cause, which is the presence of vulnerable seams in the first place.

Suitability

There are many types of waterproofing membranes in the world made from a variety of base chemistry. These include well known systems such as polyurethane, epoxy and methyl methacrylate (MMA), and lesser known systems, such as polyureas, rubber emulsions, polysulfides and polymer modified cements. All have various characteristics that are better suited to some applications rather than others.

The confined space environment of a tunnel and the high cost in terms of time of tunnel construction present some challenging requirements for a successful tunnel waterproofing membrane. In addition to it being watertight, the system must have low toxicity and a low explosion risk. The membrane must also be tolerant to moisture, as there is a negative water pressure environment and some ingress prior to application of the waterproofing is inevitable. The membrane should also cure quickly to ensure there is no costly, unproductive time during the construction process.

Rapid application and cure.



These requirements have necessitated a specific chemistry design for the product to deal with this particularly challenging environment.

Control

As with any trade, control of the activity is key. Although some perceive that forming a membrane in situ is more difficult than forming it in a factory, the material only becomes a waterproof membrane once it is installed. Therefore, controlling the installation of sheet systems can often be more difficult than a sprayed system.

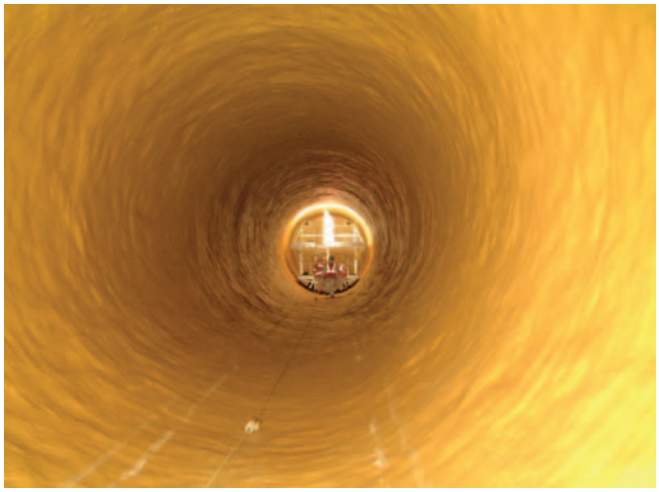
Application of sprayed membrane should be accurate. Wet film thickness tests throughout the application will ensure that the membrane is being applied to the correct thickness. The material should be installed by a spray operative as robots will not be able to see if a section has been missed. A system that is applied in two thinner coats is more effective than a single coat membrane; not only is thickness more controllable, but the second coat will rectify any potential small defects in the first coat, thus reducing the possibility of any problems.

The material should also be simple to use. To avoid on-site variance, the product should be prebatched and pumped together in fixed ratios. All of this needs to be covered by an on site quality assurance regime and comprehensive training should be given to operatives.

Proof

A membrane must be 100 percent effective, whether sheet or sprayed, in order to be watertight. Being able to prove this is of the utmost importance. Where the ground has been dewatered, the effectiveness of the membrane may not be evident until the ground water table is re-established. Therefore, using a quantitative, reliable test method to ensure that the membrane will not leak is essential and should always be undertaken. For sheet membranes, this cannot be done. It may be possible to test for defects in the preformed sheet itself in the factory, but they cannot be

Seamless spray and waterproofing.



re-tested for the effects of site damage during installation or by following trades once in situ. Also, not all seam types can be adequately checked on site. Therefore, potential for leaks go undetected.

For some sprayed membranes, testing is simple. Spark testing is a nondestructive test method that has been used to great effect in other industries. It tests every inch of the membrane and finds any defects, even one the size of a pinhole in 100,000 m^2 (1.1 million sq ft) of applied waterproofing, ensuring that the waterproofing membrane is completely continuous. If any defects are identified, these can be rectified prior to the application of the final lining, before it becomes expensive and nearly impossible to fix. This is the only method of ensuring that the waterproofing integrity has been achieved.

A dry tunnel is possible

A dry tunnel can be achieved by using products that are controllable, suitable, seamless and can be reliably tested. Other areas of the tunnel industry, such as cut-and-cover and immersed tube tunnels, as well as other sectors of the construction industry, have used this "best practice" methodology for many years throughout the world and it has been proven to work.

For contractors, there is also the benefit of reducing uncertainty. The time, expense and disruption from chasing leaks around a tunnel that should be dry, requiring expensive repair, should no longer be a concern when the waterproofing can be done correctly first time.

Consequently, there is now no reason for clients to accept a leaking tunnel. Poor quality environments for tunnel users, long-term running costs issues, such as pumping and disposal of water and early degradation by the action of water ingress and its associated damage, should be a thing of the past.

Design opportunities

At present, the tunnel industry around the world is looking at the issue of effective waterproofing carefully, not only because of increasing requirements for water tightness , but also because of a realization that a fully bonded sprayed waterproofing in tunnels of an SCL/SEM/NATM design offers some poignant design opportunities. This has much greater implications for tunneling projects, in terms of reducing cost and time.

Sheet systems

In traditional SCL tunnel construction, regardless of how much sprayed concrete is applied as the primary lining, from a structural perspective, this concrete is ignored. The full structural load is supported by the final or secondary lining. The traditional build would, therefore, be sprayed concrete onto the excavated surface, followed by installation of a sheet membrane. The sheet membrane is tacked to various points and is not fully bonded to the primary concrete. The choice for final lining construction is then limited by the nature of the waterproofing membrane because it is exceptionally difficult to get sprayed concrete to bond to a sheet membrane system. This is because the membrane does not have a continuous bond to the primary lining. Thus, the sprayed concrete therefore tends to rebound off the membrane surface. This effect can be reduced by the use of lattice girders and reinforcing steel mesh to help support the sprayed concrete during application. However, this tends to reduce the quality of the final lining, as achieving adequate compaction of sprayed concrete through a network of steel reinforcement is difficult. This results in voids and failure to passivate the steel against corrosion from ground water when it is not adequately encapsulated.

The construction method currently favored for final linings tends to be traditionally reinforced cast in situ concrete. This is much slower than spraying concrete, and therefore, potentially more expensive. In long tunnels of consistent cross-section casting. the use of shutters can be cost effective. However, in complex geometry situations, such as metro stations, where interconnecting tunnels and passages have widely varying cross-sections, shuttering becomes increasingly complex and expensive. At the same time, waterproofing requirements are usually most onerous in these areas, where both LUL and Crossrail are currently asking for completely dry tunnels in their specifications.

Sprayed systems

The great design benefit of a spray applied waterproofing membrane is that the final lining can be installed using permanent sprayed concrete instead of cast in situ. With fiber reinforcement, traditional lattice girders and rebar are no longer required, increasing build speed and reducing cost.

Colin Eddie, from Morgan Sindall Underground Professional Services, takes the view that "depending on the design of the tunnel, cost savings of up to 50 percent are achievable with a sprayed solution, when considering the

waterproofing and final lining taken together."

Reduced cost, faster build speed and higher quality waterproofing performance are a powerful argument in favor of sprayed waterproofing membranes for tunneling. However, the most significant advance that a fully bonded sprayed membrane enables is use of the "composite effect" between the primary and secondary sprayed concrete layers.

The composite effect

Construction that includes sprayed waterproofing, the primary and secondary concrete layers are both fully and intimately bonded to the membrane. Consequently, both of the concrete layers are acting together. Therefore the primary and secondary linings contribute to the load bearing capability of the tunnel, unlike when using sheet systems

Research carried out by Morgan Sindall, both in its Underground Professional Services division at Rugby and supported by further work at Warwick University to test this theory, have shown that two concentric rings of sprayed concrete, bonded together by Stirling Lloyd's Integritank HF tunnel waterproofing membrane, behave in the same way as a monolithic ring of the same dimensions.

While earlier work has suggested that a mechanical key between the concentric rings is required by way of an uneven interface, the Warwick University work actually shows that this is not the case and, even with a smooth interface the full effect is achieved.

This is where the major benefit for future tunnel design lies and one that will have a profound effect on the industry. If part of the primary lining can be considered to contribute in structural calculations then the ultimate application could mean that tunnels can be built with a lower overall lining thickness. This means reduced excavation, reduced volume of concrete required and a reduction in the associated transport and installation costs. There is also a significant environmental benefit in reduced waste and reduced carbon generation, in addition to the commercial benefits of building lower cost tunnels in a shorter timeframe.

So the move to sprayed waterproofing that is occurring around the world in tunneling has far wider implications than "only" achieving the previously seemingly impossible dream of dry tunnels. It also produces significant environmental and commercial benefits. Better performance, greater longevity, reduced environmental impact and lower cost. In a world reeling under financial constraints, this could not have come at a better time. ■

Contributed by Sterling Lloyd Polychem, Ltd., Cheshire, United Kingdom. e-mail info@sterlinglloyd.com.

Giving credit where credit is due: Tunnel education in the US

I knew it was inevitable when I was writing the article about tunnel education in the United States that I would forget some names of prominent individuals. Although the emphasis of the article was on institutions of higher learning, I did try to identify various individuals that had contributed to tunneling over the past few decades. During the NAT convention in Portland, OR (June 20-23), it became obvious that some names had been overlooked.

Foremost among those names was Mike Vitale from Hatch Mott McDonald in Cleveland, OH. Vitale is a University of Illinois graduate who has been actively involved in tunnel design for more than 25 years. Other names that popped up during discussions in Portland included Larry Eckhart, Refik Elibay, Ed Plotkin, Charlie Daugherty, Ray Henn, Bob Stier, Jerry Shaw, Ted Budd, Paul Zick, Toby Wightman, Jon Kaneshiro, Tom Clemens and Lok Home.

Two other aspects of the tunneling industry became obvious in Portland. The first is that the tunneling industry truly operates like a gigantic fraternity. Many organizations associated with tunneling have been around forever and specialize in the successful pursuit of tunneling projects. Those organizations include tunnel designers, tunnel contractors, owners, equipment suppliers, specialty contractors and major law firms.

The second aspect of tunneling that is quite interesting is how many family names are associated with the industry, such as Kiewit, Shea, Traylor, Kenny, Diponio, Coluccio, Akkerman, Lovat, Robbins, Shank, Bradshaw, Affholder, Atkinson, Kassouf and many others, I am sure.

Finally, I would like to highlight a few more names of some of the "old-timers" that were not listed in the original article such as Gail Knight, Vint Garbesi, Al Provost, Gene Waggoner, Jim Irish and Terry McCusker.

Having written the original article I now know what my wife endured trying to decide who to invite to my daughter's wedding. I know there are still more names that should be mentioned, but I guess we have to call it quits for now.

Gary S. Brierley
Andre Hawks

FEATURE ARTICLE

North American Tunneling 2010 Conference highlights

Even though the economy of the United States remains in recession — or not, depending on which economist you listen to — municipalities still need improved transportation, water and wastewater transit systems. And they are willing to spend the necessary funds on those systems, provided they are affordable, environmentally friendly and sustainable.

From June 20-23, professionals in the tunneling and underground construction industry from around the world gathered in Portland, OR to learn new ways of providing those systems using the latest technology available. The North American Tunneling (NAT) conference attracted 803 attendees and 108 exhibiting suppliers of equipment and services.

In addition to the technical programming, provided by the world's leading professionals in the underground construction industry, the NAT program included two short courses, Grouting in Underground Construction, and Soft Ground Tunneling. Two workshops were also held — Better Specifications for Underground Projects: Perspectives of Owners, Engineers, Contractors and Suppliers; and Professional Liability Issues for Consulting Engineers on Tunneling Projects: Perspectives of Owners, Constructors and Consulting Engineers.

The exhibit at the NAT Conference attracted 108 exhibitors.



Technical programming

The technical program at NAT included more than 100 papers presented in four tracks — technology, design, planning and case histories. Among the topics covered by authors from around the world were project planning and implementation, risk, project sustainability, project delivery, budgeting, innovation, applied technologies, and conventional and pressurized face tunneling.

The papers are available as a proceedings volume, available from SME, US$139 for members and student members, and US$189 for nonmembers. Online www.smenet.org/store; phone 303-948-4225 or 800-763-3132; e-mail books@smenet.org; mail SME, Book Coordinator, 8307 Shaffer Parkway, Littleton, CO 80127.

The following is a sampling of a few of the presentations.

Steve Kral, Editor

Projects in Portland. Tunneling in Portland mirrors the industrialization and urbanization of America, according to Susan L. Bednarz, Paul T. Gribbon and Joseph P. Gildner. In the Applied Technologies session, the three presented a history of tunneling in the Portland area, including rail and highways. Beginning with rail tunnels in the early 1900s, tunneling has evolved as a tool to protect the environment by reducing combined sewer overflows into the Willamette River that runs through Portland.

At least 14 tunnel projects exist in the Portland area, the authors said, ranging from a 1909 rail tunnel to the East Side CSO Tunnel, currently under construction. The variety of tunneling methods used to construct these tunnels reflects the diverse local geology, ranging from basalt bedrock to open gravel and boulders to soft silt. Challenging ground conditions have led to tunneling innovation, including the first use of a slurry mixshield tunnel boring machine (TBM) in North America and the longest microtunneling drive in the United States.

Shaft lining. In their paper "Large diameter segmentally lined shafts," Darin R. Kruse and Rodney Meadth, of Cobalt Construction, examined some of the unique engineering challenges in building shallow, large diameter (up to 90 m or 300 ft) segmentally lined shafts for nontraditional heavy civil or commercial uses, such as parking, storage, transportation or housing facilities.

The proposed design and construction approach the authors discussed addressed several inefficiencies that are

currently present in commercial practice. The studied design considers excavation depths up to 15 m (50 ft), and includes internal structural bracing (floors and ring beams) and post-tensioning elements in its final form. The results of economic modeling, field testing, prototype grouting methods and two-dimensional and three-dimensional finite element models were discussed.

Equipment suppliers showed the latest in tunneling technology.



TBM hybrids. The Lake Mead No. 3 Intake Tunnel will be constructed using a hybrid TBM — both slurry shield and open mode operation are possible — mostly through tertiary sedimentary rocks. Georg Anagnostou, Linard Cantieni and Marco Ramoni, of ETH Zurich, and Antonio Nicola, of ImpregiloSpA, discussed the geotechnical aspects of operating a TBM at the Lake Mead project.

Due to the poor quality of the ground and the high pore pressures prevailing in the 4-km- (2.5-mile-) long subaqueous section of the tunnel (up to 14 bar, the highest pressures seen to date in closed shield tunneling worldwide), the authors said that particular attention must be given to the risk of shield jamming or face collapse during boring or during the performance of maintenance activities in the working chamber. They examined the expected geological-geotechnical conditions and discussed their potential impact on the operation of the hybrid TBM (mode of operation and face support pressures), as well as proposed auxiliary measures, including advance drainage, grouting and decision-making during construction.

Underground structure design. Sustainable design is an integrated design process that complies with the principles of economic, social and ecological sustainability. In his paper, "Sustainable underground structure designs," Lei Fu, of URS Corp., said the philosophy of sustainability should be applied at various phases of an infrastructure system — the planning, design, construction and operation. The author reviewed current practices in sustainable infrastructure design, especially underground structure design. And he discussed the issues related to the application of the philosophy of sustainability to the design and construction of underground projects.

Sustainable tunnels. The concrete industry is one of the planet's largest consumers of natural resources. In their paper "Design for sustainable and economical tunnels," Derek J. Penrice and Bradford F. Townsend, of Hatch Mott MacDonald, said that cement production results in approximately 7 percent of the annual global emission of carbon dioxide (CO_2). With the continued threat of global warming, and increased costs for commodities, they said that it is critical that owners, designers and contractors promote the development of sustainable underground structures that make economical use of natural resources.

This process starts with design, the authors said. The selection of a particular design standard and design concept, as well as materials specification can significantly influence a project's resource requirements, and cost. They identified ways the underground construction industry can develop and promote more sustainable and, consequently, more economical practices within the industry.

Corrosion protection. Wastewater tunnels are continually exposed to highly corrosive environments. Owners are requiring 100-year design lives for their tunnels. So these tunnels, traditionally lined with concrete, will require protection from the corrosive environments they are deployed in. URS Corp.'s James B. Carroll and Heather M. Ivory discussed the available corrosion protection products on the market today for rehabilitation and new constructions. They examined the risks involved with the application of corrosion protection products in underground structures and the cost associated with these products.

Geotechnical variability. Geotechnical analyses for long tunnels should account for both variability and uncertainty, according to Jack Raymer, of Jordan, Jones and Goulding. Variability is a natural condition of the ground, he said. Uncertainty involves limits in knowledge about the ground. Variability can be described geologically and statistically using models based on the bell curve.

Ground problems typically involve the extreme con-

ditions at the tails of the bell curve. Uncertainty comes from having a limited amount of data, models that are imperfect and the change in scale between boreholes and the tunnel. Raymer provided several examples to show how baselines can be developed to account for both variability and uncertainty.

Washington D.C. river projects. The Anacostia River Projects (ARP) is the major component of the long term control plan for the District of Columbia Water and Sewer Authority. Amanda Morgan, of Jacobs Associates; Kevin Fu, of URS Corp.; and Ronald E. Bizzarri and Carl M. May, of the District of Columbia Water and Sewer Authority, said the ARP consists of an approximately 20.4-km- (12.7-mile-) long tunnel system. The project includes 18 large-diameter deep shafts and supporting structures.

The authors reviewed the ongoing geotechnical investigations used to characterize the subsurface for the ARP. Drilling methods include sonic and conventional, they said, and boring spacing is about 190 m (600 ft). Field testing includes pressuremeter, vane shear and crosshole seismic. Laboratory testing includes index, triaxial, consolidation, soil abrasion testing (SAT), soil chemistry and water quality. The estimated cost for the investigations is $6.5 million.

Setting the owner's budget. Many major underground public works programs have had problems with original published budgets compared with actual final costs. The cause of this, in most cases, is a poorly considered initial budget, according to Paul T. Gribbon and Julius Strid, of Portland's Bureau of Environmental Services and EPC Consultants, respecitively. The problem, they said, is that the public expects an accurate project budget to be published before there is any site investigation, engineering or design or a bid from a contractor, in addition to the inevitable changes that occur during all phases of an underground public works program.

The responsibility for establishing the budget falls squarely on the owner, the authors said. This usually occurs when the owner has no avenue for assistance from contrac¬tors or designers familiar with the type of work since they cannot hire someone to help them until program has begun. Some owners are lucky enough to have experienced personnel on staff familiar with major underground projects. But most do not, since these projects are not a regular occurrence for owners.

Additionally, the benefits of a project are not necessarily fully explored prior to the go-ahead to offer a contrast between the anticipated public investment in the project versus what the economic-environmental-community benefits are estimated to be throughout its life.

Gribbon and Strid presented an approach to setting a realistic owner's budget and preparing a benefits analysis for an underground public works program. Their presentation attempted to define the problem and give some answers. Included was a program budget guideline checklist, a benefits checklist and a few rules of thumb for predicting budgetary items.

Urban Ring Project. Three authors described the key planning phase issues and tradeoffs associated with a potential tunneled portion of the proposed Urban Ring Project in Boston, MA. D.M. Watson and J.P. Davies, both of Hatch Mott MacDonald; and J.A. Doyle, of AECOM, said the project is intended to provide new and improved transit service along an orbital corridor in Boston and several surrounding municipalities. It would link up the existing radial transportation system outside of the downtown core with a bus rapid transit system.

The tunnel portion of the corridor would be approximately 2.4-km- (1.5-miles-) long and would be constructed under the densely developed Longwood Medical and Academic area (LMA) and Fenway neighborhood of Boston. The dense urban environment, coupled with highly sensitive surface and subsurface conditions, imposed many constraints on the planning and conceptual design. Consequently, a range of alignments and profiles were considered, along with different tunnel construction techniques. These included single bore or twin bore pressurized face TBMs up to 12.8 m (42 ft) in diameter, sequential excavation methods and cut-and-cover techniques.

UCA awards, UCA Executive Committee members

The UCA of SME presented its individual and project of year awards during NAT. Refik Elibay received the 2010 Outstanding Individual Award. Elibay is a tunneling practice leader with Jacobs Engineering Group. His career spans more than 40 years in tunneling and underground construction. He has also served on the UCA of SME Executive Committee.

Edward S. Plotkin was the recipient of the Lifetime Achievement Award. Throughout his career, he has worked as a tunnel constructor and as project manager for numerous tunneling and construction projects, mostly in the East. He was also commissioner of public works for Westchester County in New York, where he was responsible for maintaining county facilities and a $200-million annual budget for new and ongoing capital expenditures.

The UCA of SME presented Levent Ozdemir its Outstanding Educator Award. He retired from the Colorado School of Mines (CSM) after 32 years of teaching and conducting research into tunneling and underground construction. Throughout his career at CSM, Ozdemir taught undergraduate and graduate courses in design and construction of underground structures, tunneling, site investigations, excavation project management and underground mining.

The Metro Gold Line Eastside Extension Tunnels

project received the UCA of SME Project of the Year Award. The project extended the Los Angeles County Metropolitan Transportation Authority's light rail system to the East Los Angeles communities. The project included a 2.7-km (1.7-mile) underground segment in cut-and-cover and twin-bored tunnel structures. Work was performed by Eastside LRT Constructors, a joint venture between Washington Group International, Obayashi and Shimmick. The tunnels were contracted to Traylor Brothers and Frontier Kemper.

Four new members of the UCA of SME Executive Committee were elected during NAT (see page 43). A fifth, Marcus R. Jensen, was re-elected to serve another term.

The four new members include Douglas Harding, vice president of international sales with The Robbins Co.; Colin A. Lawrence, senior vice president with Hatch Mott MacDonald; Michael Rispin, managing director of Normet's North American region; and David Rogstad, vice president and chief operating officer of Frontier Kemper Constructors. ■

Professional liability workshop generates interesting discussions

The Professional Liability Issues for Consulting Engineers on Tunneling Projects workshop held during the North American Tunneling conference was well attended and produced several interesting discussions about designer risk.

The workshop began with a presentation by David Hatem and topical discussions by David Corkum, Jack Lemley, Doug MacDonald, Gary Brierley and Mike Silchuck. David Hatem's presentation was comprehensive and covered many topics associated with "disappointed expectations and risk allocations" for tunnel designers including design/build procurement, subsurface investigations, construction means and methods, differing site conditions, standard of care, performance specifications, insurance considerations and third party exposures. Four of the above issues were discussed in greater detail by the panel and the audience.

Serving as the owner's consultant for a design/build project. The owner's consultant for a design/build tunnel must set the stage for every issue associated with project success including project layout, subsurface conditions, third party impacts, design requirements and construction conditions/limitations. The owner's consultant will also be heavily involved with qualifying and selecting the design/build team. It is fair to say that it is more difficult to prepare the contract package for a design/build procurement than it is for design/bid/build.

Serving as the contractor's designer for a design/build project. The contractor's designer for a design/build tunnel is also inundated by a variety of project responsibilities. In general, designers should only work with contractors with whom they have a long-standing relationship and who are dedicated to the highest standards of quality and safety. Even so, the contractor's designer becomes involved with many issues associated with construction means and methods that may not be well defined in the contractual relationship. Ground control procedures associated with adjacent third parties are particularly difficult to define since there are no contractual relationships with those entities.

Gary Brierley

Gary Brierley, member UCA of SME, is president Brierley Associates LLC, Littleton, CO, email ataylor@brierleyassociates.com.

Preparation of a geotechnical baseline report. Geotechnical baseline (GBR) reports for a design/build tunnel are difficult to write and require extensive coordination between the wwner's and the contractor's geotechnical consultants. Multiple phases of subsurface investigation and GBRs for bidding and construction must be prepared. In addition, subsurface exploration results by the contractor must be incorporated into the contract and could result in claims of differing site conditions at the beginning of a project. In general, only the best and most experienced geotechnical consultants should become involved with this process and a great deal of thought must be invested in how the subsurface risks are distributed among the parties.

Indemnification and duty to defend. Indemnification and duty to defend clauses in contract documents for engineering services are becoming increasingly onerous. This is especially true for subconsultants who are being asked to accept "flow down" requirements from the prime agreement. In general, those clauses may not be insurable and are sometimes not legally enforceable. As a minimum, a design professional should not accept responsibility to indemnify or defend a client except for actions resulting directly from negligence and/or willful misconduct. Owners must also consider the fact that the best, most experienced designers will not agree to onerous indemnification provisions that actually increase the possibility of major design errors for those projects.

This workshop was generally worthwhile but I believe additional emphasis on this topic and a much more focused and hard-hitting workshop would be appropriate. Tunnel designers need all the help they can muster when it comes to minimizing risk and avoiding liability for underground construction projects. ■

TUNNEL NAME	OWNER	LOCATION	STATE	TUNNEL USE	LENGTH (FEET)	WIDTH (FEET)	BID YEAR	STATUS
Hudson River Crossing	NJ Transit ARC Program	Newark	NJ	Subway	8,000 x 2	24.5	2010	Bid date 10/05/10
Palisades Tunnel	NJ Transit ARC Program	Newark	NJ	Subway	5,400 x 2	24.5	2009	Awarded to S3 JV
Manhattan Tunnel	NJ Transit ARC Program	New York	NY	Subway	6,000 x 2	24.5	2009	Awarded Barnard/ Judlau JV
THE 34th St. Cavern & Station	NJ Transit ARC Program	New York	NY	Subway	2,200	100 x 100	2011	Under design
Second Ave. 72nd Street Station	NYC-MTA	New York	NY	Subway	1,000	70	2010	Awarded SSK JV
Water Tunnel #3	NYC-DEP	New York	NY	Water	24,000	20	2012	Under design
Harbor Siphons Tunnel	NYC-DEP	New York	NY	Water	10,000	10	2010	Awarded OHL/Tully JV
Cross Harbor Freight Tunnel	NYC Regional Development Auth.	New York	NY	Highway	25,000	30	2013	Under design
Clinton CSO Tunnel	City of Syracuse	Syracuse	NY	CSO	2,000	17	2011	Under design
Silver Line Extension	Boston Transit Authority	Boston	MA	Subway	8,400	22	2013	Under design
East-West Subway Extension	Baltimore MTA	Baltimore	MD	Subway	32,000	18	2012	Under design
WASA CSO Program Blue Plains Tunnel Anacosita River Tunnel Northeast Branch Tunnel Northeast Boundry Tunnel	DC Water and Sewer Authority	Washington	DC	 CSO CSO CSO CSO	 23,400 12,500 11,300 17,500	 23 23 15 23	 2011 2013 2018 2021	 RFQ 3Q 2010 Under design Under design Under design
North/South Tunnel	Georgia DOT	Atlanta	GA	Highway	77,000	41	2015	Under design
Snapfinger Interplant CSO Tunnel	Dekalb County	Decatur	GA	CSO	26,400	28	2010	Under design
Port of Miami Tunnel	Florida DOT	Miami	FL	Highway	7,400	39	2011	Awarded Bouyges Civil Work Florida
Lockbourne Interceptor Sys. Tunnel	City of Columbus	Columbus	OH	Sewer	10,000	12	2012	Under design
OSIS Aug. & Relief Sewer Tunnel	City of Columbus	Columbus	OH	Sewer	25,300	18	2010	Kenny/ Obayashi JV low bidder
Olentangy Relief Sewer Tunnel	City of Columbus	Columbus	OH	Sewer	58,000	14	2012	Under design
Alum Creek Relief Sewer Tunnel	City of Columbus	Columbus	OH	Sewer	74,000	10 - 18	2014	Under design
Black Lick Tunnel	City of Columbus	Columbus	OH	Sewer	32,000	8	2013	Under design

The editors of Tunneling & Underground Construction encourage UCA of SME members to submit projects to the Tunnel Demand Forecast online at www.smenet.org. The items will be posted on the online TDF once they are verified.

TUNNEL NAME	OWNER	LOCATION	STATE	TUNNEL USE	LENGTH (FEET)	WIDTH (FEET)	BID YEAR	STATUS
Euclid Creek Tunnel	NEORSD	Cleveland	OH	CSO	18,000	24	2010	Bid date 09/30/10
Dugway Storage Tunnel	NEORSD	Cleveland	OH	CSO	16,000	24	2014	Under design
Lower Mill Creek CSO Tunnel	M.S.D. of Greater Cincinnati	Cincinnati	OH	CSO	9,600	30	2015	Under design
Water Treatment Plant #4	City of Austin	Austin	TX	Water intake	45,000	7 to 9	2010	Bid date 1st Q 2011
Waller Creek Tunnel	City of Austin	Austin	TX	CSO	5,300	22	2011	Under design
Deep Rock Connector Tunnel	City of Indianapolis	Indianapolis	IN	CSO	34,000	18.5	2011	Under design
Pogues Run Tunnel	City of Indianapolis DPW	Indianapolis	IN	CSO	11,000	18	2013	Under design
Drumanard Tunnel	Kentucky DOT	Louisville	KY	Highway	2,200 x 2	35	2012	Under design
Drumanard Tunnel - Pilot Tunnel	Kentucky DOT	Louisville	KY	Highway	2,200	12 x 12	2011	Under funding review
Alaskan Way Highway Tunnel	Washington DOT	Seattle	WA	Highway	10,500	54	2011	Bid date 10/28/10
Central Subway Tunnel	S.F. Municipal Trans. Authority	San Francisco	CA	Subway	16,600	20	2011	Under design
Bay Tunnel	S.F. Public Utility Commission	San Francisco	CA	Water	26,200	10	2010	Awarded Michels/ Jay Dee/Coluccio
New Irvington Tunnel	S.F. Public Utility Commission	San Francisco	CA	Water	18,200	10	2010	Awarded Southland/Tutor Perini JV
Sunnydale Aux. Sewer Tunnel	S.F. Public Utility Commission	San Francisco	CA	Sewer	4,000	11	2010	Awarded Super Excavators
San Francisco DTX	Transbay Joint Powers Authority	San Francisco	CA	Transit	6,000	35 to 50	2012	Under design
LA Metro Wilshire Extension	Los Angeles MTA	Los Angeles	CA	Subway	24,000	18	2012	Under design
SVRT BART	Santa Clara Valley Trans. Authority	San Jose	CA	Subway	22,700	20	2011	Under design/ delayed
Spadina Line Extension	Toronto Transit Commission	Toronto	ON	Subway	22,000	18	2010	Awarded 4th Q 2010
Eglinton West Tunnel	Toronto Transit Commission	Toronto	ON	Subway	10 km	20	2011	Under design
Yonge Street Extension	Toronto Transit Commission	Toronto	ON	Subway	15,000	18	2013	Under design
Port Mann	Greater Vancouver Regional District	Vancouver	BC	Water	3,300	10.5	2010	Bid date 10/01/10
Evergreen Line Project	Trans Link	Vancouver	BC	Subway	10,000	18	2012	Under design
UBC Line Project	Trans Link	Vancouver	BC	Subway	12,000	18	2014	Under design
Kicking Horse Canyon	BC Dept of Transportation	Golden	BC	Highway	4,800 x 2	45 x 32	2012	Under design



2011 UCA of SME Calendar
Call for Photos and Sponsors

Do you have great tunnel project photos? UCA is asking for photos for the 2011 calendar that will be sent to UCA members. The best 18 photographs will be selected. One for each calendar month....along with photo credits. Please send your high resolution photos (tif or jpg format) to Mary O'Shea at oshea@smenet.org by October 1, 2010. Selection of photos will be made by October 30th, 2010.

OR

You can be a sponsor for the 2011 UCA Calendar! The benefits include:

- Guaranteed photo of your choice in the calendar
- Photo credit
- Company logo on the same page as the photo

• Sponsorship ($1,000) •
• Sponsorship for the Front or Back Cover of the calendar ($3,000) •

Complimentary calendars will be sent to 700+ UCA members.

If you would like to be a sponsor, please contact Liz Jones:
jones@smenet.org or 303.948.4216



EXECUTIVE COMMITTEE

UCA announces new Executive Committee members

Four new members joined the Executive Commttee of the Underground Construction Association (UCA) Division at the North American Tunneling Conference in June 2010. Marcus Jensen was re-elected to serve another term. They began their terms on July 1, 2010.

Douglas Harding — Committee Member

Douglas Harding is the vice president of the International Sales Division of The Robbins Co. Robbins is a global tunnel boring machine company based in Solon, OH. Robbins has four primary manufacturing facilities and seven international sales and service locations.

Harding has served in several capacities with Robbins since 1979. These include managing the engineering, project management and manufacturing departments of Robbins. Harding's current responsibilities include international sales, as well as responsibility for overseeing the Robbins Customer Service Division. This division incorporates the field service and spares departments for North America and other divisions in China, Europe and India.

Harding received a B.S. degree in mechanical engineering from Cleveland State University in 1982.



HARDING

Marcus R. Jensen — Committee Member

Marcus R. Jensen spent the year before he entered college as a welder and structural steel fabricator. He then toured throughout Southeast Asia and India in 1976. This convinced him that he would like to make his contributions to the world as a civil engineer.

Jensen earned his B.S. degree in civil engineering from San Diego State University in 1982 and began a 28-year career focused on engineering public water systems. During the past 15 years, he has been associated with the planning, design and construction of more than $2 billion of regional water system improvements for southern Nevada, including submerged water intakes, tunnels, pumping stations, pipelines and water treatment facilities.

Jensen is a professional engineer and became director of the Southern Nevada Water Authority's engineering department in 1999. The Southern Nevada Water Authority is currently engaged in more than $500 million of construction for Intake No. 3 at Lake Mead.



JENSEN

Colin A. Lawrence — Committee Member

Colin A. Lawrence is senior vice president with Hatch Mott MacDonald and serves as the firm's deputy practice leader for tunnels in the eastern United States. He has more than 30 years of specialized experience in all types of tunneling for transportation, water and wastewater projects in a variety of ground conditions in soil and rock. He has been involved in all aspects of underground project implementation from planning, design, project management to construction management and project completion.

Lawrence has gained a reputation for successfully undertaking some of the more technically challenging and high-risk tunnel projects around the world, including the Channel Tunnel, the Storebaelt Rail Tunnel Project in Denmark and the Strategic Sewerage Disposal Scheme in Hong Kong.



LAWRENCE

Michael Rispin — Committee Member

Michael Rispin earned a bachelor's degree in mining engineering, with a minor in management, from McGill University in 1985. After graduation, he joined DuPont Canada's Explosives Division and served in positions of increasing responsibility. His 12-year career with explosives concluded at Austin Powder Canada. Throughout this period, he was primarily involved with underground applications in mining and tunneling construction.

In 1996, Rispin accepted the position of mining manager with

Master Builders in Cleveland, OH and became involved with sprayed concrete. He was responsible for the Allentown Equipment Division and served as manager of underground construction for North America. This culminated with an assignment in Switzerland with BASF, a company acquisition. His 13-year focus was on tunneling and underground mining. Since 2009, Rispin has served as managing director for Normet's North America Region, and he also serves as president of Normet Americas and Normet Canada, a manufacturer and supplier of equipment for tunneling and underground mining. It is also involved in the processes of sprayed concrete and explosives charging.

In addition to the UCA of SME, Rispin is a member of the Professional Engineers of Ontario, the Canadian Institute of Mining, Metallurgy and Petroleum, the American Society of Civil Engineers, the International Society of Explosives Engineers, the American Concrete Institute and the American Shotcrete Association.



RISPIN

David Rogstad — Committee Member

David Rogstad received a B.S. degree in building construction in 1979 and an M.B.A. in 2001, both from the University of Washington. From 1979 through 1981, Rogstad worked for Genstar Construction in Bellevue, WA. In 1981, he joined S.J. Groves & Sons and worked as an engineer on lock, dam and bridge projects on the Mississippi and Saginaw rivers.

He worked in Alaska from 1985 through 1991. He first served as project engineer for Christenson, Raber Kief & Associates of Seattle, WA, and later as project engineer and project manager for Enserch Constructors on the Bradley Lake hydro project. Rogstad was project manager for S.A. Healy Co. on the Dallas Area rapid transit's NC-1B project, which involved 10,668 m (35,000 ft) of rail tunnel and related structures. He joined Frontier Kemper Constructors (FKCI) in 1995 as an estimator in its headquarters office. In 1997, he was promoted to regional manager of FKCI's Northwest Division office. In 2004, he was elected vice president and chief operating officer.



ROGSTAD

Rogstad became president and chief executive officer of the company in 2008. ■

New topics to be discussed at Breakthroughs in Tunneling course

Emerging technologies in tunnel boring machine (TBM) construction increasingly allow large-diameter tunnels to be bored across North America and around the world. Projects in Niagara Falls and Seattle are among others in Europe and Asia using TBMs with diameters up to and exceeding 15.2 m (50 ft). The current plan for the Alaskan Way project in Seattle is to use a soft-ground TBM with a diameter of approximately 16.8 m (55 ft), which would be a world record.

Breakthroughs in Tunneling, an annual tunneling short course at the Colorado School of Mines (CSM), will explore the issue of TBM technology for large-diameter tunnels and more. The course will be held Sept. 22-24, 2010 on the CSM campus in Golden, CO.

Also new to the agenda is a focus on conditioning for pressurized face tunneling. This timely subject includes a discussion of earth pressure balance and slurry TBM projects that are coming up in the United States and for which proper face conditioning is a critical aspect of success.

CSM professor emeritus Levent Ozdemir, a recognized expert on mechanized tunneling, and Tim Coss, president of Microtunneling, are the course directors. This one-of-a-kind course is designed for contractors, owners and design engineers who are building or planning to build a tunnel. The course is organized by CSM in conjunction with *Tunnel Business Magazine* and Microtunneling. Attendees will receive continuing education units for attending the course. For more information or to register for the course, visit www.tunneling.com. ■



UCA Division seeks nominations for the 2011 Executive Committee

The Underground Construction Association (UCA) Division seeks recommendations and nominations from all UCA members for interested individuals to serve on the 2011 UCA Executive Committee. The executive committee consists of three officers — chair, vice chair and past chair — and four directors from each of the following areas: engineers, contractors, owners and suppliers. Ideally, the UCA Executive Committee has balanced representation from the four categories, but the committee has the option to have more members serving in one or more categories with fewer representatives in others.

If you would like to nominate someone for consideration, please e-mail your recommendation to Mary O'Shea, oshea@smenet.org, at SME headquarters by Nov. 1, 2010. SME staff will compile all nominations for the UCA Nominating Committee's consideration. Please identify in which of the four areas the individual should be considered for service — engineer, contractor, owner or supplier. Also include a brief biography or résumé outlining the person's industry experience and service to UCA and other professional organizations.

Please remember that the individual must be a member of the UCA of SME. ■

UCA calls for award nominations

The Underground Construction Association (UCA) Division of SME will present the UCA awards at the 2011 Rapid Excavation and Tunneling Conference in San Francisco, CA. The awards to be presented are: Outstanding Individual, Project of the Year, Outstanding Educator and the Lifetime Achievement Award. The nominations for the awards will be reviewed and the winners selected by the UCA Executive Committee at its January meeting. The recipients' photos and biographies will appear in the June issue of *T&UC*. Guidelines and nomination forms are available on the UCA of SME website, uca.smenet.org. Submit nominations by Jan. 3, 2011 to Mary O'Shea at oshea@smenet.org. ■

Submit your photos for the UCA calendar — or become a calendar sponsor

Do you have great tunnel project photos? The UCA Division is asking for photos for its 2011 18-month calendar, which will be available to all UCA members. The best photographs will be selected, one for each month, and credit will be given to each photographer. Please e-mail your high resolution photos (tif or jpg format) to Mary O'Shea at oshea@smenet.org by Oct. 1, 2010. The final photos will be selected by Oct. 30, 2010. We want to see your work.

Or be a sponsor

Sponsor's benefits include a guaranteed photo of your choice in the calendar, photo credit and a company logo on the same page as the photo. Inside sponsorships of $1,000 and front or back cover sponsorships of $3,000 are available. Complimentary calendars will be sent to the more than 700 UCA Division members. Potential sponsors should contact Liz Jones at jones@smenet.org or phone 303-948-4216. ■



Croton Aqueduct Tunnel, Croton, NY. TBM Breakthrough with Crew and Staff. Photo courtesy of Lovat.

PERSONAL NEWS

Akkerman Inc. has appointed **RICK ZAVITZ** (SME) to the position of area sales manager for the North American and Canadian markets. He has more than 17 years of expertise in lubrication products, slurry separation, mud mixing and directional drill manufacturing in the trenchless market. Zavitz previously worked for Wyo-Ben in Billings, MT, Surface to Surface Inc. and Trenchless Utility Equipment. ■

Tsurumi to represent Primax Pumps in Europe

Tsurumi Europe has announced an agreement with Australian pump manufacturer, Primax Pumps, to sell its automatic self-priming diesel pumps to Germany, France, Austria and Switzerland. The new pumps are highly versatile and will complement Tsurumi's current product range. Tsurumi Europe will introduce the new pumps at the bauma 2010 trade fair in Munich, Germany (April 19-25).

Tsurumi will sell Primax's Yakka pumps in Europe.



Tsurumi Europe continues to expand its range of specialist pumping solutions with the addition of a new product line.

The new pump line joins Tsurumi's current offerings and allows the company to provide a compact, mobile and fuel efficient pumping solution for almost any application.

The Yakka are compact and maneuverable pumps that can be mounted on a single axle trailer. The versatile range has a maximum head of 67 m (220 ft)and maximum flow of 132 L/s (2,090 gpm). The pumps can be used for general dewatering and wellpoint applications.

The Yakka have market leading fuel efficiency, with a full tank providing up to 30 hours of use. The pumps are also very quiet thanks to a special acoustic casing. Running at 1,500 rpm, the Yakka emits just 65.5 dBA at 7 m. Gull wing doors allow for easy maintenance.

www.tsurumi-europe.com

Bobcat introduces new line of compact excavators

Bobcat has introduced a new series of compact excavators known as the M-series. The new compact excavators are reengineered to deliver greater strength in a lighter machine.

Backed by industry-leading cycle times, M-series compact excavators provide improved digging performance in a lighter machine. The advanced hydraulic system provides more usable power, consistent and smooth operation and predictable results every time. Some new features include auto shift travel, auto idle and fingertip controls.

With reduced noise levels, improved climate control and convenient storage, M-series models are built for all-day operation. The new easy-to-use rotary knob allows for precise throttle adjustments.

M-series compact excavators feature a redesigned work group for improved lifting performance and durability. The new X-frame undercarriage offers better ground clearance and less cleanup time. Integrated slew brakes hold the load steady when working on a slope.

The machines include simple checkpoints for easy maintenance. The swing-open tailgate and side access hood allows for eas access to key maintenance points. Side panels are easily removed for additional engine access.

www.bobcat.com

Bobcat M series excavator.



• Denotes new listing.

Industry Events

September 2010

• **21-24, InnoTrans 2010,** Messe Berlin, Berlin, Germany, Italy. Contact: Messe Berlin GmbH, phone 49-030-3038-2036, fax 49-030-3038-2190, e-mail innotrans@messe-berlin.de, website www.innotrans.com.

• **22-24, Breakthroughs in Tunneling Short Course,** Colorado School of Mines, Golden, CO. Contact: Levent Ozdemir, 780 Kachina Circle, Golden, CO 80401, phone 303-526-1905, e-mail lozdemir1977@aol.com, website www.tunneling.com.

October 2011

26-27, Underground Infractructure of Urban Areas 2011, Wroclaw, Poland. Contact: Institute of Civil Engineering, Wroclaw Universty of Technology, website www.uiua2011.pwr.wroc.pl.

November 2011

• **8-10, 28th International No-Dig 2010,** Suntec Singapore International Convention & Exhibition Center, Singapore, China, website www.istt.com.

More meetings information can be accessed at the SME website — http://www.smenet.org.

March 2011

• **27-31, NASTT's 20th No-Dig Show,** Gaylord National Resort & Convention Center, Washington, D.C. Contact: Michelle Hill, Benjamin Media, Inc. 1770 Main St., P.O. Box 190, Peninsula,OH 44264-0190, phone 330-467-7588, fax 330-468-2289, e-mail mmagyar@benjaminmedia.com, website www.benjaminmedia.com.

May 2011

• **21-26, ITA-AITES World Tunnel Congress,** Helsinki, Finland. Contact: Congrex/Blue & White Conferences Oy, P.O.Box 81, FI-00371 Helsinki, Finland, phone 358-9-5607500, fax 358-9-56075020, e-mail wtc11@congrex.fi, website www.wtc11.org.

June 2011

• **19-22, NAT,** San Francisco, CA. Contact: Meetings Department, SME, 8307 Shaffer Parkway, Littleton, CO 80127, phone 800-763-3132 or 303-979-3461, e-mail sme@smenet.org, website www.smenet.org. ■

UCA of SME

George A. Fox Conference
Jan. 26, 2011
Graduate Center City University of New York, New York, NY

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2011

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January 25, 2011 • Graduate Center, City University of New York
New York, New York

Rapid Excavation and Tunneling Conference
June 19-22, 2011 • San Francisco, California

2012

North American Tunneling Conference
June 24-27, 2012 • JW Marriott • Indianapolis, Indiana

For more information contact: UCA of SME
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SWIFT EPB.

At 336 m in one month, a Robbins EPB is tunneling the Guangzhou Metro faster than any of the other 60 TBMs on-site. In Sacramento, a Robbins EPB has achieved a rate of 45 m in 24 hours — while installing PVC-lined concrete segments. And in Delhi, a Robbins EPB has advanced a record 202 m in one week—beating the rates of the other 14 machines on the Metro project.

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