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E&MJ ENGINEERING AND MINING JOURNAL®

FEATURES

LEADING DEVELOPMENTS

AROUND THE WORLD

This month, E&MJ *turns its attention to mine rescue. As it has in so many areas of mining, technology is improving how rescue teams communicate. On the cover, the Kirkland Lake Gold mine rescue team trains in smoke underground. (Photo: Dräger and the Ontario Mine Rescue Association)*

DEPARTMENTS

Steve Fiscor
Publisher & Editor-in-Chief

Learning to Live With COVID-19

Throughout this month's edition of *E&MJ*, readers will note the continuing influence of the novel coronavirus (COVID-19). Issues related to the pandemic are reported several times in the various news sections. It is a sign of the times as society learns to live with COVID-19.

Most mining companies continued to operate as the virus spread. They did not wait for regulators to tell them what to do. They assessed the situation, implemented proactive approaches to prevent the virus from spreading, and kept the mines and mills running to the best of their abilities. Now, mining activities that were suspended by government decree are steadily ramping up in most regions.

During this period, mining professionals demonstrated profound leadership. They not only worked to preserve their business model, they assisted the local communities. The intertwined, supporting relationship between the mines and the surrounding communities was clearly evident. This is nothing new. The five men who will be inducted into the Mining Hall of Fame this year understood this (See Hall of Fame, p. 19).

While the approaches varied, many mining companies developed staged workplace safety plans that prevented the spread, addressed how to respond to infections and planned for recovery. The protocols for prevention included proper personal protective equipment (PPE). The availability of PPE for miners should never be an issue, but medical PPE was a different story and they found a way to secure supplies. In some cases, the mines supplied PPE to the surrounding communities and educated people on its use. They also had to educate miners and local communities about sanitary practices. In many remote areas, where the mines are responsible for essential services, such as clean drinking water and power generation, they had to ensure uninterrupted service.

The second stage for many workplace safety programs involved response programs, such as employee screening and even community screenings in some cases. Considering that most operations employ hundreds of miners per shift, employee screening became an important tool to prevent the spread of the virus. This is also a sensitive area as far as employee privacy and reporting standards. In *Seeking Balance Between COVID-19 Suppression and Worker Privacy* (See Operating Strategies, p. 80), *E&MJ* offers some advice in this area.

The final stage of the workplace safety program involves recovery with everyone eventually returning to a healthy work environment. While people at many businesses found they could work remotely and may never return to their offices, this will not be the case at the mines. Miners need to drill and blast rock, load it into crushers and extract saleable minerals through sophisticated recovery systems. Mining and milling equipment must be maintained and managed and these tasks take place at the mine or in the plant.

The results of these efforts will bear fruit. Many mining companies will gain considerable community service credibility. Maintaining production at a time when many businesses were reeling will also put them ahead of the curve when the economic recovery begins in earnest. And, should a second wave occur, they will be more prepared.

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E&MJ ENGINEERING AND MINING JOURNAL
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MINING MEDIA INTERNATIONAL

Engineering & Mining Journal, Volume 221, Issue 6, (ISSN 0095-8948) is published monthly by Mining Media International, Inc., 11655 Central Parkway, Suite 306, Jacksonville, FL 32224 (mining-media.com). Periodicals Postage paid at Jacksonville, FL, and additional mailing offices. Canada Post Publications Mail Agreement No. 41450540. Canada return address: PO Box 2600, Mississauga ON L4T 0A8, Email: subscriptions@mining-media.com. Current and back issues and additional resources, including subscription request forms and an editorial calendar, are available at www.e-mj.com.

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POSTMASTER: Send address changes to *E&MJ*, 11655 Central Parkway, Suite 306, Jacksonville, FL 32224-2659.

REPRINTS: Mining Media International, Inc., 11655 Central Parkway, Suite 306, Jacksonville, FL 32224 USA; email: subscriptions@e-mj.com; phone: +1.904.721.2925, fax: +1.904.721.2930; www.mining-media.com.

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PURVIS INDUSTRIES

SSR Will Merge With Alacer to Create Geographically Diversified Company

Alacer's pressure oxidation circuit (above) processes Çöpler's sulphide ore. (Photo: Alacer Gold)

SSR Mining and Alacer Gold have entered into an agreement to combine in an at-market merger of equals pursuant to a plan of arrangement under the Business Corporations Act (Yukon). The combined entity will continue as SSR Mining and will be headquartered in Denver, Colorado, with a corporate office in Vancouver, British Columbia, and will be led by Rod Antal as president and CEO and Michael Anglin as chairman.

SSR Mining is a Canadian-based precious metals producer with three operations, including the Marigold gold mine in Nevada, U.S., the Seabee Gold Operation in Saskatchewan, Canada, and Puna Operations in Jujuy, Argentina. Alacer's cornerstone Çöpler gold mine is located in east-central Turkey about 1,100 kilometers (km) southeast from Istanbul and 550 km east from Ankara.

Alacer shareholders will receive 0.3246 SSR Mining shares for each Alacer share held. The exchange ratio implies C$8.19 per Alacer common share and a combined market capitalization of $4 billion. At closing, SSR Mining and Alacer shareholders will collectively own approximately 57% and 43% of SSR Mining, respectively.

The transaction will require the approval of at least 66-2/3% of the votes cast by the shareholders of Alacer at a special meeting. The issuance of shares by SSR Mining under the agreement is also subject to the approval of the majority of votes cast by the SSR Mining shareholders at a special meeting.

Completion of the transaction is also subject to regulatory and court approvals and other customary closing conditions.

Forecast 2020 production from the individual mines is as follows: at Çöpler, 230,000 ounces (oz) to 260,000 oz of gold from the sulphide plant and 80,000 oz to 100,000 oz from the oxide plant; at Marigold, 225,000 oz to 240,000 oz of gold; at Seabee, 110,000 oz to 120,000 oz of gold; and at Puna, 6 million oz to 7 million oz of silver, 21 million lb to 24 million lb of lead, and 7 million lb to 9 million lb of zinc.

The forward-looking three-year average annual production profile of the merged company is about 780,000 gold equivalent oz per year (oz/y) at all-in sustaining costs of about $900/oz.

Antal said, "The combination of Alacer and SSR Mining will create a diversified portfolio of high-quality, long-life mines across four mining-friendly jurisdictions. Our focus at Alacer over the past several years has been on generating peer-leading free cash flow — this merger allows us to continue this strategy while diversifying our single operating asset exposure.

"In addition, the increased financial strength of the combined business will allow us to leverage the proven project execution capabilities of the combined management team to continue delivering on the extensive organic growth portfolio and compete for attractive assets as they arise.

"The complementary nature of the assets and the cultural alignment of the organizations will facilitate an effective integration and allow us to continue to deliver value to our shareholders."

New Century Will Buy Goro Mine From Vale

New Century Resources Ltd. has entered into a 60-day exclusivity period with Vale Canada Ltd. (VCL), a subsidiary of Vale S.A., to complete due diligence and negotiate the acquisition of 95% of the issued shares in Vale Nouvelle-Calédonie SAS (VNC). VNC owns and operates the Goro nickel and cobalt mine in New Caledonia.

Subject to due diligence and negotiation of formal agreements, the financial terms would include a financial package to support the transition and continuity of VNC operations from VCL to NCZ. The parties also plan to jointly engage with the French state to confirm its continued financing support.

"New Century is pleased to secure this exclusivity agreement in relation to the potential acquisition of the Goro [mine]," New Century Managing Director Patrick Walta said.

He added that New Century has been impressed by the VNC site team and the quality and scale of the infrastructure at the Goro mine.

The Goro operations include a fully integrated and operational world-class mine, processing plant and port facility. A plan has already been implemented to improve Goro's cost base that includes converting to a low-impurity limonite only feed, decommissioning a complex refinery, which has been the major source of operational

disruptions, transitioning to 100% mixed hydroxide product (MHP), highly sought after by the electric vehicle industry, and obtaining a license for saprolite ore export.

If the transaction proceeds, it would become a major nickel supplier and a non-Democratic Republic of Congo source for cobalt.

Newmont Continues Ramp-up, Updates Guidance

Newmont Corp. will continue to ramp up operations at Peñasquito, Cerro Negro, Éléonore and Yanacocha. Among Newmont's 12 operating mines and two joint ventures, 13 sites will be fully operational in the coming weeks, the company said.

"We are pleased to be ramping up operations at our four sites previously placed in care and maintenance and we remain committed to protecting our workforce and neighboring communities," President and CEO Tom Palmer said. "We continue to respond to this pandemic from a position of strength and Newmont's diverse portfolio in top-tier jurisdictions provides a long-term, stable production profile with the potential to generate significant free cash flow over time."

Newmont also provided a revised 2020 outlook with nearly all mines operating and mining deemed an essential activity in every jurisdiction where the company operates. The revised 2020 outlook assumes that operations will continue throughout the remainder of the year without major interruptions. Newmont's long-term guidance remains unchanged with stable production of more than 6 million ounces (oz) and improving costs from 2021 through 2024.

This outlook is near the lower end of the company's previous outlook. Costs applicable to sales (CAS) is expected to be $775 per oz and all-in sustaining costs is expected to be $1,015 per oz, which were toward the upper range of the company's previous cost outlook. The revised 2020 outlook includes the production and cost impacts from the five operations temporarily placed into care and maintenance for an average of 45 days. The second quarter is expected to be the lowest production and highest cost quarter of 2020 as the sites ramp up from care and maintenance.

At Peñasquito, activities ramped up on May 18 with a phased approach consistent with the Mexican government's regulations. Over the next two weeks, the site will implement required hygiene protocols and

Industry Study Investigates Technology for Upgrading Ore

A collaborative study with Australian mining companies BHP, Norton Gold Fields and Saracen on the integration of screening and particle sorting techniques could deliver benefits across the resource sector. The Integrated Screening and Particle Sorting Collaborative (ISPS) Study aims to develop a robust and scientifically rigorous framework for collecting, testing and reporting results for integrated screening and particle sorting techniques in a variety of ore domains.

The study, which began in August 2019, is currently under way at BHP's Cliffs mine, Norton Gold Fields' Paddington Gold site and Saracen's Carosue Dam operation in Western Australia. It is expected the study will further expand during its 15-month tenure to include two additional sites.

CRC ORE ISPS Study Program Manager and Discipline Lead of Metallurgical Engineering at Curtin University's Western Australian School of Mines Dr. Laurence Dyer said the opportunity existed to use particle sorting to upgrade ores.

"Trials have recently been conducted at several gold mining operations in the Goldfields region of Western Australia," Dr. Dyer said.

Dyer said usually what isn't taken into consideration is the benefit of assessing the natural deportment of metal to a size fraction through grade-by-size screening test work.

"Missing this step has two impacts. Firstly, there is a risk that particle sorting test results will be misinterpreted as being representative of the full sample without considering the mass balance impact of high-grade material that might have been lost in the fine fraction. This fine fraction will not be detected through the particle sorter.

"Secondly, the opportunity may exist to upgrade feed first through determining if there is a concentration of high grade to the fine (or coarse) fraction, which can be separated through screening. Undertaking screening in the preparation stage of the particle sorting process will enable analysis and separation of the fine or coarse fractions of a rock mass," he said.

Dyer said the study outcome would be a blueprint for understanding the opportunity for upgrading ore feed, including an assessment of operational impacts, economic valuation and implementation approaches.

"CRC ORE will benefit from developing a broader understanding of the application and opportunity for applying particle sorting on a range of deposit types and integrating this with natural deportment grade-by-size screening opportunities to maximize value for mining operations."

Dyer said the ISPS study would be conducted through CRC ORE's Kalgoorlie-Boulder Mining Innovation Hub and Curtin University's Western Australian School of Mines.

Using the ISPS screen deck, CRC ORE is conducting grade-by-size screening test work.

mobilize key operations and maintenance teams for training. Production is expected to commence in early June.

On March 23, Éléonore was placed into care and maintenance. In early May, Éléonore began ramping up operations and the mill is expected to restart on May 23.

Cerro Negro was also placed on care and maintenance on March 23. In early May, the operation began implementing a safe restart plan and remobilizing its workforce and the mill is expected to start on May 20.

On March 17, Yanacocha ramped down in response to travel restrictions imposed by the Peruvian government. In early May, the operation began remobilizing following the confirmation that the Peru Economic reactivation plan allowed surface mining. The site is implementing a safe restart plan with milling operations starting on May 16 and surface mining activities expected to begin by the end of May.

On March 23, Newmont decided to place Musselwhite into care and maintenance in order to limit the number of people on site and prevent the possible transmission of the virus into the nearby First Nations communities in northern Ontario. Essential personnel continue to maintain infrastructure, provide security and continue environmental management. Musselwhite is the only operation remaining on care and maintenance. Conveyor installation is expected to recommence over the coming weeks.

Newmont continues to progress the majority of its development and sustaining capital projects, including Tanami Expansion 2, developing the sublevel shrinkage mining method at Subika Underground and advancing laybacks at Boddington and Ahafo. However, as a result of COVID-19, total 2020 capital expenditure is now expected to be approximately $1.3 billion due to reductions in non-essential activities and changes to the development capital schedule for Tanami Expansion 2 and Boddington's Autonomous Haulage, which defers some expenditures to 2021.

For exploration and advanced projects, approximately 80% of the company's exploration budget is allocated to near-mine with the majority of work suspended in March, the company said. However, Newmont is currently ramping up near-mine drilling programs and preparing to restart Greenfields activities as soon as local restrictions are lifted in French Guiana, Suriname, Ethiopia, Peru, Chile and Australia. The exploration teams have been working remotely focused on improving orebody and district scale models as well as developing risk mitigation plans to restart activities under COVID-19 restrictions. Advanced project study work for Yanacocha Sulfides and Ahafo North continues remotely.

Newmont said it will continue to utilize protective measures for its workforce and neighboring communities, including screening, physical distancing, deep cleaning, and avoiding exposure for at-risk individuals.

Shandong Gold Will Purchase TMAC Resources

Shandong Gold Mining Co. Ltd. (SD Gold) has entered into an agreement with TMAC Resources to acquire all of the outstanding shares of TMAC at a price of C$1.75 per share in cash. The transaction is valued at approximately $149 million and the offer represents a 52% premium to TMAC's 20-day volume-weighted average price as of May 6, according to the company.

TMAC operates the Hope Bay property located in Nunavut, Canada. The property and operations are remote but not isolated, serviced by both a port and airstrip. TMAC began producing gold in early 2017 from Doris, its first mine at Hope Bay, and processed gold at the Doris Plant, which originally had nameplate capacity of 1,000 metric tons per day (mt/d) and expanded to 2,000 mt/d midway through 2018.

"Hope Bay is a highly prospective high-grade gold camp, which requires substantial investment to optimize production and extend mine life and maximize the value of the camp to the benefit of all stakeholders," Chairman of SD Gold Yumin Chen said. "We look forward to completion of the transaction and the opportunity to invest in the project for years to come as the generational potential of the camp is unlocked."

Resource Capital Funds, Newmont and directors and officers of TMAC collectively holding approximately 58.6% of the current outstanding TMAC common shares are expected to support the transaction.

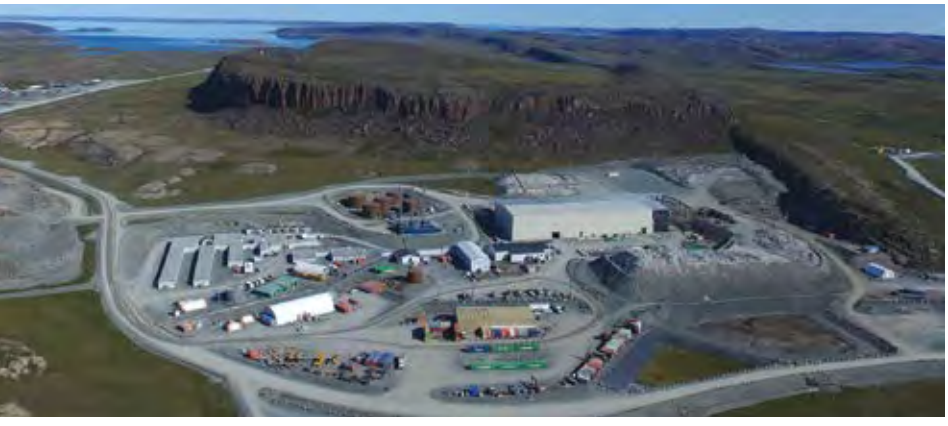
"The transaction is the culmination of the strategic review process we announced earlier this year," TMAC President and CEO Jason Neal said. "Over the past several months, SD GOLD has completed a significant due diligence review of TMAC, including a site visit to Hope Bay earlier this year. SD GOLD, as one of the world's largest gold producers, has the financial strength, technical capability and long-term vision to maximize the value of the Hope Bay camp."

The transaction will be subject to the approval of at least 66-2/3% of the votes cast by shareholders at a special meeting of TMAC shareholders expected to be held in June. It is also subject to the receipt of applicable regulatory approvals including TSX approval, approval under the Investment Canada Act (Canada), the Competition Act (Canada) and approval by relevant authorities in China.

The agreement includes a non-solicitation covenant on the part of TMAC and a right for SD GOLD to match any competing offer that constitutes a superior proposal.

In related news, TMAC has received interim financing from SD Gold to support the cost of the company's sealift this year.

Headquartered in Jinan, Shandong province, China, SD GOLD has approximately 16,000 employees and produced 1.3 million ounces (oz) of gold in 2019. Its international assets include its 50%



TMAC began producing gold from the Doris mine (above) in 2017. (Photo: TMAC Resources)

(Continued on p. 30)

How Long Should a Hose Last?

Knowing what can kill your hose is half the battle. Prevention plus proactive hose care will maximize hose life and improve the bottom line.

Brad Hoback, Motion Industries

We get asked all the time, "How long should a hose last?" If I could crystal ball this one, I'd be a very rich person. Especially in mining operations, as we have many hose applications based on system pressures and types of equipment being used in the process. Multiple types of hoses are used whether it's braided or spiral constructions being used in surface and underground mining.

Abrasion: The biggest killer of hydraulic hose

Rubbing or gouging causes the removal of the rubber cover, exposing reinforcements. Different types of abrasions exist. For example:

- Rubber against steel frames
- Rubber against ground surface (dragging)
- Rubber against rubber

If the reinforcement is exposed, it may not begin to leak or burst right away. Since the cover is removed, it compromises the construction of the hose performance. Depending on the condition or surroundings of the hose, being exposed can cause the reinforcement to rust and get brittle or can also continue to remove the exposed reinforcements layer by layer. Additionally, in mining operations, mines can be written up or fined for this condition as it poses a major safety violation to workers. Today, hose manufacturers produce many hoses with high-abrasion materials built into the cover at the time of manufacture. Also, other abrasion-resistant products exist to protect the covers, like flat and round spring guards and fabric abrasion sleeves. Using a better abrasion-type hose or product will help, but re-routing a hose — if possible — to give better protection can be an answer.

Abrasion

Heat and exposure: The #2 killer of hydraulic hose

External heat sources around engine compartments and areas of the country that have high outside heat temperature cause a hose to age and fail prematurely. Exposure to heat can be reduced by using a heat-resistant sleeving, or again, re-routing where practical to minimize exposure.

Internal system heat temperature will shorten hose life as well. In fact, any rubber-related products in the system like seals and o-rings will be affected. Let's say a hose is rated at 212 degrees as maximum temperature rating, and your system runs on the high side of that rating — you begin to cook the hose. To make a hose, it is put into autoclave oven equipment at the time of manufacturing to get adhesion of tube, reinforcement and cover. So high-temperature exposure continues to cook the hose. In this case, additional oil coolers may help reduce your system temperature, helping extend system life. Also check return line sizes to make sure it has not been replaced with a smaller ID than needed, as this will cause heat issues.

Besides heat exposure, ozone and dust contribute to shorten hose life; these environmental issues cause hoses to dry out, as they pull out plasticizers in the hose's construction.

Other conditions to hose safety and life fall into other categories:

Hose routing.
Equipment manufacturers engineer best routing for their specific design criteria. Sometimes re-routing a hose for better life just can't happen. For example, roof bolters or drills have large bundles of hose that have abrasion issues, but you can't re-route that configuration to improve on life. Anytime you can re-route or protect an assembly where practical, better life can be achieved.

Bend radius.
Bend radius is critical on hose life. Too tight of a bend will cause side loading on couplings, creating leaking issues and/or failure. Making replacement hoses that look real nice and tight along the framework may cause too tight of a bend radius. If an assembly has a specific length, replace it with that length unless you're not sacrificing the bend radius.

Fluid compatibility.
Manufacturers of newer, modern hydraulic equipment are using environmental biodegradable-friendly oils. The tube stock of many standard hydraulic hoses doesn't do well with this type of fluid. Fluid compatibility is necessary to make sure the tube stock of the hose is not affected by the fluid. Check your oil properties to see what hose tube stock is designed to handle your needs. Cover blisters and tube swelling are signs of fluid incompatibility with a hose. Cover blisters can also be caused by trapped gasses in the system. If you have a mixture of old and new equipment in your fleet, using a hose tube stock for biodegradable oils for all applications will eliminate having different hoses to cover all needs.

Cover Blister

Hose twist.
When installing a replacement hose in a system, pay attention to hose twist as you tighten the ends to create a seal. Most hoses have printed information on the cover of the hose to tell what type of hose you have by the manufacturer. It's called the lay line. If your lay line is twisted or spiraled, you are also doing the same type of twist to the reinforcement of the hose. This will greatly shorten hose life. Place the hose as close to its natural position as possible, tightening one end and then going to the second end — not allowing the hose to twist.

Hose Twist, or Kinked Hose

Correct replacement hose assembly fabrication.
When fabricating an assembly, choose the correct replacement hose and fittings to match the original failed assembly for working pressure, ID size, and fitting combination. Choosing a hose too small for the application can cause heat and sluggish performance. It's a good practice to mark insertion lengths on the hose to ensure that couplings are being pushed all the way into the hose. It's also a good practice to measure final crimp OD (outer diameter) of all hoses being made to the manufacturer's recommended setting. This ensures you've made a correct assembly and also provides safe working conditions for other personnel.

Tips:

- Temperature — Hose should be stored in a cool, dry area never exceeding +100°F (+38°C). If stored below freezing, pre-warming may be required prior to handling, testing, and placing into service.
- Don't place in direct sunlight, rain, heaters or near electrical equipment, humidity, or ozone.
- Don't expose to oil, solvents, corrosive materials, or fumes.
- Store hose in the original container if possible. Never stack hose too high, as its weight can crush hose at the bottom of the stack.

Choosing a method of protecting hose will provide better life and reduce costly downtime. Motion Industries provides many solutions in hose and fittings to our hydraulic mining customers from our world-class manufacturing partners. Local support is key, and having industry knowledge will result in less downtime and keeps personnel safe. Motion also provides on-site safety classes for your specific application needs.

***Brad Hoback** grew up in a family-owned hydraulic hose business in Denver, Colorado. For the last 20 years, he has been a hose and rubber specialist with Motion Industries. Hoback is Gates-certified and is a Safe Hydraulics trainer.*

To find out more, visit www.MotionIndustries.com/eandmj, or see the Mi Hose & Rubber webpage (https://tinyurl.com/ycecazak).

Dominion Sells Diamond Mines to Washington Companies

An aerial view of the Ekati mine, which is included in the proposed transaction. (Photo: Dominion Diamond)

On May 22, Dominion Diamond Mines announced it signed a letter of intent (LOI) with an affiliate of The Washington Cos. for the purchase of all of Dominion's assets for approximately $126 million in cash and the assumption of nearly all its operating liabilities. Washington also agreed to provide Dominion up to $60 million in short-term debtor-in-possession financing. Dominion filed for insolvency protection on April 22.

Dominion said it believes the proposed sale ensures it will be able to resume mining operations at the Ekati diamond mine in the Northwest Territories and recall its furloughed workers as the spread of COVID-19 subsides and diamond markets reopen. It also provides assurance that Ekati will continue to operate into the future, Dominion said. Dominion will also be able to pay or meet obligations owed to employees, including pension obligations.

Dominion said it expects to emerge from the Companies' Creditor Arrangement Act process stronger and better able to deliver value to all stakeholders, including the government and citizens of the Northwest Territories.

An entity managed by Washington will serve as the "stalking horse" bidder for Dominion's assets, and its bid will be subject to a court-supervised bidding process. Accordingly, Dominion intends to file a motion with the court seeking approval of the proposed asset sale, which would be subject to termination if Dominion determines it has received one or more higher and better offers; the proposed DIP financing; and bidding procedures for the solicitation of competing offers, either to purchase part or all of the company's assets or to make an investment in the company.

Dominion said it expects the sale process to move quickly and close in the 90 to 120 days.

The transaction will be subject to certain conditions, including Dominion reaching a separate agreement with Rio Tinto regarding the Dominion/Rio Tinto joint venture at the Diavik diamond mine on terms that are acceptable to Washington. If an agreement with Rio Tinto is not reached, then the sale would not include Dominion's interest in, or any liabilities relating to, the Diavik mine. It would only include the sale of Dominion's other assets, including its interests in Ekati and the Lac de Gras Diamond Project, its diamond inventory and other assets.

White Gold Will Begin Yukon Exploration Program

White Gold announced its 2020 exploration program is fully funded. The company's extensive 422,000-plus hectare land package represents more than 40% of the emerging White Gold District in Yukon, Canada. The 2020 exploration program, which is budgeted at approximately $4 million, has been designed to further test existing targets and recent high-grade discoveries on the company's White Gold, Hen, and JP Ross properties, as well as to identify and advance other targets on its extensive regional land package. Backed by partners Agnico Eagle Mines and Kinross Gold, the 2020 exploration program is scheduled to commence in the coming weeks.

"2020 is expected to be another exciting year for White Gold as we diamond drill test recent discoveries at the Ryan's Surprise and Titan targets, as well as advance other high-priority targets across our expansive land package," Vice President of Exploration Terry Brace said. "Extensive review and analysis performed in the off-season has also provided new interpretations on several projects, which we are excited to test.

"We will also continue to develop a better understanding of the geological and structural framework of our targets for follow up drill testing when ready."

The White Gold property hosts the company's flagship Golden Saddle & Arc deposits, which have a current mineral resource of more than 1 million ounces (oz) gold indicated at 2.26 grams (g) per metric ton (mt) gold and more than 500,000 oz gold inferred at 1.48 g/mt gold. Planned 2020 exploration work on the White Gold property includes 1,500 m of diamond drilling at the Ryan's Surprise target to test for strike and down-dip extensions of mineralization encountered in 2019, as well as eight RAB drill holes on high priority targets elsewhere on the property.

Cameco Restarts Production at Ontario Operations

Cameco resumed production at its Port Hope Conversion Facility's UF6 plant and its Blind River Refinery in Ontario the week of May 18, and planned to achieve regular production levels the week of May 25.

On April 8, Cameco placed these facilities in a temporary safe shutdown state for approximately four weeks and, where

possible, maintenance work scheduled for the summer would be advanced. Screening protocols and other measures put in place to align with government and public health directives around COVID-19 were contributing to workforce uncertainty at the UF6 plant, which is a complex operation designed to run as a continuous process without interruption, according to the company. The decision was therefore made to suspend production at the plant, as well as at the Blind River Refinery, since the majority of the UO_3 produced there is used in the production of UF6 at Port Hope.

The workforce situation has now stabilized, providing Cameco with increased certainty around the availability of necessary personnel to operate the UF6 plant. With the appropriate conditions currently in place to resume normal operations, the company said it decided to return both the plant and the refinery to production.

"The provinces and communities where we operate are certainly not out of the woods when it comes to this global pandemic, and we must remain vigilant in how we manage our activities during these challenging times," Cameco President and CEO Tim Gitzel said. "However, we are confident that we can maintain the required roster of qualified operators to run the UF6 plant going forward, enabling us to carefully bring the plant and the UO_3 refinery back into production."

Given the evolving nature of the COVID-19 situation and the number of moving pieces, on April 13, Cameco withdrew its 2020 outlook for its fuel services division, including production.

While the two Ontario facilities return to production, there is no change in the status of Cameco's Cigar Lake uranium mine.

Updated PEA Enhances Seabridge Gold's KSM Project

Seabridge Gold announced in late April that an updated preliminary economic assessment (2020 PEA) of its 100% owned KSM project in northwest British Columbia has confirmed the potential for a dramatic improvement in project economics by incorporating the recently expanded, higher-grade Iron Cap deposit into mine plans. The 2020 PEA considers a 44-year mine production plan capturing 19.6 million ounces (oz) of gold and 5.4 billion lb of copper from measured and indicated resources, plus an additional 20.8 million oz of gold and 13.8 billion lb of copper from inferred resources.

Life-of-mine recovered production is estimated at 27.6 million oz of gold and 17 billion lb of copper.

A 170,000-metric-ton-per-day (mt/d) processing rate would treat 2.4 billion mt of mill feed, or only 30% of the total mineral resource. Initial capital is estimated at $2.5 billion, with a four-year payback.

Average annual pretax free cash flow is estimated at $1.45 billion from 1.3 million ounces per year (oz/y) of gold and 265 million lb per year (lb/y) of copper produced during the initial five years of production. Life-of-mine average operating cost is estimated at negative $472/oz of gold produced, net of copper and silver byproduct revenues.

Life-of-mine total cost of is estimated at $4/oz of gold produced, inclusive of all project capital and net of copper and silver byproduct revenues.

Seabridge Chairman and CEO Rudi Fronk noted that the 2020 PEA was undertaken to assess an alternate approach to developing KSM by incorporating a much larger Iron Cap block cave mine into the production schedule accompanied by smaller open pits compared to prior studies and developing this opportunity much earlier in the project's mine life.

"The benefits of incorporating Iron Cap into mine plans at an early stage have exceeded the upper end of our expectations, not only for the improvements in projected economics but also for the reduction in environmental impact. The PEA is based on Iron Cap's inferred resource estimate, but we are very confident these resources will upgrade to higher categories with further drilling as they have in the past at the project's other deposits. We therefore think the new technical report gives investors a compelling view of the project's potential.

"I would like to recognize the outstanding effort by our engineering team and our consultants for these results while working under the constraints imposed by COVID-19 and also the impressive success of our exploration team for their expansion of the Iron Cap resource."

The 2020 PEA envisages a combined open-pit and underground block cave mining operation. Over the 44-year mine life, mill feed delivered to the process plant is planned principally for gold and copper extraction, with silver produced as a byproduct.

The mill would produce a flotation copper concentrate containing precious metals for transport by truck to a nearby seaport at Stewart, British Columbia, for shipment to Pacific Rim smelters and a gold-silver doré from carbon-in-leach processing of pyritic concentrates.

Metallurgical testing indicates that KSM can produce a clean copper concentrate at an average copper grade of 25% with relatively high gold and silver content, making it readily saleable.

US Gold Continues to Advance Copper King in Wyoming

U.S. Gold Corp. has received a proposal to upgrade the Copper King Preliminary Economic Assessment (PEA) to a prefeasibility study (PFS) with the objective of completing the PFS by the end of 2020. Copper King is located in the Silver Crown mining district of southeast Wyoming and approximately 20 miles west of Cheyenne.

A December 2017 PEA indicated an economic resource based on $1,250 per ounce (oz) gold and $2.25/lb copper. The PEA economics done at $1,275/oz gold and $2.80/lb copper generated a pretax cash flow of $296.8 million, net present value (NPV) of $178.5 million at a 5% discount rate, and an annual internal rate of return (IRR) of 33.1%.

The capital expense for the project is estimated at $114 million with a payback in just under 2.5 years.

Based on internal updated resource prices, Copper King's preliminary economic assessment (PEA) has a projection

U.S. Gold continues to further define the Copper King orebody with exploration drilling.

of pretax cash flow of $510.54 million, NPV of $321.6 million, and 52% pretax annual IRR at $1,600/oz gold.

At $1,600/oz, gold, the economic resource increases from 1.3 million to 1.5 million gold-equivalent oz (geo). The economic resource ore tonnage increases from 133 million tons to 170 million tons (economics are 80% gold and 20% copper).

"We are pleased with the progress of the Copper King project in 2020 and have made several trips to the property last year to advance the project from a permitting, development and community outreach standpoint," President and CEO Edward Karr said. "We are looking forward to working with Dr. Marc Levier and Mark Jorgensen to advance the Copper King deposit to the PFS level."

Karr added that the PFS is expected to be a major milestone in moving forward toward production.

"The existence of silver in the Copper King deposit could give further upside to the overall economics and will be analyzed thoroughly in the PFS," Karr said. "We have a very experienced board assisting in moving the project forward, including Tim Janke on mine engineering and development, Douglas Newby on permitting and The Hon. Ryan Zinke on state of Wyoming relations, permitting, strategy and community outreach."

In 2017 and 2018, U.S. Gold Corp. conducted geophysical studies at Copper King and drilled additional exploration holes. Several of these holes hit additional mineralization, and it has been shown the deposit has increased to the west. In addition, the Datamine analysis conducted in early 2019 shows the presence of economic-grade silver not previously accounted for the in the PEA economics. Extending the deposit along strike to the southeast will be the focus of future exploration efforts, the company said.

In related news, U.S. Gold Corp. recently completed a detailed gravity survey at its Maggie Creek exploration project on the Carlin Gold Belt in Nevada. U.S. Gold Corp. acquired the option to earn up to a 70% interest in the Maggie Creek project from Renaissance Gold through the company's acquisition of Orevada Metals Inc. The detailed gravity survey will aid ongoing mapping and future targeting-drilling activities at Maggie Creek. The survey was completed by Magee Geophysical Services with processing and interpretation completed by Wright Geophysics. Gravity interpretation supports the historic geologic mapping and identified several structural zones and potential alteration zones that require field checking and other follow-up work.

"Considering the restrictions we all have been facing due to the COVID-19 pandemic, U.S. Gold Corp. has been able to make meaningful advancements on both of its key Nevada exploration projects," said Ken Coleman, project geologist for U.S. Gold Corp. "The gravity survey at Maggie Creek will help focus initial surface mapping and sampling work on major interpreted and previously mapped structural zones and their intersections, some of which contain gold-bearing altered dikes and associated alteration zones. Structural intersection zones can be favorable for ore deposit formation, as evidenced by Newmont's Gold Quarry mine just to the southwest."

Coleman said some of more encouraging features in the gravity survey report are several areas along the Cress fault, termed "Good Hope parallel," which may represent dolomitization. Dolomitization has been demonstrated to be associated with ore grade gold mineralization on the Carlin Belt and in many other Carlin-type deposits.

First Vanadium Completes PEA for Nevada Project

First Vanadium Corp. has reported positive results from a preliminary economic assessment (PEA) of its Carlin vanadium project six miles south of Carlin, Nevada. Active mining of the project would continue for 11 years, plus five years of stockpile processing.

Process plant feed is planned at 1 million metric tons per year (mt/y) at an average grade of 0.71% V_2O_5 and average process recovery rates of 78%, resulting in an average payable production of 11 million lb per year (lb/y) of V_2O_5 flake. Life-of-mine total payable production is estimated at 180 million lb of V_2O_5 flake.

Life-of-mine average cash operating cost per payable V_2O_5 lb is estimated at $5.17/lb V_2O_5, including $4.81/lb V_2O_5 over the first 10 years. Preproduction capital requirements are estimated at $535 million. The assumed metal price in the PEA is $10.65/lb V_2O_5.

The project resources include both oxide and non-oxide materials. The mine design has two objectives: first, to mine the highest grade in the oxides, followed by non-oxides, and second, once the whole deposit is mined, to store tailings in the pit.

A drill-blast load-haul profile has been built into the model at an average cost of $2.30/short ton; however, it may be possible that some of this material can be mined without drilling or blasting. This will be determined in subsequent studies.

The process plant is designed to produce V_2O_5 as a saleable product from the two distinct material types that make up the resource, oxide and non-oxide shales, using conventional equipment and conventional beneficiation and hydrometallurgical techniques. The run-of-mine oxide feed from the mine would be attrition scrubbed and classified to produce an oxide concentrate. The run-of-mine non-oxide feed would be crushed, ground, attrition scrubbed/classified, and floated to produce a non-oxide concentrate.

Both concentrates would then be subjected to acidulation, pressure oxidation, impurity removal, vanadium solvent extraction, and precipitation as ammonium metavanadate (AMV). Finally, AMV would be calcined to form the V_2O_5 product. The overall recovery of V_2O_5 through the process flowsheet for oxide material is estimated at 78.6%. The overall recovery of V_2O_5 for non-oxide material is estimated at 77.4%.

First Vanadium President and CEO Paul Cowley commented, "The PEA crystalizes potential economics for the company's vanadium asset and provides for design options and enhancement opportunities…

"With a positive PEA, the Carlin vanadium project becomes an even more important resource of a critical and strategic metal essential to protecting U.S. national interests, particularly as the U.S. looks toward vital future domestic sources of strategic metals, which include vanadium.

"In addition, the benefit of having both vanadium and a separate gold opportunity on the same property located within the world-famous Carlin gold trend is unique, broadens our opportunities, and is another of our many strengths. With our goal to maximize on all our high-quality opportunities to enhance value for our shareholders, it is now time to bring our exceptional gold opportunity to the forefront with the aim to drill-test this summer. This drill program will be led by ex-Newmont Regional Manager and proven mine-finder Dave Mathewson, who has found six gold deposits within three to nine miles of the property."

(Continued on p. 23)

KMEC and PICOR
A Bulk Material Handling Manufacturer Who Understands Supply Chain

KMEC, a division of Purvis Industries, is an international provider of bulk material handling equipment. Located in Houston, TX, KMEC has been in the bulk material handling design, engineering, fabrication, and commissioning business for over forty years. They take on the toughest application challenges and solve them using their years of experience and expertise.

KMEC was acquired by Purvis Industries in 2017 and joins two other sister companies to provide turn-key solutions from start to finish: PICOR and Foresight Automation.

KMEC – Bulk Material Handling

Some of the installations that KMEC has successfully designed and built include:

- Horizontal curved conveyors
- Long overland conveyors (up to 12 miles)
- Double-arm and radial stackers
- Complete ship loading systems

KMEC can start with a blank sheet of paper and your specifications, or simply build quality equipment to your design!

PICOR – Innovation, Quality, Value

PICOR has been in the bulk material handling business for over forty years. Their specialty is solving tough material handling challenges in product flow control, reclaim and loading of truck, train and barge.

- Walker Reclaimer – no touch, 100% reclaim of material.
- Slide gates.
- Mass flow gates.
- Diverters.
- Precision Loading Systems (PLS) for road or rail – within 0.1% accuracy.

PICOR's unique, patented designs will save you time – loading up to 6,000 TPH. They'll also save you money in lost freight capacity with their Precision Loading System™ – a high-speed weighing system that is so simple you must see it to believe it.

Foresight Automation – Automation & Control

Foresight Automation joined the Purvis family of companies in 2019 and is located in Fort Worth, TX. Foresight has been in the automation, custom machine building, and industrial control integration business since 2000.

Foresight's engineers add automation and control intelligence into the KMEC and PICOR designs. Automated loading and operation? Done it. Data acquisition and retention? Done it. Rail manifests? Done it. Foresight handles it all from the service entrance to the newest generation IoT sensors.

Putting the "Smart" in Material Handling!

Nothing is really exciting about bulk material handling to the average person. If you're a mine engineer or mill manager, however, you need that product coming in consistently and reliably! KMEC does it with the newest generation of Industrial Internet of Things devices from ABB – the ABB SmartSensor!

Powered by ABB Ability, and available through your phone or tablet, ABB's intelligent bearing sensors, AC motor sensors, and connected VFDs provide constant feedback to your operations department about conveyor condition and uptime. Catch vibration and temperature alerts early or get real time fault information from a tripped VFD.

Purvis Industries
The One Call You Need to Make!

Purvis' 78 branch offices are located throughout the Western and Southwestern US. Every one of them is stocked with conveyor components and has experts available to coordinate all our services for you. Their eCommerce site provides up to the minute availability for your operational needs. Through their CAPCORP conveyor belt division they can also provide and install heavyweight conveyor belt, including track, train, splice, and repair. The Purvis Industries team has you covered for all your bulk material handling needs.

Want to Learn More? Call, go online, or email to schedule your bulk material handling expert call! Their motto is "Purvis for Service"! (purvisindustries.com)

PURVIS INDUSTRIES

ABB's Dodge® Bulk Material Handling team
Your trusted conveyor design partner

ABB's Dodge Bulk Material Handling team utilizes an expansive portfolio of Dodge mechanical products and ABB and Baldor-Reliance® motors, Passport online selection tool, and decades of conveyor engineering expertise. These capabilities allow customers to partner with one manufacturer who offers complete proposals and quick delivery of factory assembled packages which increase reliability, boost productivity and improve safety in operations.

Two conveyor design paths to fit your needs

1. **On-demand conveyor design via Passport,** a web-based product selection program which utilizes a visual, intuitive process to quickly guide users through the selection of components and assembled packages for conveyor applications. This path empowers users to design complete conveyor packages, obtain pricing, view real-time availability, and enter orders. It is ideal for capacities up to 3500 tons per hour with standard belt widths up to 60" wide.

   This path also provides quick shipments of gearbox assemblies (gearbox, motor and accessories) and pulley assemblies (pulley, bushing, shaft, and bearings) from stock. Factory assembled, complete packages provide easy installation, reduced maintenance time, and minimizes safety risks.

2. **Engineered projects via the Bulk Material Handling team,** a dedicated group of individuals who support your entire project from quote through installation. They provide a single point of contact for projects and ensure the project stays on time from start to finish. Working with this team is best for non-standard conveyor profiles, belts longer than 3500 feet, and more than 3500 tons per hour.

   This path provides peace of mind with a three-year extended warranty. An additional year of warranty is available with the purchase of a field services package.

Reliability, productivity and safety

The Dodge Bulk Material Handling team applies decades of conveyor engineering expertise to the design of your project. By incorporating this expertise with Dodge mechanical products and ABB and Baldor-Reliance industrial motors, they can design, manufacture and assemble complete packages specifically for your application and operation.

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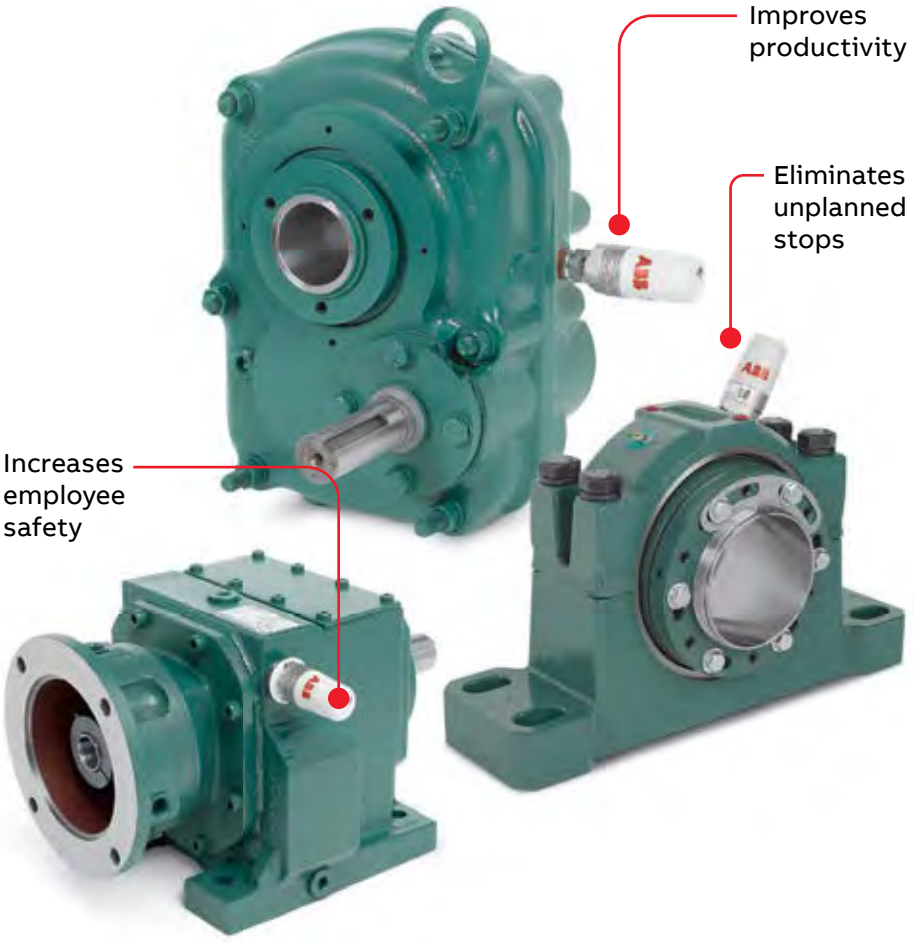

Condition monitoring

For mechanical components

The ABB Ability™ Smart Sensor for mechanical products is an easy-to-use, wireless sensor which monitors the health of mounted bearings and gear reducers. The sensor provides warnings when health status declines, reducing the risk of unplanned downtime. In addition, connectivity and trend data allow maintenance to be planned proactively instead of reactively, and remote monitoring capabilities keep employees away from areas that are difficult or dangerous to access.

Operate safely. Reduce downtime. Improve reliability.


Edgar Basto

BHP appointed **Edgar Basto** as president of Minerals Australia, effective July 1. Basto will be a part of BHP's executive leadership team and responsible for BHP's iron ore and nickel operations in Western Australia, metallurgical and energy coal in Queensland and New South Wales, and copper in South Australia. Basto has been the acting president of operations for Minerals Australia since **Mike Henry** was announced as CEO in November 2019. From 2016 to 2019, Basto was asset president of Western Australia Iron Ore.


Luis C. Marchese

Sierra Metals appointed **Luis C. Marchese** as CEO. Marchese is replacing current President and CEO **Igor Gonzales,** who will resign. Marchese is a highly regarded mining executive with 25 years of experience in the mining sector, mostly at Anglo American for 22 years. He was Anglo American's Peru country manager and, during different periods, general manager of Quellaveco.


Michael "Mick" Routledge

Coeur Mining appointed **Michael "Mick" Routledge** as senior vice president and COO. Routledge will assume leadership of Coeur's operations from **Terrence F.D. Smith** who will continue as the company's senior vice president and chief development officer. Most recently, Routledge served as vice president of major projects and studies at Alacer Gold Corp.

Dr. Mphu Ramatlapeng has retired from *Anglo American* after almost seven years. Ramatlapeng has served as an independent non-executive director since July 2013 and brought a broad range of global social welfare and health expertise from across both the public and private sectors.

Nornickel appointed **Christophe Koenig** as its head of global sales and marketing. Koenig will also occupy the position of CEO of Metal Trade Overseas AG, Nornickel's Switzerland-based sales division. Prior to joining Nornickel, he managed sales and procurement as senior vice president of commercial and SCM at Aurubis Group.


Sepanta Dorri

Horizonte Minerals appointed **Sepanta Dorri** as a director. Dorri has now been appointed to the board as the nominee director for Teck Resources as a direct replacement for **Alex Christopher** who is stepping down. In her capacity as vice president, corporate development, of Teck Resources since late 2018, Dorri is responsible for the identification and pursuit of external growth opportunities and providing support for internal growth initiatives.


Dr. Mark Cruise

New Pacific Metals Corp. appointed **Dr. Mark Cruise** to its board of directors. Dr. Cruise assumed the CEO position on April 27, after serving as the COO of the company. Previously, Cruise was the founder and CEO of Trevali Mining Corp.


Robert Hall

Robert Hall, Ph.D., is the new head of the Department of Mining Engineering and Management (MEM) at *South Dakota School of Mines & Technology*. Hall most recently served as a professor in the School of Mining and Petroleum Engineering at the University of Alberta, Canada.


Samantha Espley

The *Canadian Institute of Mining* named **Samantha Espley** the president for 2020-2021. She has worked in Sudbury for most of her career and spent 30 years at Vale, most recently as the company's director of mining technology and innovation, before retiring in October 2019. She has been a member of CIM since she was an engineering student at the University of Toronto.


Raphael Carmona

Sandvik Mining and Rock Technology appointed **Raphael Carmona** as new business line manager, stationary crushing and screening, North America. He will start in this role, responsible for Canada and the USA, on August 3. He is currently the business line manager for crushing and screening.


Stephan Kirsch


Jari Ålgars

Several appointments were made to the *Metso Outotec* Executive Team. Current President, Aggregates, Equipment, at Metso **Markku Simula** will become president of aggregates. **Stephan Kirsch** will become president, minerals. He currently serves as president, mining equipment at Metso. **Jari Ålgars,** CFO of Outotec, will become president, metals. Current President of Recycling at Metso **Uffe Hansen** is the president, recycling. **Markku Teräsvasara** will become president, services, and deputy CEO. He currently serves as the president and CEO at Outotec. Current President, Minerals Consumables, at Metso **Sami Takaluoma** will become the president, consumables.


Jason Savage

Jason Savage was named senior vice president, Underground Soft Rock, at *Komatsu*. In his 35 years with the company, he has served in a variety of leadership roles in South Africa, the United States and Australia, including global controls and automation, operations and supply chain, and most recently as senior vice president, soft rock regions and operations.


Joseph "Joe" Dzierzawski

Joseph "Joe" Dzierzawski has been named president and CEO of *BEUMER Corp.* He joined BEUMER from Hatch Metals & Minerals group where, as a senior member of the Hatch metals team.


Jari Tuorila

MacLean Engineering appointed **Jari Tuorila** as area sales manager for Australia and southeast Asia.


Michael Bailey

Michael Bailey has been promoted to the position of general manager of *Mole MasterServices Corp.*


J. David Lowell

Solaris Resources Inc. announced that **J. David Lowell,** a consultant and strategic partner of the company, passed away at his home in Tucson, Arizona, at the age of 92. Innovation and ingenuity were constants throughout his legendary career, which began with first defining the porphyry copper model with John Guilbert. The direct application of this model in the field led to his discoveries at Kalamazoo and Vekol Hills in Arizona, and the discovery of Bajo Alumbrera, Argentina's greatest copper deposit, in the mid to late 1960s. He went on to discover the world's largest copper deposit, La Escondida, in Chile in 1981. Likewise, in Peru, he identified the Northern Peru Gold Belt after library study, regional mapping, reconnaissance and sampling in a region that was not thought to be prospective. This work allowed him to narrow his focus and make the Pierina gold discovery in 1996, which was acquired by Barrick Gold for more than C$1 billion later that year. With Peru Copper, he took what was a known but underappreciated deposit in Toromocho, re-logged the existing drill core and completely reinterpreted the geology to lay the foundation for an exploration program that would increase its size by more than an order of magnitude. Finally, in Solaris, he had a vehicle to bring his Warintza discovery to full fruition and his other discovery, Mirador, was made in an unrelated company and the deposit has since been developed into Ecuador's largest mine.


Tadeusz Gerus

Tadeusz Gerus passed away on April 7, 2020. He attended Silesian University in Poland to study mining mechanization, graduating in 1964 with a master of science. He began his 40 years career as a mining engineer engaged in research and design of mineral processing equipment particularly crushers and screens. He held many patents and was a long-time member in ISO TC 27, participating in conferences in the USA, China, South Africa. He was engaged in development of standards on comminution and screening. He retired in 2002.

Metso is a world-leading industrial company offering equipment and services for the sustainable processing and flow of natural resources in the mining, aggregates, recycling and process industries. With our unique knowledge and innovative solutions, we help our customers improve their operational efficiency, reduce risks and increase profitability.

THIS IS METSO

At the heart of Metso is our drive to make the big difference to our customers. Our products range from mining, aggregates, and recycling equipment to industrial valves and pumps. Our services account for 54% of our sales. Our customers are supported by a global network of over 15,000 professionals in more than 50 countries.

MARKET ENVIRONMENT AND COMPETITIVE POSITION

Metso is well positioned in all our customer industries globally.

Our customers' and their customers' needs derive from certain global trends – urbanization of communities, a circular economy, digitalization, an ever-increasing need for minerals, and the growing demand for oil and gas. We need raw materials to maintain our modern way of living. Many types of materials and waste can also be reused after the appropriate processing. Developing energy-efficient and cost-effective processes for refining different waste streams is a big business opportunity, as the global risk of material scarcity is continuously increasing.

Mining companies today are faced with declining ore grades and more complex ore bodies, as well as increasing environmental and safety requirements. In the quest for capital efficiency, continuous performance improvement has become the biggest challenge in the industry.

To accommodate growing populations, more houses, parks and roads, among others, are needed. Many aggregates producers are now studying the possibility of producing crushed sand, as natural sand deposits located near growth centers are being depleted and environmental regulations are becoming stricter.

Paper mills, power plants and oil refineries have countless needs for valves. As they evolve to stay competitive and to respond to new emissions regulations, they are constantly seeking ways to make their processes more reliable and efficient.

PRODUCTS AND SERVICES

We provide our customers with world-leading products and services built on technological excellence, experience and the highest safety standards.

In mining, we offer equipment, services, spare and wear parts and process knowledge for the whole value chain of mining, from the mine to the finished products of mineral concentrates or mineral pellets. Large-scale project deliveries are typical for the mining industry.

In aggregates, we supply our customers with energy-efficient mobile and stationary rock crushing plants, screens, feeders and conveyors, as well as expert and maintenance services. Metso's services and spare and wear parts ensure high-quality end products and secure continuous production.

In oil & gas and in pulp & paper, we provide valve solutions and related services that offer reliability and maximum performance, including industry standards for health, safety and the environment.

In metal recycling, we offer a wide range of efficient solutions for the fragmentation, compaction and separation of virtually every type of metal scrap. Our shears and shredders are well known for their robust design, performance capabilities and versatility.

In waste recycling, we provide a comprehensive shredder offering for processing solid waste and side products to produce, for example, alternative fuels.

Metso's services offering covers the whole lifecycle of our customers' products and processes. Metso's comprehensive service network ensures that our customers get professional support whenever they need it.

OUR CUSTOMERS

We serve a variety of customers in different industries, all processing raw materials.

In mines and mineral processing plants, both global and regional miners trust our mining solutions and pumps to process minerals efficiently and safely. Ultimately these minerals are utilized in countless everyday applications, e.g. lithium in mobile phones and copper in electric cars.

In quarries, our deep process know-how and our technology and strong service capabilities are used to produce high-quality aggregates and manufactured sand. The end products are then used in, for example, construction and road building.

Scrap yards, automotive manufacturers, and other household or industrial waste processing facilities use our efficient solutions to take care of shearing, baling, briquetting, shredding and pre-shredding of virtually every type of scrap. Recycled material can be used, for example, to produce alternative fuels.

In petrochemical plants and in pulp and paper mills, our valves, equipment and services provide reliability and maximum performance in controlling the flow of pulp and other liquid media and fluids.

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Mining Reactivation Begins in Peru

By Oscar Martinez, Latin American Editor

Currently, mining activities in Peru are slowly going back to normal thanks to a four-phase mining reactivation plan implemented by the Peruvian government. Phase 1 allows for major mining companies resume operations; Phase 2: Exploration activities restart; Phase 3: Midsize mining companies resume operations; and Phase 4 (final): Conventions, trade shows and meetings resume.

The Peruvian Institute of Mining Engineers (IIMP) recently organized a discussion panel to address some of the challenges for the reactivation of the mining sector during the COVID-19 pandemic. The panel was hosted by IIMP Director Dr. Miguel Cardozo, and the speakers were Gonzalo Tamayo, former minister of mines and energy, and Ricardo Marquez, president of the National Society of Companies (SNI).

"It will be a priority to return mining to normal, but it won't be easy," Tamayo said. "It will face big challenges as the mines resume day-to-day activities. Investing in mining exploration will be another issue, and I think it will be postponed." He also pointed out that informal mining in Peru has not stopped.

Cardozo believed that Peru's GDP could fall up to 20% due to the lower activity in the mining sector. "Mining leads private investment and accounts for more than 10% of Peru's exports," Cardozo said.

Cardozo also said it is mandatory for every mining company operating in Peru to maintain the highest safety standards and extend the shifts during operation.

"Shifts will probably move to a 30 (on) x 15 (off) system," Cardozo said. "There should not be manpower downsizing in mining because the companies will try to keep or even increase their current production rates.

"In addition, I strongly feel that exploration should continue. I believe that mining companies in Peru will draw upon innovation to maintain costs and cash flows."

Chuquicamata Underground Extracts 1M Tons

The Chuquicamata Underground project in Chile continues its historic transformation from a large open pit to a block-cave operation. Codelco recently announced that Chuqui UG's material handling system had placed more than 1 million tons of ore on the stockpile.

General Manager Juan Cristobal Videla said credit for this milestone should be given to the miners. "The entire team has risen to the challenge," Videla said. "We have been implementing our operating model with productivity practices that allow us to see favorably how we are going to face the most demanding future periods."

At the same time, Videla said they have gained considerable experience seeing the real behavior of the geology underground and that has allowed an increase in the cave rates for the first macroblock and the increased production.

Drifters advance development at Chuqui Underground. (Photo: Codelco)

This milestone is the first of others that Codelco said it hopes to achieve in the short and medium term.

"We are currently achieving production rates of around 20,000 metric tons per day (mt/d) and we have caved about 35,000 m^2, equivalent to approximately 40% of the surface area of the macroblock," Videla said.

Videla also noted a very good correlation between cave and the bottom of the pit. "This technically allows us to make better production decisions," Cristobal said. "We hope to cave 100% of the first macroblock this year and begin automated haulage with teleremote operated equipment from our Integrated Operations Center (CIO)."

More Mines Begin Restart in Mexico

The Mexican government designated mining as an essential activity, which will allow mines to begin operations on May 18. Several companies have announced plans to restart operations. Some mines were placed on care and maintenance in early April to comply with the government-mandated shutdown.

Coeur Mining has taken steps to restart active mining, processing and exploration activities at its Palmarejo gold-silver complex in the state of Chihuahua.

Alamos Gold expects to begin ramping up full operations at its Mulatos mine on May 18. Given the significant number of contained ounces stacked on the leach pad during the first quarter of 2020, Mulatos has continued to recover gold in April and May. Mining and stacking activities are expected to ramp up to normal levels in June.

Capstone Mining said it has safely started ramping up operational activities at its Cozamin mine in Zacatecas. Cozamin's underground expansion remains on track for completion by the end of 2020 and is expected to increase production to a new annual run rate of approximately 50 million to 55 million lb of copper and 1.5 million ounces of silver in 2021.

Peñoles Suspends Zinc Mining Operations at Madero

Mexican mining company Industrias Peñoles has temporarily suspended oper-

Mexican miner Peñoles to suspend zinc mine due to tough conditions and low prices. (Photo: Industrias Peñoles)

ations at its zinc mining unit, Francisco I. Madero, located in Morelos, Zacatecas. The company said it based this decision on the low ore grade it has encountered over the last several months, its hardness and the depth of the orebodies. That together with the abrupt drop in the price of zinc and the high cost of the operation have made this mining unit no longer viable.

Madero began operations in 2001. In 2019, it mined and milled 2.3 million metric tons (mt) of ore and produced 41,541 mt of zinc and 8,905 mt of lead. Peñoles said idling the Madero operations will not have material consequences for its production of refined zinc.

Yamana Launches Suyai Project

Canadian gold producer Yamana Gold announced the signing of a definitive option agreement under which it has granted a privately held portfolio management and capital markets company, based in Argentina owned by Eduardo Elsztain and Saúl Zang, the right to acquire up to a maximum of 40% of participation in a joint venture formed to manage the Suyai Project. This project is an advanced-stage gold project located in the province of Chubut.

The portfolio of companies includes Argentina's largest real estate company, international agricultural companies listed on the NASDAQ index, along with banking and mining investments. Throughout its history, the group has led the successful development of important construction projects in Argentina.

Under the terms of the option agreement, an initial amount of US$2 million will be paid to secure the option, and the Argentine group will assume responsibility for all environmental, social and government matters (ESG) and, in particular, will lead permitting efforts to advance the project through its different stages of development. The Argentine group has the right to access a maximum interest of 40% in the resulting joint venture to manage the Suyai Project through the fulfillment of certain obligations and achieving certain milestones, in addition to paying US$31.6 million in various installments plus all of the proportional expenses as of December 31, 2024, or before.

Equinox Planning Underground Mine at Aurizona

Equinox Gold has reported results from a positive preliminary economic assessment (PEA) of development of an underground mine at the company's Aurizona gold mine in Maranhão state, northeast Brazil. The mine would operate concurrently with the existing open-pit mine and has the potential to deliver an additional 740,500 ounces (oz) of gold, $1 billion in revenue, and $204 million in after-tax net cash flow over a 10-year mine life at a base case gold price of $1,350/oz.

The open-pit mine is forecast to produce about 120,000 oz of gold in 2020. Underground ore would be processed through the existing 8,000-metric-ton-per-day (mt/d) plant and would benefit from existing surface infrastructure. At steady-state operation, the underground mine would provide 2,800 mt/d of mill feed.

The PEA underground mine plan incorporates 2.8 million mt of indicated resources grading 2.73 grams/mt gold and 6.2 million mt of inferred resources grading 2.89 g/mt gold. Initial capital costs to develop the underground mine are estimated at $69.7 million. All-in sustaining costs of production are estimated at $925/oz.

The PEA contemplates development of an underground mine along a total strike length of 3.3 kilometers (km) to access an initial eight separate mining areas. The internal ramps will be accessed from surface by a common main double ramp arrangement developed directly into fresh rock from within the existing open pit. All mine development is in more stable rock units located on the hangingwall side of the mineralized body.

Long-hole stoping was selected as the mining method due to the good ground conditions and the steep dip of the deposit. The PEA contemplates owner mining of stopes and underground development. Completed stopes would be filled by rockfill from underground development or open-pit waste. The addition of cement to rockfill is confined to higher-grade areas, where mining recovery can be maximized by eliminating the need for rib pillars and above-sill pillars.

First mill feed from the underground mine would be expected approximately 2.25 years after the start of underground mine development, with steady-state production of 2,800 mt/d achieved at the end of year four and continuing through year eleven within the currently defined mineral resource. The mine plan schedules higher-grade areas earlier in the underground mine life to enhance mine economics.

Equinox is continuing to advance studies focused on underground development and intends to complete a prefeasibility study for the underground mine in 2021. The company has commenced a 17,000-m drill program aimed primarily at converting underground inferred resources to indicated resources in support of the prefeasibility study. Future drilling will also target expansion of the underground deposit at depth and along strike.

Equinox Gold CEO Christian Milau commented, "This PEA demonstrates the substantial opportunity for both mine life extension and increased annual gold production at Aurizona through development of an underground mine. With the potential for expansions to the current open-pit, additions of other near-surface resources, and further opportunities for underground resource expansion at depth and along strike, Aurizona is expected to be a long-life cornerstone asset for Equinox Gold."

Rio Tinto Looks for Miners in Western Australia as Recovery Ramps Up

Interested in a FIFO career in the Pilbara (above)? Rio Tinto has many openings. (Photo: Rio Tinto)

Rio Tinto's iron ore business in Western Australia is continuing to recruit for skilled roles, apprentices, graduates and Aboriginal trainees to fill vacancies as the company progresses its development plans in the Pilbara. There are more than 300 jobs currently available, including skilled operational and maintenance roles such as frontline supervisors, experienced operators of excavators, haul trucks and graders as well as experienced maintenance staff such as heavy diesel fitters. The roles are a mix of fly-in fly-out from Perth and the company's regional hubs in Western Australia as well as residential positions in Perth and the Pilbara.

Rio Tinto is maintaining its commitment to the development of skills for the future through the hiring of around 160 apprentices, graduates and Aboriginal trainees from the Pilbara, Perth and other regional centers. The 2020 intake of apprentices and graduates is up 25% from last year with gender diversity also significantly increased.

On top of this recruitment effort, the company's medical provider for COVID-19 screening at Perth Airport has recently hired more than 100 staff including out of work nurses.

"Throughout this challenging period, we are committed to keeping our people and our communities safe and supporting Western Australians with employment opportunities to help deliver on our plan to invest A$10 billion in the Pilbara over the next three years," Rio Tinto Iron Ore Chief Executive Chris Salisbury said. "This will help ensure we can continue to operate while making a strong contribution to the State and national economies."

In addition to direct employment opportunities at Rio Tinto, the company said it remains committed to skills development for current and future workers in the resources industry.

Element 25 Targeting Near-term Startup at Butcherbird

Element 25 Ltd. has reported results of a prefeasibility study (PFS) of its Butcherbird manganese project in the southern Pilbara region of Western Australia. The study contemplates export and sale of manganese concentrate from the project over a long mine life and delivers outstanding economic metrics.

Butcherbird project development has a low capital spending requirement of just A$14.5 million, plus A$9.2 million working capital. The project development timeline is targeting first production in early 2021.

The Butcherbird PFS complements and enhances Element 25's ongoing plan to develop an electrolytic manganese metal plant.

Element 25 Managing Director Justin Brown said, "The opportunity for a low capital and operating cost, rapid startup will transform Element 25 into producer status much earlier than previously anticipated. The robust cash flows will be transformational in growing the company and generating long-term shareholder value."

The Butcherbird project hosts eight known manganese mineral resources in an approximately 600-km^2 area of the southern Pilbara, about 1,050 kilometers (km) north of Perth. The site is accessible directly from Australia's Great Northern Highway.

The current 2019 JORC measured, indicated, and inferred mineral resource estimate stands at 263 million metric tons (mt) grading 10% Mn. The PFS proven and probable ore reserves for the project total 50.55 million mt.

Project approvals are well advanced, with two Native Title mining agreements in place.

The Butcherbird mine plan is designed to utilize the tabular geometry of the mineralization at Yanneri Ridge to provide a simple and low-cost mining operation. Mining will consist of loaders mining 1-meter (m) to 2-m benches and delivering the ore into a mobile crusher feed hopper via a grizzly. To enable the loaders to operate more efficiently, the ore will be cross ripped by a dozer prior to mining. Drill and blast will not be required.

A contractor will be utilized for the mining operations, which will be overseen by Element 25 management.

Beneficiation test work has been conducted over an extensive period since 2009, specifically focusing on both a manganese ore product and more recently on the feed material for the hydrometallurgical process to produce electrolytic manganese metal.

The Butcherbird project will produce between 270,000 mt/y and 370,000 mt/y of manganese ore. Manganese lump product will be trucked from the mine site to Utah Point at Port Hedland.

2020 Mining Hall of Fame Inductees

The National Mining Hall of Fame and Museum (NMHFM) will induct five new members. "Their contributions to the mining industry are immense," President of NMHFM David Brown said. "Please join us for a banquet at the Marriott Denver South on October 24 to honor these individuals."

For event details, reach out to Amber Johnson at Amber@MiningHallofFame.org or +1(719)486-1229. The 2020 Hall of Fame inductees include:

Alberto Benavides: Benavides started his career at Cerro de Pasco Corp. He worked as the resident geologist in Cerro de Pasco and became the company's first exploration chief. He was involved with the discovery, evaluation and early development of the Antamina, Las Bambas, Toquepala and Cuajone projects. Benavides was successful in bringing U.S companies Newmont, Phelps Dodge, and ASARCO together in a joint venture to develop the Toquepala and Cuajone deposits. In 1953, Benavides founded Compania de Minas Buenaventura. He was instrumental in the discovery of the Conga, Tambomayo, Trapiche, and Chucapaca mineral deposits and the development of La Zanja, Tantahhuatay, Orcopampa, Uchucchacua, Shila, Mallay and Anapite mines. Despite terrorist activity at the time, he forged a joint venture between Buenaventura and Newmont to develop the Yanacocha mine. He insisted all partners in mine development help improve living conditions of the locals and access to services by improving or constructing roads, schools, health clinics, and providing clean drinking water and sanitation in the communities near the mines.


Alberto Benavides

Dr. Roshan B. Bhappu: Globally recognized as a leading authority in extractive metallurgy, Bhappu was a visionary pioneer in biohydrometallurgy. He published more than 100 technical papers and coauthored several books on mineral processing, metallurgy, and environmental remediation, and was granted several patents in bacterial leaching of sulphide ores and the recovery of metal values through in-situ extraction. While head of the Department of Metallurgical Engineering at the New Mexico Institute of Mining and Technology, Bhappu received numerous research grants from the U.S. Bureau of Mines to further his cutting-edge research in biological oxidation of sulphide minerals. At his research lab, Mountain States R&D International, he built a reputation for developing efficient and optimized metallurgical flowsheets while advancing energy conservation and new mineral processing technologies.


Dr. Roshan B. Bhappu

Hugh W. Evans: After serving in World War II with the U.S. Army's 10th Mountain Division, Evans attended the Colorado School of Mines earning an engineer of mines degree and joined the Army Reserves. He was recalled to active duty during the Korean War. After serving his country, Evans built a 36-year career from grassroots exploration to large-scale mining operations that have become some of the world's largest producers. Highlights include the discovery of a substantial uranium deposit on the Colorado plateau for Union Pacific, leading their stock price to increase a hundred-fold; for Utah International, Evans demonstrated the presence of enough coal near Farmington, New Mexico, to justify building the Navajo mine, Arizona Public Service power plant, and the Navajo Dam on the San Juan River; in Queensland, Australia, he led the development of the Blackwater mine, one of the largest coal reserves in the world, and the town of Blackwater that grew from a rail stop to a community of 8,000, launching Australia into the worldwide coal market; as vice president of coal operations for the Atlantic Richfield Co., he was responsible for the design and development of Wyoming's Black Thunder mine.


Hugh W. Evans

Raymond W. Threlkeld: Threlkeld's technical expertise leading teams through exploration, reserve estimates, feasibility studies, and construction and operations led to successful gold mines in Australia (Cowal); Argentina (Veladero); Peru (Lagunas Norte and Pierina); and Tanzania (Bulyanhulu). At Pierina, his team developed the deposit in record time. The Pierina mine produced more than 8 million ounces (oz) of gold in a 20-year period and launched Barrick Gold to the top of the South American mining industry. In senior executive positions with Barrick Gold, Western Goldfields, Newmarket Gold, and Rainy River Resources among others, Threlkeld has been involved in the acquisition of more than $1 billion in assets, managed an estimated $1.4 billion in construction spending and created billions in shareholder value. As president and CEO of Western Goldfields, he commissioned the Mesquite gold mine in California on time and budget, resulting in the company's market capitalization increasing from $12 million to more than $300 million. While CEO of Rainy River Resources, he led the team that completed permitting and feasibility studies, increasing gold resources to more than 6 million oz. As chairman of Newmarket Gold, Inc., his team sold the company for more than $1 billion in 2016 from an initial acquisition cost of $25 million.


Raymond W. Threlkeld

Dr. Spencer R Titley: After serving as a 2nd Lieutenant in the U.S. Army during the Korean War, Titley earned his doctorate in geology from the University of Arizona (UA). After two years as regional exploration geologist for New Jersey Zinc Co., he joined the UA faculty in 1960 rising through the ranks to distinguished professor of geosciences. His research in the search for the origin of porphyry copper deposits took him to more than 30 countries. It led him to investigate all scales of copper deposits, from entire deposits down to the level of atoms. Considered a world authority on Phanerozoic porphyry copper deposits, metal provinces, and metallogenesis, the books he wrote and edited along with the scholarly articles he published on porphyry copper deposits of southwestern North America are still widely read today. In 1964, Titley was selected by the U.S. Geological Survey to map the moon by telescope. Titley explained the geology of the moon to NASA Apollo astronauts before they landed. Widely recognized for his groundbreaking work in the fields of economic geology, engineering and science, Titley's list of awards is lengthy.


Dr. Spencer R Titley

Barrick Pays $100M to Tanzania, Resumes Concentrate Shipments

Since taking over North Mara (above), Barrick has focused on improving water management.

Barrick Gold Corp. has settled the majority of the North Mara legacy land claims and has paid the first tranche of the $300 million settlement it agreed to with the Tanzanian government to resolve the disputes it inherited from Acacia Mining.

The shipping of some 1,600 containers of concentrate stockpiled from the Bulyanhulu and Buzwagi mines resumed in April and the first $100 million received from the sale has gone to the government, Barrick said. All material issues have been dealt with or are being finalized. This initial payment will be followed by five annual payments of $40 million each.

President and Chief Executive Mark Bristow said these events demonstrated the strength of the partnership the company forged earlier this year through the formation of the jointly owned Twiga Minerals Corp., which oversees the management of Barrick's operations in the country.

At the same time, some 90% of the outstanding land claims at North Mara have been settled with payment scheduled to start May 25. The compensation process is being overseen by a committee representing Twiga, the government, the local authorities and the affected communities.

Barrick COO for Africa and Middle East Willem Jacobs said the basis of the settlement, which also provides for future claims, was produced during several weeks of close and constructive engagement between Twiga, the Ministry of Mines, the Ministry of Land, the local authorities and the community.

Operationally, since taking over North Mara, Barrick has focused on improving the mine's water management with special emphasis on its tailings storage facility. Jacobs said Barrick's intervention put an end to 15 years of poor water management on site and ensured that going forward its environmental risks are properly contained in line with the group's best practice standards.

"This is a striking example of what a true partnership can achieve in building a sustainable business capable of creating long-term value for all stakeholders," he said.

Amplats Temporarily Closes ACP Phase B Unit

On May 31, Anglo American Platinum (Amplats) detected a water leak in the high-pressure cooling section of the Anglo Converter Plant (ACP) Phase B unit. The unit was brought down proactively and safely and all employees evacuated the area safely.

A detailed technical investigation into the cause of this leak and potential repairs is under way, and the company decided to temporarily close the ACP Phase B unit to ensure an ongoing safe operating environment, protect employees and protect the integrity of the plant.

The company reported that this latest action is separate from the repair work that was recently completed at the ACP Phase B unit and there is no damage to the prior repairs or to the furnace.

During the beginning on May the company reported that it had safely and successfully completed the repair of the Phase B unit. The ACP and full downstream processing operations are completing a safe ramp-up and expect to be fully operational by May 12. Force majeure to suppliers of concentrate will be lifted on that date.

"We were vigilant in adhering to strict health and safety protocols to keep the repair team safe during the lockdown, while ensuring that we were able to implement social distancing and hygiene requirements, which form our new way of working during the COVID-19 pandemic," Amplats CEO Natascha Viljoen said. "We have carried out substantial testing to ensure the stability of the ACP Phase B unit, and as we complete the ramp-up, we are engaging with suppliers of concentrate to lift force majeure imminently. All temporary commercial arrangements applicable during the force majeure period will revert to normal commercial terms."

The estimated final cost of repairs for ACP Phase B is ZAR150 million ($8.1 million), in line with the lower end of guidance provided. Repair work on the ACP Phase A unit continues and is progressing in line with the project plan. All orders for long lead items have been placed and the dismantling work started on site.

The construction teams were able to continue with repairs in accordance with regulations during the extended South African lockdown. All materials required for repairs were ordered and available on site ahead of the lockdown, and there were no supply chain disruptions that impacted the ability to complete the repairs, Amplats explained. Safety protocols were implemented on site in line with government approvals and regulations. A construction work risk review was completed to determine work phasing, method of execution, key resource identification and increased health protocols.

The ACP construction repair group was split into two teams that self-isolated for the duration of the repair work, and COVID-19 specific health protocols were put in place for cleaning, screening and transport to site, the company said. A new shift pattern was introduced that fostered social distancing. Increased site hygiene measures for sanitization, together with site safety and health supervision were implemented to ensure safety and quality of construction.

Due to the time taken to refine the respective platinum group and base metals, Amplats explained, the force majeure notice remains in effect for refined metal customers. Force majeure arrangements with these customers will be lifted in the future and in line with the provisions of our agreements, the company said.

Amplats said it is retaining its current guidance until they are comfortable with providing an update.

Ivanhoe Making 'Excellent Progress' with Kakula

Ivanhoe Mines reported in mid-May that development of the Kakula mine, the first of multiple planned mining areas at the Kamoa-Kakula project in the Democratic Republic of Congo (DRC), is making excellent progress.

The first underground access drives intersected Kakula's initial high-grade ore zone (+8% copper) in April. Ivanhoe and its joint-venture partner Zijin Mining are rapidly advancing construction of the 3.8-million-metric-ton-per-year (mt/y) processing plant and other surface infrastructure. Initial copper concentrate production is scheduled for the third quarter of 2021.

In parallel with construction of the Kakula copper mine, an independent Kakula definitive feasibility study (DFS) and an updated Integrated Development Plan for the entire Kamoa-Kakula mining complex also remain on schedule for completion in the third quarter of 2020. The Kakula DFS will provide a high level of accuracy for the project economics for Kakula's initial phase of mine development, as most construction contracts and orders for significant capital items have been placed at fixed prices. The Integrated Development Plan will include details on the planned expansion phases for the entire Kamoa-Kakula mining complex.

In early March, Ivanhoe in conjunction with its joint-venture partners implemented strict quarantine and lockdown procedures to ensure the well-being of its employees and mitigate the impact of COVID-19 on its operations. The Kamoa-Kakula mine site has been locked down, and all key personnel are on site. As a result, mine development at Kamoa-Kakula has continued uninterrupted.

Also in early March, following guidelines outlined by the World Health Organization, the company appointed a task team with overall responsibility for COVID-19 response planning. Ivanhoe's response team is led by Dr. Nicolette Du Plessis, a specialist in Pediatric Infectious Diseases and a professor at the University of Pretoria, and includes specialist doctors, paramedics, and nurses, as well as counsel from several external, world-leading epidemiologists.

Ivanhoe is in a strong financial position with cash and cash equivalents of $603 million at the end of March 2020 and no significant debt.

In April, Ivanhoe announced cost-reduction initiatives to generate cash savings of up to $75 million through 2021, including reducing discretionary spending at the company's projects, lowering general and administrative costs, voluntary salary reduction for senior management, and deferral of certain exploration activities. The savings will be directed towards developing the Kakula mine to commercial production on schedule and on budget.

Underground development at the Kakula copper mine continues to advance ahead of schedule, with more than 14.4 kilometers (km) of underground development completed, 4.4 km ahead of plan. The pace of development is expected to continue to accelerate as additional mining crews are mobilized.

In April, crews at Kakula began mining ore in areas with a grade of greater than 8% copper. This ore is being stockpiled on a dedicated high-grade surface stockpile, which was forecast to contain 105,000 mt grading 5.95% copper by the end of May. Kakula's medium-grade ore stockpile is forecast to contain an additional 250,000 mt at 3.01% copper. The high-grade stockpile is projected to significantly expand in the coming months as the majority of Kakula's underground development will be in mining zones grading +5% copper.

On February 5, 2020, an updated, independently verified indicated mineral resource increased the combined Kamoa-Kakula project indicated mineral resource to 423 million mt grading 4.68% copper at a 3% cutoff. At a 1% cutoff, the combined indicated mineral resource stands at 1.4 billion mt grading 2.7%.

The initial indicated mineral resource estimate for the Kamoa North Bonanza Zone includes 1.5 million mt grading 10.7% copper at a 5% cut-off. Drilling in the first quarter of 2020 continued to target additional resources in the vicinity of the ultra-high-grade Bonanza Zone and the Far North Zone. Given the shallow depth, remarkable thickness, and massive copper sulphide mineralization discovered within the Kamoa North Bonanza Zone, Kamoa-Kakula's engineers are evaluating potential opportunities to accelerate development of this discovery.

The Ivanhoe announcement, dated May 13, 2020, includes additional information about ongoing Kamoa-Kakula development, as well as updates on the status of the company's Platreef mine development project in South Africa and its work to restart production at the historic Kipushi zinc-copper-lead-germanium mine in the DRC.

Members of one of Kamoa-Kakula's first-rate mining crews at the Kakula copper mine's northern declines. Development at the high-grade underground mines at Kakula and Kansoko continues to proceed exceptionally well. Kakula's underground development is 4.7 kilometers (km) ahead of schedule, with more than 15.4 km now complete.

Centerra Gold Begins Commercial Production at Öksüt

The CIC tanks at Öksüt's ADR plant remove gold from cyanide solution. (Photo: Centerra Gold)

Canada-based Centerra Gold Inc. announced that the Öksüt Gold Mine located in Turkey has achieved commercial production as of May 31. Since first gold pour on January 31, the Öksüt gold mine has continued to ramp up mining, crushing, stacking, irrigation of the heap leach pad, as well as, the operation of the ADR plant and gold production, the company said.

President and CEO Scott Perry said, "Commercial production at Öksüt marks a major milestone for the company. Öksüt was delivered on time and under budget."

Centerra now has three producing operations that are expected to deliver growth and value for shareholders, Perry said. This includes the Öksüt mine, the Kumtor mine in the Kyrgyz Republic and the Mount Milligan mine in British Columbia, Canada.

Indian Miners Seek Government Bailout

By Ajoy K. Das

With the COVID-19 pandemic bringing the Indian mining industry to a grinding halt, miners across the country have sought a bailout package for survival of the industry.

"The spread of COVID-19 has created an extra-ordinary and unprecedented situation in the Indian mining industry. The mining industry had been under severe stress even before the pandemic and now challenges from the pandemic have brought the industry to a grinding halt," Federation of Indian Mineral Industries (FIMI), the apex mining industry representative body, said in a petition to the government.

"It is imperative that for survival of the industry, which is at the heart of infrastructure development, required relief and stimulus is extended enabling its continued operation," FIMI said.

The impact of the pandemic and the national lockdown, extended twice since first imposed on March 24, has been such that the stockpile of iron ore across producing eastern states of Odisha and Jharkhand has amounted to 162 million tons.

On one end, domestic steel mills have reduced their plant capacity utilizations to the levels of 30%-50% since the national lockdown and triggered sharp offtake of raw materials, and the 30% export tax levied on iron ore shipments overseas is not finding many takers in international markets either.

The domestic mining industry has sought immediate scrapping of the export tax levied on iron ore with FE content of 58% and higher to enable miners to be more competitive in international markets and rapidly reduce stockpiles, lower carrying costs and improve cash flows.

At the same time, FIMI has petitioned scrapping the 15% export tax on non-plant grade bauxite, pointing out that every other major exporting country like Australia, Brazil, Malaysia had a nil rate while Guinea had a nominal rate of 0.75%.

The imposition of the export tax was largely responsible for declining of bauxite exports from India, from a peak of 8.91 million tons in 2015-2016 to a meager 500,000 tons in 2019-2020. This despite India ranking sixth in global ranking in terms of bauxite resources estimated at 3.896 billion tons.

According to the Indian body, not only is the country self-sufficient in bauxite resources, all domestic alumina and aluminum producers have their own captive bauxite mines. On the other hand, much of the bauxite deposits in the western part of the country were of low alumina content ranging 38%-45% and high silica content of above 7%, and not used by domestic smelters and refiners.

In order to lower the cumulative incidence of various taxes on miners, FIMI has sought that contributions to the District Mineral Fund (DMF) should be treated as a miner's mandatory spend on Corporate Social Responsibility (CSR). FIMI argued that contributions to DMF were ultimately spent on the development of mining lease hinterland.

Considering deviations from mining plans were inevitable during the national lockdown, the Indian Bureau of Mines (IBM), the mining regulatory and advisory body, should relax approved mining plans of each lease held during the current fiscal year 2020-2021.

On prevailing domestic taxes imposed on mining production, FIMI has sought that Integrated Goods and Service Tax (IGST) on imported machinery ranging 18% to 28% should be reduced to at least 5% while 18% GST charged on royalty payable to the government should be lowered to 5%, at par with the rate payable for sale of mineral produced.

Steppe Gold Starts Up ATO Mine in Mongolia

Steppe Gold has started production and initiated gold and silver sales from its ATO open-pit, heap-leach mine in eastern Mongolia. As of mid-May, the company had sold 5,233 ounces (oz) of gold and 1,372 oz of silver in two separate deliveries to the Central Bank of Mongolia, generating cash flow before stream obligations of $8.5 million.

At the time of the announcement, Steppe had mined, crushed, and stacked approximately 640,000 metric tons (mt) of ore at a grade of 2 grams/mt gold on to Cell 1 of the leach pad, where leaching was in progress. A further 100,000 mt of ore had been delivered to the run-of-mine pad and was being crushed and stacked. Mining was ongoing and was being scaled up.

Steppe expects the ATO mine to produce approximately 60,000 oz of gold in 2020 at cash costs of about $500/oz. Positive cash flows from the mine will go toward studies to expand the open pit and processing facilities to increase production to a targeted 150,000 oz per year (oz/y) of gold.

Exploration drilling results from approximately 11,000 meters of diamond core drilling targeting extensions at depth on the ATO1, ATO4, and Mungu deposits will be available in the coming months.

The COVID-19 pandemic had not had any material impact on Steppe Gold's operations as of mid-May. Preventative measures were in place to ensure the well-being of employees and contractors. Management continues to monitor the situation at the site and corporate offices to prevent or minimize any effects that the pandemic may have on operational or financial reporting activities.

The Central Bank of Mongolia stated, "We are happy to welcome Mongolia's most recent gold producer. Steppe Gold is playing a vital role in growing our gold production and contributing to the foreign exchange reserves in Mongolia."

"We are delighted to commence gold sales at the ATO gold mine," Steppe Executive Chairman Matthew Wood said. "In a very difficult business environment, we have been able to reach this key milestone.

"We thank our team for their dedication and professionalism and all our stakeholders for their support. We are well placed to pursue our vision to be Mongolia's premier precious metals company."

(Regional News-U.S. & Canada - from p. 10)

Development Plans Progress at Pumpkin Hollow Mine

While copper production has been temporarily suspended at Nevada Copper's Pumpkin Hollow mine due to the impact of COVID-19, the company has made significant progress with its previously reported accelerated mine development plans.

As far as vertical development, multiple key milestones have been completed on final configuration of the East Main Shaft. The Main Haulage Shaft has been completed to a final depth of 2,131 ft. Miners have completed the shaft ramp. A loading pocket has been excavated and the form work is being installed for a concrete pour. A 25-person underground refuge chamber and an underground fuel delivery station have been installed. Preparations for final furnishing of the production shaft are on schedule.

Lateral development is advancing along with underground infrastructure. Orebody definition drilling continues to support mine planning. The ore stockpile now sits at more than 95,000 tons.

Nevada Copper said it intends to quickly complete its accelerated development plan and restart concentrate production in Q3 2020. "We are excited to be progressing rapidly with our accelerated critical path development program moving us closer towards recommencing copper deliveries with increasing reliability," said Evan Spencer, CEO of Nevada Copper. "Completion of the main shaft to final depth is a key milestone for the project and allows us to commence the final phase of furnishing the shaft. The speed of our progress is a testament to the dedication of our team and the support of our key suppliers and stakeholders during the recent period of uncertainty."

Montana Gold to Begin Production

For more than 25 years, Tom L. Lee, founder and president of Montana Gold Inc., has searched for, discovered and acquired long-lost, forgotten 19th century gold mines in the remote mountains of western Montana. To date, Lee has discovered and acquired 301 such 19th century gold mine sites. Each mine site contains from one to five gold-bearing mine tailings dumps, on the surface, ranging in size from 5,000 tons to more than 100,000 tons. The tested tailings dumps contain gold content upwards of 0.51 ounces per ton. The 19th century miners were unable to recover this gold, but it can be recovered from the tailings today with modern heap leaching processes.

During June, privately held Montana Gold will begin processing and heap leaching its tailings dumps. Lee projects the company's tailings gold recovery undertaking will continue for eight to nine years. The company will not consider mining the underground gold resources, until it has completed the tailings dump gold recovery.

Minerals Permitting Bill is Introduced in US House

On May 28, U.S. Reps. Paul A. Gosar (AZ) and Michael Waltz (FL) introduced the American Critical Mineral Exploration and Innovation Act of 2020. They were joined by House Committee on Natural Resources Ranking Rep. Rob Bishop (UT), House Committee on Space, Science, and Technology Ranking Rep. Frank Lucas (OK), and House Rep. Leader Kevin McCarthy (CA). This bill is intended to facilitate the availability, development and environmentally responsible production of domestic resources to meet national material or critical mineral needs.

Currently, 14 of the 35 critical minerals identified by the United States Geological Survey are imported to the U.S. at a rate of 100%.

"This dual-committee effort will make significant strides toward securing our nation a domestic supply chain of critical minerals from the United States for the United States," Rep. Gosar said.

The global pandemic has demonstrated the consequences of allowing America's overreliance on China to go unchecked, Gosar added, "and this legislation will begin the complex process of unraveling our addiction and addressing this problem."

The bill will address current impediments to domestic critical mineral development, such as requiring federal agencies to streamline the permitting process. It will also promote technological advancements, such as minerals recycling.

"We need to bring this supply chain back to America — and this bill will be an important step to do that," Rep. Waltz said."

Arizona Mining Association Executive Director Steve Trussell said proper measures must be taken to "protect, responsibly extract and utilize our resources so we are not reliant on foreign sources."

MAPEI's Underground Technology Team (UTT) provides the construction market with a range of products dedicated to underground construction work. MAPEI's UTT group and the products it represents were created to meet the expectations of these challenging environments.

From the project specification to the admixtures for shotcrete and concrete to the final protective coatings, MAPEI's UTT group and technology are there to support clients "for the complete job," said James Pinkley, UTT Country Manager. The UTT group is a successful division of MAPEI Group, which has provided proven construction system solutions for more than 80 years.

Established in 1937, MAPEI Group is a global corporation, based in Milan, Italy, and with 87 subsidiaries that include 83 plants in 36 countries. MAPEI is the world-leading manufacturer of mortars, grouts and adhesives, as well as complementary products for installing floor and wall coverings. MAPEI manufactures chemical products for building, including waterproofing products, admixtures for concrete and repair products, and decorative and protective exterior coatings — as well as the UTT product line, which began in the United States in 2015.

In the underground industry, speed is essential – not only of the products themselves, but also of the evolution of technology. MAPEI reinvests a considerable percentage of its annual profits back into research and development to maintain a leading technological advantage.

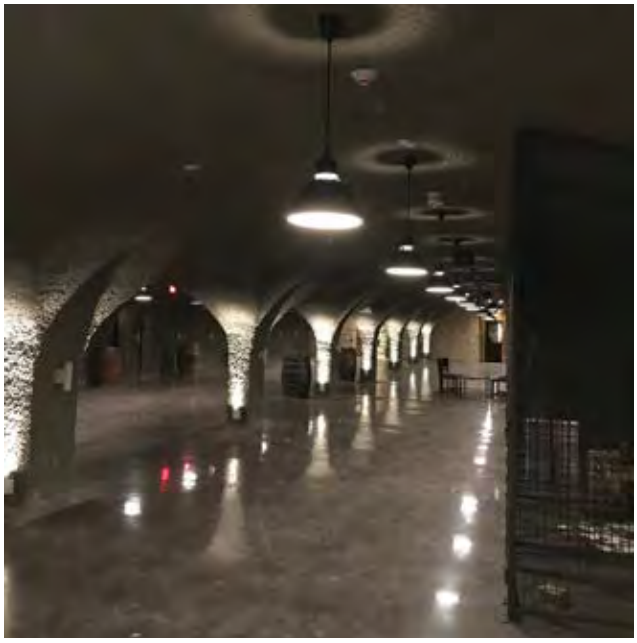
MAPEI's commitment to R&D ensures that the UTT line comprises the most innovative and technologically advanced products available. In addition to the latest in cutting-edge products, the UTT team is trained in their use.

The UTT product line is divided into six categories: Concrete; Injection, consolidation, and anchoring; Waterproofing; Renovation, maintenance, and repair; Coatings for underground construction; and Mechanized tunneling.

No matter the division or the product line, MAPEI is known for quality products and for providing system solutions. It is no surprise that this approach is one of the key points to the success of MAPEI's UTT group. As Pinkley stated, "MAPEI's UTT is known for our superior field support, and our applied technology in the field. With MAPEI UTT customers know that the team will go into the field and help them use the products — on the jobsite, in the actual conditions with the actual equipment. It isn't just about selling products, it is about technical service and agility to adapt to our customers' needs from the beginning to the end of the project."

MAPEI's UTT products were used to help a tunnel boring machine dig the Anacostia River Tunnel, which extends for 2.37 miles from Robert F. Kennedy Stadium in northeast Washington, D.C., to Poplar Point in southeast D.C.

To learn how MAPEI's UTT experts can bring their decades of experience to your project, contact MAPEI's UTT group at www.utt.mapei.com.



MAPEI's UTT products have commercial as well as industrial applications. Its additive technology was added to shotcrete to create the walls of this high-tech wine cave.

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Alkane Planning Underground Exploration Drive at NSW Mine

Alkane Resources has received approval from the government of New South Wales, Australia, for development of an exploration drive from the existing Wyoming One underground mine at its Tomingley gold operations to the Roswell and San Antonio deposits, approximately 4 kilometers (km) south of the mine.

Alkane considers the drive to be an important milestone toward a future potential underground mine at Roswell and San Antonio that could be developed independently of an open-cut operation. The exploration drive will be sized such that it could also accommodate production in the future.

Alkane Managing Director Nic Earner said, "Alkane has the equipment purchased, personnel recruited, and land acquired to allow this development to proceed, and we will now incorporate the timing of the drive development into the Tomingley Gold Operations' budget schedules, as well as our regional exploration plans.

"Given the prospectivity of the region around our existing operations, this approval provides Alkane with all the exploration and, in time, production options, to extend the life of mine at Tomingley well into the future."

The Tomingley gold project covers an area of approximately 440 km^2. Over the past two years, Alkane has conducted an extensive regional exploration program with the objective of defining additional resources that have the potential to be mined either via open pit or underground operations and fed to the Tomingley processing facility.

The exploration program has yielded broad, shallow, high-grade intercepts that demonstrate potential for material project life extension in excess of 10 years and show that a return to open-pit mining and/or underground extension is possible with appropriate resource confirmation, landholder agreement, and regulatory approvals.
(*alkane.com.au*)

Exploration Briefs

An **Alliance** of **Japan Gold** and **Barrick Gold** has initiated an exploration program on properties held by Japan Gold on the islands of Kyushu, Honshu and Hokkaido in Japan. The program will include sampling of stream sediments for bulk leach extractable gold (BLEG) and multi-element pathfinder analysis, along with gravity surveys over the 1,521 km^2 covered by the Alliance projects.

The program is anticipated to be completed within one year. Japan Gold is acting as the operator.

Sediment samples are being collected systematically in streams at a predetermined density across all of the project areas. The BLEG analysis allows ultra-low detection of gold, silver, mercury and copper to highlight anomalous stream catchments. A portion of the sediment sample is split off and separately analyzed for gold and a multisuit of pathfinder elements to confirm the BLEG result and better understand the nature of the source rocks.

Once anomalous catchments are identified, further sediment sampling is carried out upstream along the anomalous drainage to define the point of entry of anomalous metal. Further definition of the mineralized source is then carried out by rock float sampling and/or soil sampling on the slopes above the anomalous drainage.

Japan Gold Chairman and CEO John Proust commented, "The regional exploration program will assist the Alliance in evaluating the Japan Gold portfolio of projects to determine areas with anomalous gold showings and potentially fertile large structures. This will enable focused exploration on highest-priority areas to generate drilling targets."
(*japangold.com*)

Great Bear Resources has reported results from its ongoing $21 million exploration program at its flagship Dixie project in the Red Lake district of Ontario. As of early May, the company had completed 99 of approximately 300 planned drill holes into the LP Fault target as part of its 5-km-long by 500-meter-deep grid drill program.

Drill highlights included a hole completed in the middle of a 150-m gap in drilling that intersected two significant mineralized intervals: 10.17 grams per metric ton (g/mt) gold over 6.80 m within a broader interval of 3.18 g/mt gold over 56.95 m, beginning at the bedrock surface at 30.20 m down hole; and 18.57 g/mt gold over 13 m, including 132 g/mt gold over 0.50 m, within a broader interval of 2.67 g/mt over 104.15 m beginning at 127.15 m down hole.

The Dixie project hosts two principle styles of gold mineralization: high-grade gold in quartz veins and silica-sulphide replacement zones, and high-grade disseminated gold with broad moderate-to-lower-grade envelopes (LP Fault). The LP Fault is a significant gold-hosting structure that has been seismically imaged to extend to 14 km depth and has been interpreted by Great Bear to have up to 18 km of strike length on the Dixie property. High-grade gold mineralization is controlled by structural and geological contacts, and moderate-to-lower-grade disseminated gold surrounds and flanks the high-grade intervals.
(*greatbearresources.ca*)

Rockcliff Metals has completed its phase four drill program at the Bur property in central Manitoba. The program was successful in identifying additional shallow, near-surface, high-grade zinc-copper mineralization along strike of the historical Bur zinc-copper deposit.

Rockcliff is earning a 100% interest from Hudbay by spending C$3 million over a four-year period on the Bur property.

Rockcliff President and CEO Alistair Ross commented, "Our phase four drill program has shown great promise in extending the known mineralization of the historical Bur zinc-copper deposit. The drilling has identified shallow, high-grade mineralization above 150 m vertical over a distance of more than 500 m in an under-explored area south of the high-grade deposit.

"We look forward to continuing to advance the property as we near our 100% earn-in requirement of C$3 million. Given our current copper focus, we are particularly interested in the number of copper assays over 2% in this area."
(*rockcliffmetal.com*)

EX1200-7

EX2600-7

Hitachi EX-7 Series delivers efficiency, reliability and durability

Hitachi delivers outstanding efficiency, reliability and durability with its new EX-7 Series line of mining excavators, which were released in 2019. The lineup includes the EX5600-7, EX3600-7, EX2600-7and EX1200-7 – each available in North and South America.

"The new EX-7 Series feature the latest technologies that reduce fuel consumption costs while achieving superior productivity and enhancing sustainability," said Jordan Popp, mining engineer, Hitachi Construction Machinery – Americas. "At Hitachi, we're always thinking of ways to provide the ultimate efficiency, reliability and durability of our machines. We know our customers' bottom lines are affected by those key areas, so we focus on continuously improving and developing new technology that takes our machines to the next level. This innovation is a collaborative effort, which includes listening to our customers and their needs. We invest our time and energy into making great machines, so our customers can rest easy knowing they made a sound investment."

With the EX2600-7, EX3600-7 and EX5600-7, customers can choose from a Cummins or MTU EPA Final Tier 4 (FT4) engine option. For non-regulated countries, customers can choose from a Cummins or MTU engine option that features Fuel Consumption Optimization (FCO) settings that contribute to improved efficiency. For example, on the EX3600-7, the Cummins FT4 engine, which also has FCO technologies but uses DEF, contributes toward four percent net fluid savings while the MTU FCO engine without DEF features a seven percent net fluid savings as compared to the previous model, the EX3600-6.

The EX5600-7 (544,000 kg or 1,199,315 lbs. in shovel configuration) kicked off the EX-7 Series release. This machine provides increased reliability with cylinder stroke end control, which helps ensure structural longevity and operator comfort by using angle sensors to help reduce the cylinder pump flow rate for smoother and slower movement.

The EX3600-7 (369,000 kg or 813,506 lbs. in shovel configuration) is loaded with intelligent features to minimize downtime and optimize machine longevity, also improving reliability on the jobsite. A new auto-lubrication system with a large capacity grease tank, new grease pump, in-line grease filter with breather and grease level indicator in the cab reduce downtime.

At a lower operating weight (259,000 kg or 570,997 lbs. in shovel configuration), the EX2600-7 provides many of the same capabilities as the EX3600-7 such as reduced fuel consumption through engine selection and system improvements. The EX2600-7 also includes features that strengthen its durability. A pressurized cab bed improves the life of electrical components and controllers by using an air filter to keep out dust and debris. Maintenance is also reduced with a greaseless center joint that utilizes available hydraulic oil for lubrication rather than needing grease lubrication.

The smallest of the EX-7 Series excavators, the EX1200-7 (118,000 kg or 260,146 lbs. in shovel configuration) also features a 4.5 percent increase in bucket capacity with a 7 m^3 (9.2 cu. yd.) capacity. Equipped with optimized swing control, the new machine also has an improved hydraulic system with a flow regeneration valve to reduce power requirements from the hydraulic system and engine, lowering fuel consumption and improving pump life.

"Available in a backhoe or shovel configuration, the EX1200-7 is our smallest mining excavator and also serves as a crossover machine for construction customers," said Jim Plourde, mining engineer, Hitachi Construction Machinery – Americas. "This versatile machine delivers an astounding combination of power and the latest technologies our customers need to get the job done, whether its large-scale excavation or mining."

HITACHI

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For more information about the EX-7 Series, visit www.HitachiConstruction.com.

EX3600-7

EX5600-7

Sev.en Energy Buys Blackhawk Mining

The Czech company Sev.en Energy AG has acquired U.S. coal operator Blackhawk Mining LLC, which operates nine mining complexes in three states: West Virginia, Kentucky and Indiana. Blackhawk mines and sells metallurgical, thermal, PCI, stoker and specialty coals from the Central Appalachian Basin (CAPP) and thermal coal from the Illinois Basin (ILB).

The company's annual production is 7 million metric tons (mt) to 8 million mt of metallurgical coal and 3 million mt to 4 million mt of thermal coal. In 2019, Blackhawk Mining had $1 billion revenues and $120 million EBITDA.

"This is a significant step for Sev.en Energy as the group ventures fully into the metallurgical coal mining industry," Executive Director of Sev.en Energy Alan Svoboda said. "Blackhawk is a great company with highly productive Tier-1 assets and large coal reserves. We look forward to working with Blackhawk, its management and employees to secure the long-term success of the company and establish a platform for further growth in the region."

Blackhawk CEO Jesse Parrish said, "With the support of Sev.en Energy, Blackhawk is well-positioned to navigate the current market environment and pursue synergistic growth opportunities in the sector."

He added that Blackhawk looks forward to integrating into Seve.en Energy's portfolio. Sev.en Energy currently owns coal mining and power generation assets in the Czech Republic, in the United Kingdom and in Australia. In the Czech Republic, it is the largest privately held operator of coal mines and conventional power plants with more than 3,500 employees.

Sev.en Energy's first venture in the metallurgical coal industry was its acquisition of a 17% ownership interest in Corsa Coal in May 2020.

Whitehaven Gains Government Approval for Vickery

This week in Australia, the New South Wales government released its comprehensive technical assessment for Whitehaven Coal's Vickery Extension Project and its key recommendation that the project can proceed. The report, according to Whitehaven, will be now be considered by the New South Wales Independent Planning Commission (IPC), which will hold a public hearing regarding the project in the coming weeks. Consistent with the statement of expectations released by Planning Minister Rob Stokes last week, the IPC must make a final determination on the project within 12 weeks.

A first round of public hearings into the project was held in early 2019. The Department of Planning and the IPC also sought and received written submissions as part of the initial EIS and first-stage public hearing processes, respectively.

"We know there is strong support for Vickery from the comprehensive community consultation process that has already been undertaken — 60% of public submissions to the Department of Planning and 75% to the IPC called for the project to be approved," Coal Managing Director and CEO Paul Flynn said. "Vickery has the potential to be one of the most significant sources of employment and investment in northwest NSW in the coming years and major infrastructure projects have a key role to play in the post-COVID-19 economic recovery, including for regional Australia."

The Vickery Extension Project proposes the construction of a new open-cut coal mine and associated on-site infrastructure about 25 kilometers (km) north of Gunnedah in northwest New South Wales. The mine will produce predominantly metallurgical coal. The proposal builds upon and optimizes an already-approved mine, on a site that has already been extensively and safely mined over many years.

Vickery is estimated to generate around 500 construction jobs and 450 operational jobs, growing Whitehaven's existing 2,400-strong workforce, around 75% of whom live locally.

The project will contribute a net economic benefit to NSW of A$1.2 billion, including $656 million in royalty payments to the NSW Government.

New Coal-fired Power Plant is Commissioned in Germany

Uniper's 1,052-megawatt (MW) Datteln 4 power plant began operating on May 30. The launch of the coal-fired power plant, located in Northrhine, Westfalia, Germany, has attracted a lot of attention from environmental activists.

The Finnish company Fortum, which recently acquired a majority share in Uniper, said, "We understand people's concerns, and we agree that coal must be phased out, and emissions must be reduced. However, the transition to a low-emission society must be made without compromising the security of supply or an affordable cost of energy, in a socially just manner.

"This has been the starting point for the comprehensive solution of the Ger-

A new coal-fired power plant, Datteln 4 (above), is recently brought online in Germany.

man government, which allows the commissioning of Datteln 4 and systematic phasing out of coal by 2038."

Contura Completes Exit From Powder River Basin

U.S.-based Contura Energy Inc. has officially ended its connection to the Powder River Basin in Wyoming. Effective May 29, two previously wholly-owned subsidiaries of Contura Energy — Contura Coal West LLC (Contura Coal West) and Contura Wyoming Land LLC (Contura Wyoming) — have merged with certain subsidiaries of Eagle Specialty Materials LLC (ESM).

Contura Coal West still holds the mining permits for the Eagle Butte and Belle Ayr mines, which have been under the operational control of ESM since October 2019.

"With today's announcement, Contura has completed the final element of its years-long exit from the Powder River Basin," Contura Chairman and CEO David Stetson said. "We are pleased to conclude this clean-up transaction and continue our focus on operating and developing our Central Appalachian metallurgical properties."

ESM will pay Contura Energy $625,000 in cash consideration for assets owned by Contura Coal West but not previously conveyed.

Warrior Met Will Build New Barge Facility

Warrior Met Coal Inc. plans to invest $50 million to construct a barge load-out facility in Walker County, Alabama, to support its expanding metallurgical coal mine near Tuscaloosa. The project is expected to add 12 new jobs.

The barge load-out facility will become integral to transporting the company's coal production, according to David Knight, executive director of the Walker County Development Authority. The coal will be transported by barge to the Port of Mobile's McDuffie Coal Terminal for export.

Warrior Met announced plans in February to construct the Blue Creek development, which will be a single longwall mine and is expected to have the capacity to produce an average of 4.3 million short tons per year of met coal over the first 10 years of production. First development tons from continuous miner units is expected to occur in the third quarter of 2023 with the longwall scheduled to start up in the second quarter of 2025.

Warrior Met Coal plans to invest $50 million in a new barge loading facility in Alabama. (Photo: Warrior Met Coal)

This new mining operation involves a total investment of $578 million and will create 371 jobs.

"Warrior Met Coal's growth plans will provide a significant injection of economic vitality into Alabama's coal country, and the high-paying jobs being created by the company will benefit many families and communities in this region," Secretary of the Alabama Department of Commerce Greg Canfield said.

Decker Coal Brings Back Furloughed Employees

After laying off nearly 30% of its workforce earlier in May, all 98 furloughed Decker Coal Co. employees have returned to work.

On May 8, the company announced it was furloughing the miners from its Decker Coal mine in southern Montana until May 26, citing decreased demand because of the coronavirus (COVID-19). However, at the time, the company said the layoffs were temporary and Decker would be bringing the employees back by June for scheduled production.

In a statement, Decker Coal said there are no health-related issues at the mine and hope workers can return at the end of the month.

The Decker mine is in the northwest portion of Powder River Basin. It produces approximately 5 million metric tons of coal per year.

Foresight Energy Reports Weak Q1 Coal Sales

U.S. coal operator Foresight Energy reported quarterly coal sales revenues of $99.1 million on sales volumes of 3.2 million tons, compared to $267.3 million for the first quarter 2019, representing a decrease of $168.2 million, or 63%. The company reported a net income of $35.7 million, which included $85.1 million in gains on reorganization items associated with the March 2020 bankruptcy filing. Foresight mines produced 3.8 million tons during the quarter. Cost of coal produced was nearly $80 million for the first quarter 2020 compared to nearly $134 million for the first quarter 2019.

Foresight Energy said the weak overall coal sales realizations were primarily due to decreased pricing on export volumes, which were a function of market considerations as well as modified sales terms of its export contracts, whereby its mines are the delivery point of its export volumes in exchange for its customers bearing the responsibility and cost of transporting the coal to export facilities on the Gulf of Mexico.

Foresight Energy is a leading producer and marketer of thermal coal controlling nearly 2.1 billion tons of coal reserves in the Illinois Basin. Foresight Energy operates three longwall mining complexes with four longwall mining systems (Williamson (one longwall mining system), Sugar Camp (two longwall mining systems), and Hillsboro (one longwall mining system), which has fully resumed longwall mining operations in March 2020), and the Sitran river terminal on the Ohio River. With the resumption of longwall mining at Hillsboro, Foresight Energy has idled continuous miner production at its Macoupin complex.

(News-Leading Developments - from p. 6)

interest in the Veladero mine, with its partner Barrick Gold.

Hudbay Lands $115M Gold Prepay

Hudbay Minerals has entered into a gold forward sale and prepay arrangement with existing lenders where the company will receive a payment of $115 million for delivering 79,954 gold ounces (oz) in 2022 and 2023 based on gold forward curve prices averaging approximately $1,682/oz. The upfront payment is not subject to any conditions and will be paid on May 11.

"We are pleased to bolster our liquidity position and prefund the entire capital budget for the New Britannia gold mill refurbishment, which is a low-risk, high-return investment with a short payback that is expected to more than double our gold production in Snow Lake to more than 150,000 oz/y by 2022," Hudbay President and CEO Peter Kukielski said. "This transaction allows us to take advantage of the strong gold price environment at a forward price that is significantly higher than our internal gold price forecasts used for reserve calculations and budgeting."

The gold prepay was executed by National Bank Financial, as lead arranger, and includes Bank of Montreal, ING Capital Markets LLC and Canadian Imperial Bank of Commerce as counterparties.

Yamana Studying Expansion at Jacobina Gold Mine in Brazil

Yamana Gold reported in early May that a proposed Phase 2 expansion project reaffirms its Jacobina mine in northeast Brazil as a low-cost, long-life asset with significant value. Planning for Phase 2 outlines an increase in plant throughput capacity from 6,500 metric tons per day (mt/d) to 8,500 mt/d to be achieved through the installation of an additional grinding line and incremental upgrades to the crushing and gravity circuits.

The Jacobina Phase 2 expansion would ramp up annual gold production to 230,000 ounces per year (oz/y) by 2023 at average feed grades of 2.40 grams/mt gold. The mine produced 159,500 oz of gold in 2019.

Total Phase 2 project capital costs are estimated at $57 million, of which $35 million is related to the processing plant (including a 35% contingency), $14 million for underground mining, and $8 million for infrastructure. Yamana expects the project's capital cost to be invested incrementally, allowing the project to be funded by Jacobina's cash flow.

Average life-of-mine all-in sustaining costs are estimated at $727/oz. Average life-of-mine cash costs are estimated at $532/oz.

Jacobina's current mining equipment fleet and underground infrastructure are able to support most of the additional production requirements for the Phase 2 expansion, including electrical substations and pumping stations. However, acquisition of certain infrastructure will be brought forward to support the increased production rate. Ventilation infrastructure will be upgraded to provide adequate airflow for the additional working areas and increased equipment fleet.

Total underground development is unchanged from Phase 1, but the peak development rate is planned to increase from approximately 16 km/y to 19 km/y to support the higher production rate.

At the plant, crushing capacity will be increased by replacing an HP 500 tertiary crusher with a larger HP 800 crusher. In addition, a third ball mill with a nominal capacity of 195 mt/y will be added to the plant to bring grinding capacity to required levels. Further, a new 6,000-mt-capacity silo, similar in size to the operation's existing silos, will be installed to serve the new ball mill. The new grinding line will also have a new gravimetric concentration system.

Current planning is based on current mineral reserves only and delivers an 11.5-year mine life. An Extended Case scenario is also being studied, which includes 9.5 million mt of additional plant feed at an average feed grade of 2.4 g/mt of gold and which would extend mine life to 14.5 years at the 8,500-mt/d processing rate.

A feasibility study is currently planned for mid-2021. Permitting is ongoing and expected to be approved by late 2021. Further optimization opportunities are advancing in parallel, aimed at improving mining recovery, reducing costs, and converting mineral resources to mineral reserves.

Exploration at Jacobina is focused on identifying areas of higher-grade mineralization and converting those areas to measured and indicated mineral resources. The successful program is not only expanding mineral resources and mineral reserves on a yearly basis but is designed to augment mine production by increasing mill feed grade over the life of the mine.

NEWS - CALENDAR OF EVENTS

SEPTEMBER 8-11, 2020: UGOL & Russia, Novokuznetsk, Russia. Contact: Web: www.ugol-rossii.com.

OCTOBER 20-22, 2020: MiningWorld Russia, Crocus Exhibition Center, Moscow. Contact: Web: https://miningworld.ru/.

NOVEMBER 7-14, 2020: ALTA 2020, Pan Pacific Hotel, Perth, Australia. Contact: Web: www.altamet.com.au/conferences/alta-2020/.

NOVEMBER 9-13, 2020: Expomin, Espacio Riesco, Santiago, Chile. Contact: Web: www.expomin.cl.

NOVEMBER 30-DECEMBER 4, 2020: The annual meeting of the **American Exploration & Mining Association, Nugget Casino Resort, Sparks, Nevada, USA.** Contact: Web: www.miningamerica.org.

FEBRUARY 7-10, 2021: 47th Annual Conference on Explosives and Blasting Technique, Orlando, FL, USA. Contact: Web: www.ISEE.org.

FEBRUARY 8-11, 2021: Investing in African Mining Indaba, Cape Town, South Africa. Contact: Web: www.miningindaba.com.

FEBRUARY 28-MARCH 3, 2021: SME Annual Conference & Exposition, Colorado Convention Center, Denver, CO, USA. Contact: Web: www.smenet.org.

MARCH 7-10, 2020: The annual meeting of the **Prospectors & Developers Association of Canada, Toronto Convention Center, Toronto, Canada.** Contact: Web: www.pdac.ca.

MARCH 14-17, 2021: Haulage & Loading 2021, Hilton El Conquistador Resort, Tucson, Arizona. Contact: Web: www.haulageandloading.com.

SEPTEMBER, 2021: MINExpo INTERNATIONAL, Las Vegas, Nevada. Contact: Web: www.minexpo.com.

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Submit to Steve Fiscor at sfiscor@mining-media.com

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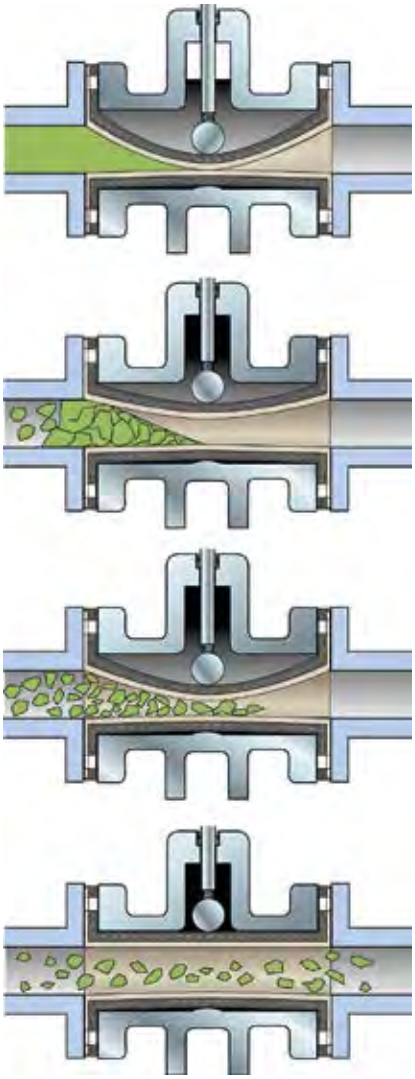
Red Valve Manual and Control Pinch Valves – the Industry Standard

Traditional ball, plug aand gate valves used in mine slurry applications experience repeated difficulties and often break down or wear out quickly. The constant maintenance and replacement of these valves can result in high expenses and downtime. Red Valve Pinch Valves outlast these valves with state-of-the-art fabric re-enforced specialty elastomer sleeves that provide extremely durable structural support. Similar in construction to a heavy-duty truck tire, Red Valve's Pinch Valve Sleeves are actually much tougher than metal. Unlike the flow patterns of conventional valves, which create deflection that causes wear, the flow pattern of a Red Valve Pinch Valve is streamlined. The valve lining, flange gaskets and seating surface are combined into one unit, and expensive metal alloys are eliminated because the sleeve is the only wetted part of the valve.

For more than half a century, Red Valve's elastomer experience and know-how have become legendary, and truly unmatched in the industry. Red Valve offers a worldwide, world-class custom service network. With corporate offices in Pittsburgh, PA, manufacturing facilities in Gastonia, NC, and 114 sales representatives in 61 countries around the globe, Red Valve has the sales engineering team to help you select the best choice of valves and related products for your applications. "Rely on Red" to provide reliable soltions for your toughest mining challenges, day after day, year after year. Call 412-279-0044 or visit us at www.redvalve.com to learn more.



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Answering the Call

The latest advances in mine rescue solutions reveal which suppliers have become the zealots of the digital revolutions

By Jesse Morton, Technical Writer

With a deep history, Dräger's PSS BG 4 closed-circuit breathing apparatus features the Sentinel II electronic monitoring unit that can capture critical data on users. (Photo: Dräger)

There is a quiet revolution under way in mine rescue.

Players that have been in the discipline for decades describe it as the biggest step change in a generation. "I've been involved in mine rescue for 20 years and this leap into digital data communications is the greatest advancement during that time," said Chris Whitt, who leads the official mine rescue team for the state of Virginia (U.S.).

"Since 2000, the most significant advancements in mine rescue technology have been in sensors and monitoring solutions, like gas detection, and the move from the old sound-powered communication cable to the wireless systems," he said. "We are also experimenting with ways to use these new tools in several different scenarios facing other emergency teams we support."

The list of benefits of the digital revolution is topped by optimal outcomes in safety and in responses to emergencies, Whitt said.

"I've seen big improvements in safety since 1985," he said. "Efficient communications solutions is a big piece of that picture and critical in any emergency situation for the best possible outcome."

Best possible outcomes is one of the foremost goals of the top suppliers in the mine rescue solutions space. Another is meeting the changing needs of the mines as the industry evolves. The top suppliers in the space describe their pursuit of both goals as a "higher calling." The latest news from the space suggests they are answering the call.

Set Offers Reliability, Data

Dräger, one of the oldest and most trusted brands in the mine rescue solutions space, told *E&MJ* that current trends in mining will, in the near future, mandate substantial changes in safety and rescue protocols, processes, refuges and gear.

"The drivers for the marketplace are the customers, their mine designs, and how they are going after their orebodies," Kent Armstrong, global business development manager, mining, Dräger, said. "And they're expanding in distance underground all over the world."

As mines grow and run deeper, the number and magnitude of the challenges faced by mine rescue teams will grow apace. Armstrong said that means those teams will have to adapt their processes and maximize usage of available technologies.

"We are going to have to change the method in which we do things," Armstrong said. "We've got to work with the specifics of the mines. That plays into shelters and refuges, both portable and fixed. It plays into self-rescue and early detection of emergencies underground so that miners can properly get to fresh air."

Plans will have to be revised regularly to meet the new realities underground, he said. "What will be the procedures and requirements for the 13,000-ft level?" Armstrong said. "What are the expectations, options and challenges at that level, and, from a risk assessment angle, how do we solve them?"

Answers will likely prompt disruptive step changes in the mine rescue solutions space. Such could unfold similarly to the evolution of Dräger's flagship breathing apparatus, the BG 4, which has been on the market in North America for more two decades.

BG stands for Bergbaugerät, which loosely translates to mining device. Early models date back more than a century.

From the early 1900s until near-mid-century, a two-hour breathing apparatus was required.

As the mines went deeper, "no longer were two hours good enough," Armstrong said. "There were major changes in the approval regulations."

For the next few decades, up until the early 1990s, the BG 174 set the standard in the field.

"The 174 means 1.7 liters of oxygen for 4 hours," Helge Trabert, product manager, closed circuit breathing apparatuses, Dräger said.

In 1993, after the approval organizations required a higher safety factor, the BG 4 launched and soon dominated the market.

Currently, the approval organizations continue to dictate the pace of change. "Right now, they do not require a BG 6 or a BG 8," Armstrong said.

Until they do, the company is focused on meeting the more pressing demands of customers.

"It is getting more digital," Armstrong said. "That is what the feedback suggests. People are looking for more digital information provided by the set. That is the driver for us."

The latest iteration of the set, the Dräger PSS BG 4, released in 2009, speaks to the need for digitization.

The set is equipped with a Sentinel II electronic monitoring unit that captures data on optical and acoustic warning signals, such as the residual pressure warning, two selectable electronic alarm thresholds, an alarm for lack of movement, and a manual emergency call alarm.

For the 33, Fame Taints Commemorations

By Jesse Morton, Technical Writer

With the 10-year anniversary of the collapse of the San José copper-gold mine near Copiapó, Chile, approaching, most of the 33 survivors will be ambivalent to the impending commemorative celebrations. Having each had their fill of fame, most of the miners would prefer instead to let the past be the past, Héctor Tobar, author of the award-winning, bestselling book, *Deep Down Dark: The Untold Stories of 33 Men Buried in a Chilean Mine, and the Miracle That Set Them Free*, told *E&MJ*.

"I think that by now everyone has gotten over their taste of fame," Tobar said. "Most of the wives, girlfriends and children of these men are probably really happy that it is behind them, and maybe are not all that excited about the anniversary coming up because the anniversary brings back bittersweet memories."

The memories are bittersweet in that they include heady highs and abysmal lows.

"The wonderful part of those memories are the reunions that took place, and that wonderful feeling of having somebody resurrected, somebody you thought was dead, because a lot of them were taken for dead," Tobar said. "Having that person resurrected is a wonderful feeling."

The flipside is the misery inherent to the limelight. "The Chilean media has seen them as reality television stars, not as real working men who suffered this horrible accident that they had to survive," Tobar said. "I think a lot of them have a very poor vision of what the media does."

The limelight enveloped the miners before they were even determined to be alive after a massive rockfall blocked the mine ramp and the only escapeway in early August 2010. The refuge lacked adequate food and supplies, and the miners, beforehand divided into contractors and company employees, were soon also split by differences of faith and survival strategies. A mostly Catholic and Christian bunch, prayer and respect for it kept the peace as the men slowly starved.

More than two weeks after the collapse, surface drilling reached the drift near the refuge. Quickly, food and supplies were piped in. The miners were gifted money by celebrities and promised financial support by the government. By mid-October, the last of the miners had been hoisted to the surface through a small capsule.

The media frenzy launched within days of the collapse. Tobar said the news press corps did a good job reporting on the events of the day and supplying analysis. "The mining press, I thought, did a fantastic job," he said. "As for the political press, I read some great coverage that unfolded at the time and that came out later about the way the Chilean government used this. I think certain elements of the press handled themselves very well."

Once on the surface, the miners lawyered up to get ownership of their stories. They toured gratis to destinations like the Acropolis, the Vatican, and Real Madrid Stadium.

The initial surge in funds helped briefly, but didn't last.

A handful were able to take advantage of their celebrity status, did speaking engagements, appeared on reality television, and ran for public office. The majority of the rest, however, after a time were thrust back into a semblance of normal life. And normal life for a few was fraught with turbulence.

"A lot of these guys had problems before the mine collapse," Tobar said. "A few of them have had problems with the law, problems that a lot of working men in Chile sometimes encounter, problems related to family dysfunction, and sometimes to drinking and whatnot, but nothing really horrible."

In the movie *The 33*, Antonio Banderas plays San Jose mine collapse survivor Mario Sepúlveda who spoke openly to the Chilean media during the 2010 rescue and afterward. (Photo: IMDb)

They had to navigate their complex lives while at the same time being "the most famous miners on Earth," Tobar said. For a spell, that impossible balancing act made for great TV viewership ratings.

The infotainment outlets that had initially latched on to the symbols the men had become turned and started targeting their characters. "That section of the media really did a disservice to these men, especially once they were rescued and it became clear the men wanted to monetize their story and weren't going to grant interviews," Tobar said. "The news-as-entertainment outlets transformed them into symbols of greed and objects of ridicule."

The infotainment trafficked in prejudices "people have towards working people, specifically toward working men in Chile," Tobar said. "That was a dark chapter in Chilean media history."

In 2015, Tobar's book was adapted for the screen in *The 33*, with Antonio Banderas and Lou Diamond Phillips, and with some of the proceeds going to the miners. Tobar and the miners walked the red carpet and saw the premier at Grauman's Chinese Theatre in Hollywood.

Tobar told *E&MJ* the miners hoped the movie would help set the record straight. "Mario Sepúlveda said that it was the hope of the miners that the movie and the book would bring them back their dignity in Chile because they felt like they had been basically ridiculed," Tobar said. "They were no longer treated as heroes but as objects of disdain."

The 10-year anniversary is expected to be widely celebrated at the behest of the Piñera government. For Piñera, the rescue was an unambiguous victory that merits revisiting, Tobar said.

"At the time, the right wing government saw them as political gold and tried to take advantage of their image," he said. "I think a lot of the miners are sick of that, and not looking forward to the 10th anniversary as much as you might think."

Tobar said that in the years following the collapse and rescue, a couple of the 33 returned to underground mining, but only briefly. It is likely that none, he said, work underground today.

Overland conveyors often run through rough terrain and over unstable ground.

BEUMER Group GmbH & Co. KG: Reliable across rough terrain

BEUMER Group based in Beckum, Germany, with group companies around the globe develops and implements system solutions which provide greater efficiency in the mining and bulk industry. The company can draw on more than 80 years of experience in this international sector. Controlled growth, a global presence and a wide product range in conveying and loading, palletizing and packaging technology ensure the long-term success of the company. BEUMER Group employs around 4,500 people and achieved an annual turnover of around 950 million euros in 2019.

The overland conveyors and Pipe Conveyors of BEUMER Group can be used by companies in the mining industry to transport various bulk materials, even over long distances and often through rough terrain. This is generally faster, more cost-efficient and environmentally friendly than trucking. High angles of inclination and tight curve radii enable individual routing adapted to the respective task and topography. BEUMER Group relies on camera-equipped drones for the planning, projection, implementation and documentation of these systems. Using special software solutions, the system supplier evaluates the aerial photographs photogrammetrically to generate digital terrain models.

BEUMER Group also provides belt and central chain bucket elevators for safe and economic vertical transport of all powders and small-sized bulk materials, e.g. raw meal, cement, grits, sand or concentrated ores.

For storage yards for special material blending the BEUMER Group installs stackers and reclaimers. These stack the bulk material and guarantee a maximum blending effect. Customers can also efficiently homogenise large quantities of various bulk materials and thus ensure the uniformity of the raw materials used.

With loading systems from BEUMER Group, the bulk material is safely transferred into the ship's cargo hold.

To ensure efficient loading, BEUMER Group supplies ship loaders. They consist of a fixed boom with an extendable telescopic belt conveyor. This allows ships to be filled efficiently. The systems are also equipped with a dedusting unit which keeps the process emission-free. BEUMER Group also manufactures loading heads for fast and dustfree loading of bulk materials into silo vehicles. Their double-walled design separates the dedusting system from the material inlet. BEUMER Group has developed mobile loading units that can be adapted to the length of the vehicle. It also offers various telescopic systems for loading open vehicles without generating dust.

In addition, BEUMER Group offers comprehensive customer support in order to ensure high levels of availability for its customers' machines and systems. It comprises intensive customer service, flexible service agreements, individual modernizations, efficient spare parts supply, extensive training for the users, and residential service.

BEUMERGROUP

"The PSS BG 4 is basically a facelift of the original BG 4," Trabert said. "It is a positive pressure set and offers a higher safety factor or protection level. It has an integrated cooling system, which wasn't on the earlier models."

Also featuring improvements in robustness and serviceability, the set is ideal for extended use, the company reported.

"The slight positive pressure breathing circuit protects the wearer by preventing hazardous substances from entering the sealed breathing system," Dräger reported. It offers a duration of four hours. A CO_2 absorber filters the exhaled air.

"At the same time, the breathing air is enriched from the oxygen cylinder," the company reported. "Before the regenerated breathing air is inhaled again, it flows through the breathing air cooler."

As complex as the set sounds, after some training the use and maintenance of it can quickly become routine, Trabert said.

"It is a lot easier to manage than you might think," he said.

It is as user-friendly as a common breathing apparatus, Trabert said. With practice, its use can become second nature, he said. "Miners have a lot of stuff to think about, and the apparatus is something they really shouldn't be worried about."

The foremost benefit of the set is rock-solid reliability, Armstrong said. The set is proven technology, he said.

"We did a lot of field testing on this unit," Armstrong said. "We took it to some of the leading players around the world and it went through months of surface testing and underground testing. We reviewed checklists and comments, and looked for where to make changes both to the operational design and to the functionality or durability of the unit."

That process was supplemented by the experience the company gained in supporting mine rescue teams and in responding to underground emergencies around the world.

It was spurred on by an R&D policy that values a big-picture understanding of the challenges of mine rescue today, Kathryn Kasper, marketing manager, mining, Dräger, said.

"We tend not to look exclusively at one individual product because they all work really closely together," she said.

The company supports the International Mines Rescue Body, which in turn supplies information on the latest trends. "It really helps us to understand what challenges the mines rescue communities are facing, where they are looking for solutions, how we can support them, and what they are trying to accomplish," Kasper said. "That has really assisted us, in the last 20 years, to know what we should be changing or adapting on the technology that we provide to really put our customer in a good position."

As a result, the BG 4 is one part of a broader solution offering that includes service, support, information and access to other critical technologies.

"We are not single solution," Armstrong said. "We look at all facets. Mines are going deeper, going farther, and mining faster. All these things play into our approach."

They will continue to play into the development of the BG 4 and other related Dräger solutions, he said. "We can't stand still," Armstrong said. "We have to move forward to meet the demands of the market, and we will."

Adaptable Refuge Offers Connectivity

Strata Worldwide recently announced the release of the new Strata Emergency Refuge Chamber, the ERCX, a customizable,

connected chamber that can be easily modified when conditions or regulations require it.

"We've developed from the ground up a new chamber for the metal and nonmetal mining markets, that can also be configured for coal and tunneling," Dave Maust, general manager, refuge chambers, Americas, Strata, said. "We've taken advantage of some new CNC machining technology, which makes for more simple fabrication, competitive design, and local manufacturing, so the refuge chambers are tailorable to standards around the world."

The new chamber is the evolutionary successor of one of the company's first chambers introduced more than a decade ago. It is described by the company as a highly flexible and truly global design.

"We've had years of experience with refuge design and we know what customers have experienced in the past," Maust said. "We've taken the things that we've learned over the years, along with customer comments and suggestions, and looked at a new construction technology that makes it a little easier to build the chamber they want."

That experience and feedback also led to selecting more robust components, from batteries to door bearings.

"We have changed from just using steel door shafts to stainless steel, with oil-impregnated bronze bearings for less maintenance," he said.

Better fasteners are used. "The old way of doing things was using zinc fasteners or steel fasteners with paint," Maust said. "Now we use stainless steel fasteners throughout."

Better scrubber technology is used. Predecessor chambers used loose soda lime in-tray scrubbers. The lime has a shelf-life of two years. "Now with this new global design, all chambers will use sealed soda lime cartridges with a far more extended shelf-life," Maust said.

Described by the company as highly adaptable, the ERCX can be easily modified for greater duration capability, and increased blast resistance.

"In many cases, there is no specific requirement for overpressure, however, in some locations, there is a minimum requirement for 15 psi overpressure, for blast resistance," Maust said. "The new design and manufacturing process allows the miner to adjust the design of the standard chamber to meet the higher regulations."

CNC manufacturing makes it easier for Strata's global manufacturing facilities to build the shell to exact specifications. "For

Strata's new ERCX refuge chamber is designed for connectivity and gives miners the option of remotely monitoring battery charge levels, the air conditioning system, oxygen levels and other sensors. (Photo: Strata Worldwide).

example, there is a demand in Russia for our chambers and our partner facility can build the shell locally," Maust said. "With CNC machinery, it is considerably easier for them as compared to our original design."

Strata has also made it possible to remotely monitor the status and health of the chambers. The chambers come ready for the inclusions of a DigitalBRIDGE QuadPort, which supports Power-over-Ethernet (POE) devices.

DigitalBRIDGE, Strata's underground data-over-coax communications offering, "then connects the chamber to the mine's existing communications network," Maust said.

Devices that can connect to the QuadPort include, but are not limited to, wireless access points for voice and data, gas sensors, atmospheric monitors and even the chamber's batteries and air conditioning unit, Rob Albinger, general manager, safety electronics, Strata, said.

"You can use IP cameras for live viewing of the occupants, which also helps to identify personnel who have entered the chamber," Albinger said. "Typically, gas monitoring is installed and used to monitor the oxygen and carbon dioxide levels inside the main compartment and sampling pumps can be used to evaluate the atmosphere outside the chamber."

Other conditions within the chamber can be remotely monitored too. "It provides the ability to see the internal parameters of the chamber such as, relative humidity, pressures and temperatures," Albinger said. "The monitoring capabilities of this network are limitless."

With Wi-Fi access in the refuge, Voice-over-IP devices can be used to communicate to the surface.

On a routine, day-to-day basis, operators on the surface can monitor, among other things, the chamber battery charge levels.

"Mines can get a live battery reading and a charge status from the chamber system without physically going to the location," Albinger said. "Only if the batteries don't seem to be charging, or there are other issues noted, will maintenance need to schedule a visit to the chamber."

The system also allows for remote monitoring of air conditioners. "With DigitalBRIDGE, mine operators can monitor the status of the air conditioning units from the surface and verify if any preventative or routine maintenance is required," Albinger said. "This is imperative to ensure that the chambers remain operationally ready at all times."

Maust said DigitalBRIDGE can be easily added to legacy systems. "We can connect not only to a fiber network but also a leaky feeder system, which is something that is very unique. Many mines have leaky feeder systems for radio communications," he said. "And with the DigitalBRIDGE Plus+ system, Strata's PoE leaky feeder offering, mines are able to backhaul digital information over an existing leaky feeder cable."

Strata also introduced new automated controls in the new chamber. "For example, rather than manually monitoring and adjusting the oxygen levels in the chamber, the chamber will automatically keep the oxygen levels within the proper range," Maust said. "It doesn't depend on somebody regularly monitoring the levels and making manual adjustments anymore."

The new design could be optimal for customers with multiple operations that share sections, or ones that expect to relocate chambers at some point.

Team Profile: Virginia's Teams Serve All State Mines

Virginia hasn't had a major mine emergency since 1992. That doesn't mean the state's official mine rescue teams haven't been busy. More recently, they've been doing their part in helping mines stay safe and economical.

The teams save miners money by playing a role that otherwise would pose an expense.

Every underground mine in the state has to have two mine rescue teams. Virginia Department of Mines, Minerals and Energy's (DMME) mine rescue teams can legally fill that role at any underground mine in the state.

Such has helped many mines meet that requirement, according to department leadership. "We were fortunate that we could put federal grants from the Mine Safety and Health Administration (MSHA) to such a great service to our coal miners and other underground miners across Virginia," Butch Lambert, deputy director, DMME, said. "We know it helped ease a financial burden to several companies. But, it is also important that it helps our miners feel safe going to work each day."

The team serves as primary and secondary coverage at Lhoist, Virginia's biggest underground mineral mine, the department reported.

Members complete approximately 30 hours of training each month and the teams are required to visit and become familiar with each mine. "While they are studying the layout of the mine, they also serve as a second set of eyes on these operations," said Randy Moore, mine chief, Virginia. "Sometimes they point out issues or needed improvements an inspector may not always find."

DMME's mine rescue teams can serve as the backup team for mines across the state. The team trains regularly, is familiar with all the mines in the state, and competes. (Photo: DMME)

The teams are comprised of experts from a number of pertinent fields. "We chose people that had years of experience in the mining industry and on company teams," Chris Whitt, emergency manager, DMME, said. "We have a variety of expertise from engineers to roof specialists and electricians to firefighters. Each member brings something unique to the table that will only make us better in an emergency."

Many team members also volunteer as firefighters and emergency responders in their local communities.

IWT CEO Eric Hansen, right, says the company received the innovation award for answering a higher calling. (Photo: IWT)

It is also ideal for customers in areas of the world that can expect to see refuge regulations change in the future. "Russia is currently looking at their refuge chamber regulations," Maust said.

Maust stated that the new global chamber is supported by local distributer partners around the world. "We have representation in each region to support the customers locally and configure the chambers to meet the applicable regulations."

Innovative UG Comms Gets Award

During the annual meeting of the Society for Mining, Metallurgy and Exploration in February, Innovative Wireless Technology (IWT) received the Robert E. Murray Innovation Award.

IWT CEO Eric Hansen accepted the award and said it is recognition that the team serves a higher calling. "The reason we are doing this is greater than selling products," he said. "Our hope is that we continue to work with our customers and our partners in the mining and mine rescue community to keep making better products that make mining safer and that make our customers profitable and successful. If they are successful, we are successful."

The award was given for IWT's line of SENTINEL underground networking, communications and tracking solutions, used on a day-to-day basis for safety and operations and also for mine rescue responses.

Modular and scalable, SENTINEL is comprised of a series of small nodes that are deployed in a working section or throughout a mine that, combined, create a wireless communications network. It can support wireless voice, text, tracking, atmospheric monitoring, performance metrics, and more, the company reported.

The mine rescue solution is specifically tailored to rapid and fast deployment, for when seconds count.

Over the years, SENTINEL evolved from a mobile safety system to a comprehensive, enterprise-level network for underground mining operations. "It started almost as an afterthought," Hansen said. "We had this capability we'd developed for warfighting. After the Sago and Upper Big Branch disasters, we saw applicability to support the mining industry."

The solution evolved from military technology to underground mining technology.

In underground mines, it proved popular, and feedback showed it could be used for applications beyond just safety and compliance. "The customers wanted a battery-powered solution in their working sections, so, fairly quickly, we put out the SENTINEL Battery Mesh Node, and it was really well received," Hansen said.

"More and more our customers started to use this product in a different way, really in a way it wasn't initially designed to be used," he said. "What piqued our interest is that they wanted mobility."

Ideal was a node that did not require power but had the same capabilities. "Mobility was a big drive as well as a focus on the SWaP (Size, Weight and Power) of the Solution," Hansen said.

Cabled nodes gave rise to mobile battery-powered nodes, and as SENTINEL evolved so did the ways it could be used, Hansen said.

History shows one way is in mine rescue.

During his acceptance speech at SME, Hansen spoke about a mine that had deployed SENTINEL and used it after a roof fall crushed the limb of a miner. "The roof fall caused an amputation of the limb, and he was at high risk of bleeding out right there in the working section," Hansen said.

The SENTINEL infrastructure survived the fall and "continued to operate, monitor, and provide communications, tracking and situational awareness to the dispatcher post-incident," he said.

A fellow miner at the site of the roof fall made a private, secure call and relayed HIPPA and personal medical information to the dispatcher.

"The dispatcher was able to look at the situational awareness display of his screen and immediately start dispatching first aid resources and EMTs based on which ones were closest," Hansen said. "In parallel, as the EMTs approached the location where the miner was down, the dispatcher was calling 911 and summoning above-ground resources and first responders."

The SENTINEL-based system gave the dispatcher the visibility needed to order equipment movements to clear the exit path. "He was able to free the travel way to quickly get this injured miner out of the mine as soon as possible," Hansen said.

Within six minutes, the miner was loaded onto a truck and being transported out of the mine. "The EMTs on the truck "were calling in vital life signs during the exit from the mine," Hansen said. "For over 10 minutes, those EMTs were on their networking gear, communicating blood pressure, oxygen level, and heart rate," he said. "They had uninterrupted communications."

It took 11 minutes to get topside.

"As the paramedics flew in, they were amazed," Hansen said. "They had all the information on this injured miner before they even landed," he said. "They were shocked that the mine was able to provide all this information so they could bring all the first response gear they needed."

The story illustrates the importance of innovation in underground communication systems, Hansen told *E&MJ*.

"If they had run a legacy system with a wired backhaul and it got knocked out with the roof fall, they may not have been able to respond to the event at the pace that they were," he said. Instead, "they had mobile nodes in their working sections. Nothing was interrupted in their service, which was a game changer for their response."

The story also speaks to the higher calling of the company. "These types of events don't just affect the mine operation, they affect families, they affect kids and spouses," Hansen said. "It still to this day chokes me up when I think about it. Positively impacting lives, families, kids, grandkids and spouses, that makes it all worthwhile."

CR extends range to meet market demands

CR has a leading range of Productivity Defining Technology across three categories: Surface Mining, Digital and Wear Protection and Processing. Their products include cast lip systems, dragline buckets, ground engaging tools (G.E.T) and lock systems, dragline rigging and locks, Titan 3330™ load haul optimization, conveyor accessories, stone dusting systems, and plate block and wear materials.

With an innovative design approach and a commitment to high-quality and reliable mining products, CR is a leader in engineering innovation and the manufacturer of productivity-enhancing mining equipment and software.

Continually pushing the limits of their capabilities and technology, CR is proud to announce the release of their DecaEdge (DE2553) Cast Lip System.

DecaEdge - Proven Innovation

The DecaEdge system has been delivering productivity outcomes for our customers for over 5 years. The DecaEdge (DE2559) cast lip launched in 2015 and was a world-first innovation, followed by the DecaEdge (DE2566) in 2017. With over 154,000 combined operating hours and counting, the DecaEdge lips can last for up to 25,000 operating hours with no major rebuilds, resulting in over a 33% reduction in total cost of ownership of the lip and G.E.T system.

A recent case study involved a WA1200-6 wheel loader that featured a DecaEdge cast lip. The customer reported 5-year maintenance-free milestone using the DecaEdge product. This delivered improved machine availability, increased productivity and personal availability and significantly improved safety on site.

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DecaEdge Range Extension

The DecaEdge (DE2553) is due for public release in December 2020 and will further complement the DecaEdge range to suit Large Mining Wheel Loader buckets with capacities between 14 and 20m^3. Anticipated to uphold the durability and maintenance savings benefits experienced with current DecaEdge range, CR is excited to broaden the range of this revolutionary technology.

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Slurry Pumps: Picking the Best Type for the Task

From motor size and pump speed to wear life and operating costs, an imposing array of choices face a buyer intent on reaching and maintaining optimum pump performance. Here are some tips from experts.

By Russell A. Carter, Contributing Editor

Slurry pumps are essential for moving hard-to-handle, high solids-content fluids and sludge, and annual demand for these pumps reflects just one aspect of the significant space they occupy in several industry sectors. The global market for all types of slurry pumps is estimated at well more than a billion dollars each year, and although those sales represent only a single-digit portion of overall pump sales, slurry pumping costs take up a lot of space in mining's collective energy budget. Process equipment supplier Metso estimates that slurry pumps account for only about 5% of centrifugal pumps — the most common type used for this purpose — installed throughout the mining industry, yet this small segment represents up to 80% of the industry's total operational pumping costs.

GIW Industries' TBC-92 slurry pump is the heavyweight king of the mining industry, according to the company, weighing roughly the same as a loaded medium-range, twin-engine commercial airliner.

The space they physically inhabit in a mining operation is typically harsh — at the bottom of a sump, a mill or thickener-underflow discharge point, or serving a pipeline carrying abrasive ore or tailings. Their duty cycles range from continuous to sporadic depending on the application, often with highly variable flow rates and particle sizes. Internal wear can be severe in some applications, with as much as 2 mm of material a day disappearing from crucial component surfaces. Due to the increased probability of high wear rates from the materials being transported, pump builders add thicker, heavier components and/or internal liners, making slurry models larger and heavier than their water-pump brethren.

The wide range of pump-performance requirements encountered at thousands of mine, mill and other industrial sites requires an equally wide variety of pump types, sizes and mounting configurations. Two recent product introductions illustrate the range of available choices.

Going Big, Going Mobile

Late last year GIW Industries announced that it had developed the TBC-92 slurry pump specifically for use in oil sands operations. Named for its 92-in.-diam (234 cm) impeller, GIW claims the TBC-92 is the largest and heaviest slurry pump available in the mining industry. GIW also noted

that installation of the TBC-92 marks an important company milestone: it now has pumps in service at all operating Canadian oil sands hydrotransport applications.

Overall, GIW's TBC line comprises a series of horizontal, high-pressure, end-suction centrifugal pumps with a conventional single-wall design in which the pressure load against the shell is transferred to non-wearing side plates, which are held together by large tie bolts to ensure safety. TBC pumps components include abrasion-resistant white iron, ductile iron and special alloys to match duty requirements. Alternative wear liner materials such as urethane and neoprene are also available.

The company said the TBC-92 retains the best features of models that preceded it, including many elements from the TBC-84 Super Pump, and has features from GIW's MDX product line. "This pump incorporates lessons learned over the years from operating in the oil sands, and features our latest hydraulic and wear technologies," GIW Business Development Manager Mollie Timmerman said. "Because this is the heaviest TBC pump we have ever designed, particular attention was given to maintainability, as well as material selection and construction of the pressure-containing components."

The TBC-92 weighs about 209,000 lb (95,000 kg) — roughly equivalent, said GIW, to a fully-loaded Airbus A321 airliner — with a casing that alone weighs 34,000 lb (15,400 kg). For ease of maintenance, customers are provided with custom-lifting devices to facilitate safe removal and installation of wear components. The pump also features a long-lasting suction liner that can be adjusted without shutting the pump down, according to the company.

At the other end of the size and portability scale, Gorman-Rupp's transportable SludgeKat self-priming, positive displacement hydraulic piston pump is designed for convenient pumping of sludges and slurries from clarifying pits, wastewater treatment, mud pumping, environmental cleanup and similar applications.

The SludgeKat has 4-in. (100-mm) suction and discharge ports and is capable of flows up to 226 gpm (14.3 lps) and heads up to 390 ft (118.9 m). Depending on the product being pumped, SludgeKat can pass up to 2.4-in.-diam solids without damaging or clogging the pump. Units are equipped with Kohler Tier IV diesel engines.

Each SludgeKat comes standard with a wheel kit. The pump end frame is mount-

Designing for Durability

A rule of thumb when selecting a slurry pump is to look for the most robust pump, in terms of performance, wear resistance, power and maintainability, that falls within the service class rating for the type of material being pumped. Even that simple process can be complicated when special circumstances arise, such as unusually high mechanical wear experienced in a specific application, or intermittent operation rather than steady running. Pump manufacturers generally have vast knowledge of what works and what doesn't under many conditions, and they incorporate the features that do work into their latest designs. For example:

FLSmidth Minerals expanded its line of Krebs millMAX slurry pumps with the introduction of the millMAX-e, which features a unique wear-ring design that the company claims solves grinding and recirculation problems within the pump by maintaining clearances between the impeller and the suction side. By maintaining the design performance without increasing the speed, the wear ring extends the life of all wet end parts and reduces power consumption.

The millMAX-e model is unlined and offers a compact, space-saving exterior design aimed at reducing capital and replacement costs as well as motor-power requirements. However, according to the company, millMAX-e's power frame uses the same bearing and shaft components as the equivalent millMAX power frames and is capable of handling applications requiring high speed and power. The millMAX-e is equipped with the patented Krebs pump belt tensioning system that allows users to quickly change out v-belts without having to realign the sheaves.

Tsurumi Manufacturing's entries in the mining-class slurry pump market include its GPN and GSD series, rated at motor outputs of 7.5-50 hp (5.5-75 kW) kW and 50-100 hp (37-75 kW), respectively. Both series comprise submersible three-phase, high head and high volume heavy-duty slurry pumps driven by a four-pole motor. They are equipped with high-chromium cast iron agitators that the company said assist in smooth handling of settled materials. Motors are enclosed by a water jacket that assures efficient cooling even when the motor is exposed to air. Pumps in this series incorporate seal pressure relief ports that prevent pumping pressure from affecting the shaft seal.

Finland-based Flowrox's heavy-duty CF-S horizontal centrifugal pump is the first in a series of centrifugal pumps to be introduced by the company and capable of continuously pumping highly abrasive and dense slurries. The company said the new pump can provide flows from as low as 2.3 m^3/h to more than 4,000 m^3/h at heads exceeding 76 m. The pump's split-case design is claimed to provide a good balance between efficiency and wear, and models are available with a range of liner material options. The pump is compatible with Flowrox's Digital Services platform, a customized IIoT-based process data collection and analysis system.

MBH Pumps unveiled the Ni-Hard series submersible slurry pumps, designed and built to pump slurries containing abrasive solids up to 65% by weight. These heavy-duty pumps, according to the supplier, are equipped with an external agitator that breaks settled or compacted solids, while its adaptive spiral plate technology delivers higher pumping with less energy consumption.

FLSmidth's Krebs millMAX-e pumps are designed to save space and reduce motor-power requirements by up to 30% without compromising performance.

ed to a 52-gallon (197-l) fuel tank base and offers a full-load run time of 25.5 hours. The pump end frame can be detached from the unit and when connected to optional 150-ft (46-m) hoses, provides increased portability around the job site.

In the space between these two very different pump solutions lies an array of conventional horizontal and vertical centrifugal models, submersibles and other types offering a wide range of performance characteristics that can be applied to specific slurry pumping requirements (see sidebar). It's not uncommon to find that a pump intended primarily for one application can perform well in a different role.

For instance, an iron ore mine in the Northern Cape of South Africa reportedly benefitted from the versatility of a Grindex Bravo 800 pump — a submersible model that, in this case, was dry-installed by pump distributor Integrated Pump Technology to improve slurry flow by acting as a booster, mounted on the wall of one of the mine's settling-pond dams. An existing pump had failed due to extreme wear from the heavy sedimentation level in the pond. In the new setup, a submerged unit pumps slurry from the pond over a distance of about 30 m at a head of 8 m to 10 m to the Bravo 800 mounted on the dam wall. The Bravo 800 provided the wear resistance required by the application, and at a rated output of 45 kW and shaft speed of 1,475 rpm, can output almost 100 l/s in this application.

Pumps, unsurprisingly, can also fail to perform adequately if specified or installed incorrectly. Tsurumi America, which makes and markets a full line of light, medium and heavy-duty submersible slurry and wastewater pumps, reported earlier this year on a situation that involved both problems: One of the largest gold mining operations in Nevada was experiencing unplanned retention-pond pump breakdowns that cost the mine an average of $40,000 to $50,000 each in lost production, and repairs usually only lasted about three months or less. The mine attributed the frequent breakdowns to faulty repairs and brought in Tech-Flow, a nearby Tsurumi Pump distributor and equipment service company, to handle future repairs and also conduct a site study to determine if the overall performance of the mine's submersible pumps could be improved.

The highly portable Gorman-Rupp SludgeKat pump can handle slurries and sludges containing objects up to almost 2.5 in. diam, and can run for more than 24 hours on a full fuel tank.

Jace Church, territory sales manager at Tech-Flow, said, "We found the original pumps were not properly installed because they were mounted too high out of the water. This caused air bubbles to enter the

pump, leading to cavitation, which led to the pumps breaking down. They were also using municipal pumps that are typically used in wastewater applications, so they were not entirely suited for this purpose."

The mining company chose to replace the existing pump with one designed for the application, in this case Tsurumi's GSZ-150 electric submersible. The duty cycle is intermittent — between 75%-90% — and operates at 110-120 ft of head, pumping 2,200-2,600 gpm. "They are pushing a year and a half now with no issues, which correlates a lot with properly submerging the pumps," Church explained.

The combination of a large selection of pump models and the capability of many of those models to solve a variety of pumping problems might make it seem easy to choose an optimal unit for a given application. However, concerns about long-term maintenance costs, liner or wear-part interchangeability for maximum life, and options for minimizing energy consumption can muddy the waters. Further complicating the selection process are other factors that need to be considered — not just a pump's performance characteristics, but also sump sizing, piping specs and the properties of other components associated with a mill's process-flow setup.

Look Beyond the Pump

The industry's continuous drive to increase production from existing assets makes it important to view a mill's pump systems as one part of a much larger picture. In a recent blog post, Metso's head of pump product management and marketing, Chris Wyper, outlined some important points to consider about pumps when aiming for plant-wide production increases. Among his recommendations:

Ensure motor power availability: "A well-designed plant has enough power allocated to mill pumps. Pumps typically operate on variable speed drives, meaning there are many process variables affecting speed and, finally, the power draw. It is a good idea to look at SCADA data on historical power drawn to better estimate the amount of power that would be available for tonnage increases. Rather than using engineering data sheets that are somewhat oversimplified, it is beneficial to use a point cloud type plot showing flow and pump pressure as a function of time. This information makes it possible to determine the optimal size of all the pumps and cyclones for the plant."

Consider gearbox cooling at higher power: "As pump duty is increased, it usually also increases the power transmitted through the gearbox. This means that the amount of heat increases as well: a gearbox that is sized marginally for air to air cooling may overheat with higher continuous duty. Consideration must be given to the cooling capacity of the lubrication system, particularly at higher ambient temperatures and altitudes."

Ensure gland seal water pressure at higher heads: "The pump gland seal water system should be sized so as to be able to deliver a constant flow of gland water under all operational conditions. This applies to the pump duty, including any increase in head due to tonnage increases. It should also be checked that the gland seal water system is adequate when other demands are placed on it, such as hose downs or flushing."

Take a close look at pipe sizing: "If you double the speed, the rate of material loss increases 16-fold and the rate of abrasive wear on the surface is approximately proportional to the fourth power of velocity. If there is a significant increase in input, it

is necessary to consider whether the pipe sizing is optimal. The right size allows friction losses and wear to be minimized. Of course, if there is a large variation in flow, then minimum velocity to prevent settling should be examined."

Prepare for crash stops by calculating floor sumps: "In the case of a plant crash-stop, prepare for the maximum inflow based on calculations on the live volume of floor sumps. This may include the mill static overflow and any dump valves to empty pipes and sumps. If sump size is increased or the mill volume changed, then the sumps may be undersized. In this case, the existing sumps can be deepened or enlarged, to deal with the volume, or then additional sumps created. Typically, mill sumps should be separated from the other sumps in the plant due to the possibility of mill balls entering the sump."

Expanding Future Options

As industry-wide figures indicate, slurry pumping can serve as a prime example of purchased capital equipment where operating and maintenance (O&M) costs rapidly eclipse the initial procurement cost. A myopic view of TOC (Total Cost of Ownership) factors when selecting a pump can result in a variety of bad outcomes ranging from the need to prematurely replace an inadequate unit, to sky-high maintenance costs and production losses from unscheduled downtime. Conversely, pump OEMs and aftermarket suppliers are increasingly cognizant that their customers can't always predict future events and consequently are expanding their product and services portfolios to provide affordable options when mining conditions, maintenance resources or technology changes occur over time.

The Schurco slurry pump shown here feeds a cyclone, an application that requires precise and reliable pump performance.

Understanding the differences in industry-sector preferences and practices is important for a pump supplier in order to tailor its offerings to provide maximum value to the customer, according to pumpmaker Schurco Slurry's vice president of engineering, Will Pierce, who told *E&MJ* that hard rock and coal operators, for example, typically might take different approaches to pump maintenance — and for good reasons.

He explained that even though basic pump maintenance procedures — checking clearances, adjusting the impeller, inspecting the seal or packing for damage or leaks and ensuring proper lubrication — will always be similar in both hard rock and coal, the specific application dictates the frequency of preventive maintenance checkups.

"Heavy media separation is probably one of the highest wear applications in coal, and we would recommend checking a pump, depending on the tonnage

being moved and hours of operation of course, every 1,000 hours. Yet there are gold mines in Nevada and Alaska that have a wet-end maintenance interval of 500 hours. They go in at 450 hours and tear everything out, because they know if they wait until 550 hours, they've got a shelled-out pump and it's now an emergency situation."

The two mining sectors also can differ in how they collect, analyze and act on pump operational data for maintenance planning. "Most coal prep plants have PLC integration with the equipment, but they often have fewer data inputs than large hard rock plants, which may additionally monitor pumps for vibration, pressure and flow. Those plants are set up to monitor trends and can proactively plan for maintenance based on trend data," Pierce noted.

The differences also can apply to how pump maintenance is performed. "Generally, hard rock operations won't send pumps out for repairs. They usually have well-staffed maintenance departments and their own shops," said Pierce. This provides an opportunity for suppliers to offer maintenance kits, which Pierce explained are "a type of a vendor-managed maintenance program that the mine operator executes. We manage the kit, making sure it always has every part in it that the end user might need to perform any repair on the pump. When they perform a repair, if there are 30 parts in the repair kit, they might only consume seven on that repair. We will audit those kits and replenish the parts that are consumed so that any time a maintenance department would need to perform a repair, their kits are always fully stocked."

He continued: "Some coal plants that we work with have a different philosophy for managing pump maintenance. They keep a spare pump on hand. When they have a pump problem, their crew removes all ancillary equipment from the unit that's being replaced, installs that equipment on the spare pump, and puts the spare online. With the worn pump out of service, they can perform the maintenance in a workshop on site or send it out to the manufacturer or a third-party shop."

Manufacturers are also looking at ways to incorporate more performance flexibility into their pump models and ease some of the concerns associated with necessary pump modifications. "For example, we are developing a line of pumps designed with a solid casing with replaceable all-metal, liner-like elements. The metallurgy for these wear components is a novel enhancement to the proven 27%-28% chrome white iron that the industry has used for decades. We have hard rock customers that started with rubber liners 20 years ago, now they're in a different ore deposit at the same mine and the material is sharper or has different abrasive characteristics and the rubber isn't lasting. With the shell we've developed, they're able to convert to a completely metal lined pump without major impact to the overall installation through using backward compatible adapter plates," Pierce explained.

The new design also offers Shurco's coal clients notable benefits: "Our coal customers almost always use metal-lined pumps, but the industry is very price-sensitive right now, so this new development doesn't have the traditional massive ductile iron outer shell and metal liner — instead, it has replaceable metal wear components. There's no quality compromise on the pump's internal components, no change in wear or hydraulic performance. It's just a lower-cost alternative."

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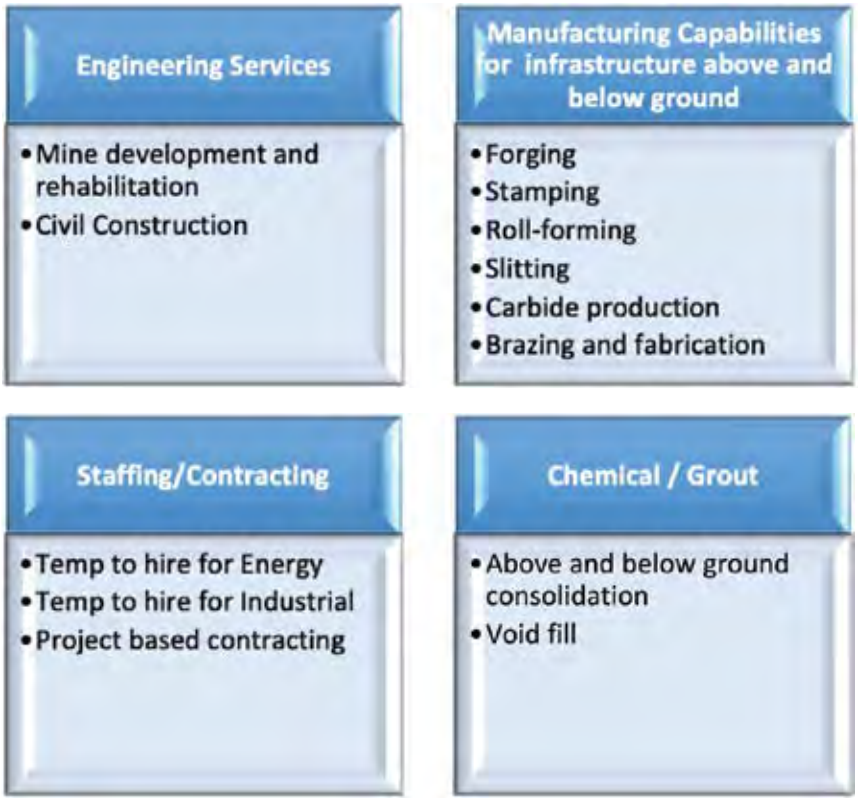

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Management Systems for Future Fleets

Autonomy is a powerful tool for driving productivity and efficiency in mine fleets and, if done right, can offer substantial cost reductions. E&MJ *explores the path from FMS to AHS.*

By Carly Leonida, European Editor

Advances in GPS, wireless communications and cloud computing have greatly contributed to the evolution of fleet management system (FMS) capabilities in recent years. Through these and other correlative technologies, today's FMSs can deliver greater accuracy, speed and data security, which translate into increased productivity, higher profits and fewer infrastructure-related overheads for mine operators.

Greg Lanz, vice president for business development at Modular Mining, explained to *E&MJ*: "Another significant factor in FMS improvements is the proliferation of automation. Mines leveraging this technology are better able to reduce or eliminate human error, increase predictability within workflows, and decrease the frequency of personnel working in extreme conditions or hazardous environments.

"At present, utilization of automated technologies varies across the industry. At opposite ends of the spectrum are mines with little to no automation, and mines operating fully autonomous truck fleets. Situated between the two extremes are those using semiautomated and operator-assist technologies."

The majority of open-pit mines globally use an FMS — DISPATCH, Wencomine and MineStar are just a few examples (there are many more available on the market). These are geared primarily towards the optimization of manned vehicle fleets, and many offer remote operation or semi-autonomous functions for equipment like dozers, drills and excavators.

Haulage is currently the only part of the load and haul process that can be fully automated and to run a truck fleet, or part of one, autonomously requires an autonomous haulage system (AHS). Currently, there are three commercially available, with more in the pipeline. Caterpillar (Command for Hauling) and Komatsu (FrontRunner) are the leaders with solutions primarily targeted at their own fleets, the Cat AHS has been deployed on to Komatsu 930E trucks, too. Combined, these OEMs have deployed more than 400 autonomous trucks.

Hot on their heels is ASI Mining with its Mobius third-party OEM agnostic solution. Hitachi Construction Machinery (HCM) and Wenco Mining Systems are currently installing their first commercial scale AHS at Whitehaven's Maules Creek mine in Australia following a proof-of-concept trial at Meandu in Queensland, and BELAZ also has AHS trials ongoing.

Wenco is working with Hitachi Construction Machinery to design solutions that comply with ANSI/ISA-95 and ISO standards for autonomous interoperability. (Photo: Wenco)

It's hard to beat the cost and efficiency improvements that AHSs can offer but, despite nearly 35 years of research and testing into their operation (the precursor to AHS was a multi-truck deployment in the USA in the 1970s prior to GPS being widely available), commercial-scale deployments are still relatively thin on the ground. Fewer still are mines that are getting the full benefit from their investment in these technologies. Success with an autonomous fleet requires far more than just new software and hardware; a full transformation is required from mine planning to company culture with commitment at every level of the business, and change on this scale can be off putting, daunting even, for some companies.

But, until we get to grips with AHS usage and learn to optimize their performance, it will be difficult to expand full autonomy to other parts of the mine, particularly equipment with more complex roles, and incorporate them into otherwise autonomous operations.

Interest is Growing

As markets become tougher and mines more expensive to build and run, it's likely that mining companies will look increasingly to autonomy as a way of driving efficiency and productivity in their operations.

It has been nearly 15 years since the first commercial deployment of an AHS — Komatsu's FrontRunner at Codelco's Gabriela Mistrel operation in Chile — and, since then, our experience and understanding of the technology, as well as its capabilities and limitations, have

advanced significantly; to the point where some mining companies are now leveraging it to achieve nearly a 30% reduction in hourly operating costs.

The success of companies such as Fortescue Metals Group, Rio Tinto and BHP with AHSs is spurring others on to evaluate autonomous haulage for their own operations.

While the largest and most successful AHS implementations are currently at iron ore operations in Australia's Pilbara, many oil sands operations are now looking into converting their manned fleets to autonomous operation too. Suncor Energy (Calgary, Alberta) spearheaded the use of autonomous haulage in the oil sands in 2018 with its phased implementation of the FrontRunner AHS, set to roll out over six years across multiple sites. Ukrainian iron-ore producer, Ferrexpo, announced an installation in late 2019. Teck's Highland Valley Copper operation in Canada is trialing autonomous haulage, and so is Barrick at its Arturo JV in Nevada. Whitehaven's Maules Creek mine in New South Wales will be the first coal operation to run an AHS once its new HCM-Wenco system is fully operational, and Newmont recently approved an investment for Boddington in Western Australia.

And there are other indicators that more mines are readying themselves for autonomous haulage too. In March, Boliden announced the installation of Modular Mining's DISPATCH FMS at its Kevitsa mine in Finland, citing future integration with Komatsu's FrontRunner AHS as a key influencer in the buying decision.

William Nassauer, manager for AHS Product Strategy at Komatsu, explains: "Komatsu has seen a 50% year-on-year increase in tons moved by our autonomous fleets over the last six years. The quantity and seriousness of inquiries that we are fielding have escalated as well and, early indications are that the upward trend will continue in the short-term despite current economic hardships. There are many who believe that demand for autonomous technologies will strengthen as mining corporations look to manage the risks of deploying a large workforce in the aftermath of a global pandemic."

Many mining companies are now planning new mines in a way that will allow autonomous haulage to be used from day one too.

An AHS in action. This one was delivered by Modular Mining and Komatsu. (Photo: Komatsu)

"This is a much easier path than the conversion of an existing mine with manned trucks," said Andrew Pyne, CEO at Wenco. "Making the transition from operators in trucks to an autonomous fleet is very challenging. Many mining companies have completed economic and engineering evaluations required to potentially migrate their operations toward autonomous haulage. There are, however, significant barriers to adoption and, in some cases, it's unachievable due to technological barriers, barriers in terms of the social impact of job losses, supplier and engineering challenges, and of course the CAPEX requirements to make the transition. This is why the adoption rate has been quite slow."

The Interoperability Challenge

One of those barriers is the prevalence of mixed OEM fleets on many mine sites and the use of different operational technologies including FMSs. Many of these OT systems must be replaced as they aren't interoperable with current AHSs and, likewise, the trucks.

According to the 2019 report "Accessing the Fast and Furious Pace of Autonomy to Transform Mining" by Clareo and TWIN, interoperability and open architecture will be key in allowing more widespread adoption of autonomy in mining and, ultimately, to the creation of the fully autonomous mine site.

"An open and interoperable technology system is one whose interfaces are completely understood to work with other products or systems, at present or in the future, in either implementation or access, without restrictions. They enable a plug-and-play approach with different systems and are often based upon a standard," the companies explain in the report.

While groups like GMG and AMIRA are working toward developing universal standards for autonomous mining technologies, they have yet to emerge, and so some technology providers are engaged in tackling some of the barriers toward the adoption of AHS systems.

Wenco, together with its parent company HCM is working to design solutions that comply with ANSI/ISA-95 and ISO standards for autonomous interoperability.

"Wenco embarked on its 'open system' initiative many years ago and, in that time, we have continued to build upon our system integration capabilities," Pyne said. "We share actionable information with numerous systems both horizontally across the mining value chain and vertically into ERP systems and other IT platforms."

Wenco started with an open database and published APIs and has expanded to features such as a unified alarm system that allows third-party systems to show data on Wenco onboard displays. Wencomine can also share the GNSS data that it collects with other systems

onboard, and there are other functions that help to reduce the total cost of ownership and increase the value of the data by increasing its accessibility.

Beyond particular functional sets though, the company has embarked on a much grander interoperability vision.

"To execute on IIoT and the vision of Mining 4.0, vendors need to have interoperability and data intelligence solutions that can operate across the customer's end-to-end mining process," Pyne said. "In support of that, a Wenco executive is currently convening a new ISO standards subcommittee group that allows the command and control orchestration of autonomous fleets while sharing that information back into customers' existing infrastructure. In other words, enabling autonomous fleet solutions to be able to work with any FMS."

Both companies are strongly committed to this approach. In fact, during the 2019 CIM conference, Hideshi Fukumoto, chief technology officer for HCM and chairman of Wenco, said publicly: "We will champion the enabling of new entrants to autonomy. Customers should have the choice to use whomever they desire. These may be vendors with autonomous technology but who may not have experience in mining, or their own fleet management systems like Wenco. These new vendors should be able to participate without being locked out of a closed silo approach that is more designed for the benefit of the OEM vendor than the customer."

Pyne added: "We are already working with numerous mining companies and a few non-traditional autonomous vehicle mining systems, leveraging our open platform approach. We firmly believe this will enable next generation technology to emerge and facilitate autonomy to become more accessible to an increased number of mining companies."

Managing Change

At present, if a mine wishes to convert its manned truck fleet to autonomous operation, and, if the FMS it uses across the mine site isn't compatible with an AHS (i.e., the Cat MineStar FMS is compatible with Cat Command for Hauling AHS, Modular Mining's DISPATCH system is compatible with Komatsu's FrontRunner AHS etc.), then it has to switch FMS as well. This makes the implementation process far more costly and time consuming, and change management tricky for staff.

For example, Newmont's Boddington mine currently uses Hexagon's Jigsaw system but, as Jigsaw doesn't support Command for Hauling, it will be replaced by Cat's MineStar system as part of the ongoing project to convert the mine's 39-unit Cat 793 fleet to autonomous operation. Boddington's drills will remain on Jigsaw though as this system provides very accurate drilling in combination with the Locata ground-based GPS system that Boddington uses around its pits. Locata is necessary given the pits' depth, the steep angle of their walls, pit orientation, and the

mine's southerly latitude — all make for poor GPS coverage up against the walls for the drills.

Newmont has said publicly that this was one of the biggest challenges in the mine's decision to switch to an AHS. Changing a FMS is not an easy task, even without autonomy, and running the two in parallel will be a major undertaking.

And this is not a one-off situation: FMG also switched out the FMS at its Cloudbreak operation in the Pilbara as part of the move to autonomy, as did Imperial Oil at its operations in Canada.

Speaking of change… an AHS is often thought of as a FMS for autonomous trucks, however, consultant Richard Price gives a more accurate and holistic description in his 2017 article "Autonomous Haulage Systems — the Business Case" for AusIMM Bulletin.

"There is no industry standard definition of an AHS; it is referred to as the people, technological devices, infrastructure and software that combine to create a system allowing off-highway haul trucks to operate without truck drivers" he states.

People are the key component here. Company culture and willingness to change business processes and systems in order to make the most of the technology underpins every other aspect in the successful planning and execution of an AHS project.

"When transitioning to an AHS environment, mines need to institute a cultural transformation," Nassauer said. "Mines cannot continue to think and act in the same manner as for conventional operation; the autonomous environment requires a more disciplined mindset. Overcoming this barrier requires a great deal of effort, training, and determination by employees at all levels and in all roles across the board. Being ready for change as an organization is the starting point; choosing an experienced technology partner is key to a successful transformation."

Ben Miller, principal consultant at Autonomous Correct, agreed, "There are mines and operations that are ready for autonomy, and there are those that are not," Miller said. "When you go out and assess a site, use of a FMS is a very good indicator of that mine's ability to embrace that transfer of human decision over to an automated system.

"Companies that are reliant on a lot of human decision-making in their processes are going to struggle. A mine which is very committed to use of its FMS and doesn't manually assign trucks using it is more likely to successfully deploy an AHS."

Of course, a change as fundamental as autonomy requires a lot of planning and formal design from the mine engineering department too, from material extraction to the haul road network design, without forgetting the coordination of large equipment tramming from one dig location to a new one.

"An AHS fleet does not have a human brain on each truck that can compensate for what is requested versus what

An in-cab display for Modular Mining's DISPATCH FMS. Today's systems must be capable of not only collecting the vast amounts of data generated by equipment on-board sensors, but also making the data relevant and actionable. (Photo: Modular Mining)

was intended," Pyne said. "The system will blindly obey requests and does not interpret what people meant. It just executes what it's requested to do. This also means that the system won't always pivot and redeploy the trucks when reality does not go according to plan."

These limitations do not apply to the Komatsu AHS, however. Integration of the DISPATCH FMS' optimization logic in the FrontRunner system makes it possible for autonomous trucks to respond to situational changes in real time, and redeploy in the same manner as trucks in a crewed fleet. Because AHSs can provide so much operational data and the systems involved can't operate without clear directives, all and any planning flaws or propagation of these plans in the operational flow are exposed very rapidly.

"If mines can keep their current FMS and use an interoperability layer like ISO-23725, then they can realize the benefit of an AHS much faster with a lower cost of deployment," Pyne added. "That approach allows miners to keep all the integration of material movement, maintenance, financials and reporting intact without redesigning and reintegrating each interface with the new AHS. They also won't have to retrain all their staff on a new FMS."

Processes and procedures must also be implemented. Nassauer pointed out that with autonomous operation, it is extremely important that mines manage and control access to the site and implement clear safety policies and precautions.

"Processes are also required for responding to occasional upset events, such as an obstacle detected on the road, and ensuring optimal performance of the communications network," he said. "The change management and training programs that we roll out with our customers are sophisticated and comprehensive. They put in place a strong framework of best practices to help ensure long-term success."

Better Communications

Another crucial piece of the puzzle is the communications network that a mine uses and its data transfer capabilities.

Nassauer said that LTE has been working its way into mainstream adoption at many of Komatsu's AHS sites.

"This has brought about new levels of stability and provided tools that allow us to tightly manage security and assure a degree of service previously unobtainable with Wi-Fi," he said. "We are keeping a close watch on the emerging 5G technology. It has the potential to enable massive instrumentation and analytics and open up as-yet undiscovered avenues for product improvement and downstream innovation."

One of the major benefits of autonomy is removal of variation introduced by people; consistency has a major positive impact on operating costs and productivity. (Photo: Wenco)

Pyne stated otherwise though: "I don't believe [5G] will affect the performance of FMSs or the next generation of AHSs much," he said. "Better communication technology will provide lower cost of ownership, which may yield more deployments if the ROI is more positive. It will also allow the use of more devices that produce data. This can further be analyzed to build better models and help optimize the mine's operations.

"We predict that AHS technology will become more sophisticated and rely less on real-time, mine-wide communications as the technology matures, and enable new innovative entrants to provide next-generation AHS solutions. So, AHS performance will grow less dependent on 5G or low latency communication as time goes by."

From Ultra Class to Swarms

Nuances aside, the benefits that AHSs can deliver when done right are undoubtable. The technology also plays into some of the wider environmental goals many mining companies have.

"Autonomous haulage balances the needs of societal growth with the natural resources required to achieve it," Nassauer said. "On a per-ton basis, AHS operations have a reduced carbon footprint through increased fuel efficiency and lowered CO_2 emissions, produce less waste, and consume resources in a more responsible manner."

On an operational level, an AHS delivers consistent, reliable and repeatable performance day after day, year after year. Variability is eliminated, making it possible for mines to routinely execute to plan and hit production targets. The economics of extraction are also improved, and profits can be increased so lower quality ore bodies can be mined profitably; something that will be vital going forward.

It's likely that we also will see an increase in the networking capability of autonomous vehicles in the coming years and the integration of artificial intelligence, as mines look to improve the efficiency and independence of their AHSs.

HCM recently announced it has selected Rajant's Kinetic Mesh network to support the AHS at Maules Creek. The industrial wireless network enables vehicle-to-vehicle (V2V) communication, which allows autonomous vehicles to talk directly to each other, providing enhanced coverage and reliability.

Caterpillar has also gone down this route. The company announced in April it has validated Fluidmesh Network's wireless technology to improve networking capabilities for users of its MineStar Command solutions for hauling and dozing. The Fluidmesh solution, transmitting at 5 GHz end-to-end, uses artificial intelligence algorithms and dual-polarity antennas to improve data transmission in challenging environments. Fluidmesh is currently being acquired by Cisco, which provides Wi-Fi networks for many of Caterpillar's AHS deployments.

Better V2V communication will eventually allow the use of large fleets of smaller, fully autonomous trucks like Volvo's HX2, Scania's AXL or Komatsu's Innovative Autonomous Haulage Vehicle — cabless trucks capable of operating in a swarm-like fashion, redeploying themselves immediately in response to changes in the mine plan or operating conditions.

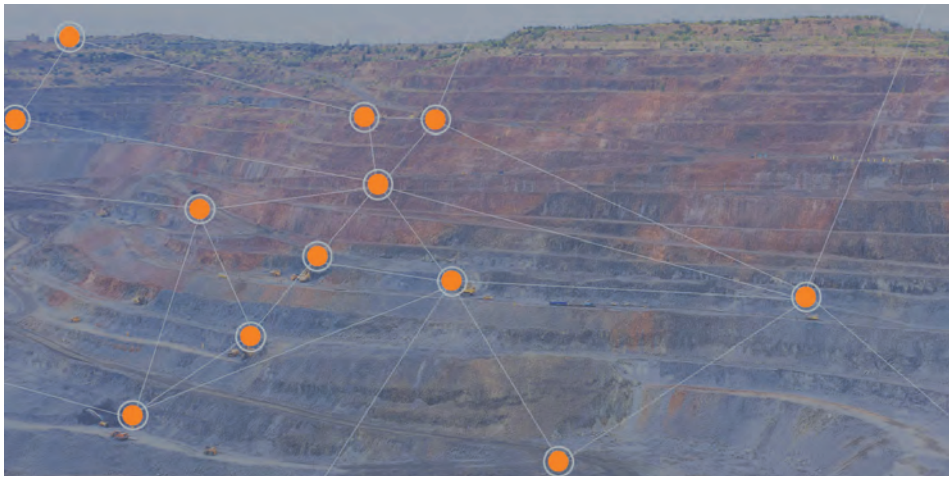
"The reign of the ultra-class mining equipment will likely become a legacy of the current paradigm," Pyne told *E&MJ*. "In the autonomy paradigm, the economics that drive fleet decisions are very different. That does not mean current mines will change their profile of haul trucks and loading units, but new sites will not naturally default to the same ultra-class size units.

"We also predict that the autonomy trend will diversify and start to include other ancillary vehicles. As we know, drills are also widely automated and we're going to start seeing, very soon, fully autonomous water carts, dozers and eventually even shovels and excavators in time. We see a logical step toward some of this spread of autonomy will be via teleremote control of some machines, particularly loading units."

It's worth remembering that, though impressive and seemingly "high tech," haulage is actually one of the simpler parts of the load and haul process to automate. The tasks trucks perform are repetitive and their range of functions minimal. The more complex the role a piece of equipment is and the more decision-making involved in its tasks, the harder it is to fully relinquish control of it to an autonomous system and achieve optimal performance safely.

Though companies like Rio Tinto and BHP are working on developing fully autonomous mine sites in the Pilbara, we are still a way off of the "holy grail," and some question whether it will ever be possible to fully eliminate humans from mines given the necessity of maintenance crews. As such, the shift toward increasing autonomy will likely concentrate mining and operational knowledge in a few individuals working in cooperative teams. New ideas will likely come at a slower pace, but will be much more widely applied as the software is updated throughout AHS deployments.

In essence, the autonomy shift is indisputable. However, the paradigm of closed systems has to change to make the technology more widely accessible, and for the industry, as a whole, to take the next steps toward building "mines of the future."



The fully autonomous mine will require vehicles to network with each other in order to intelligently respond to changing conditions and business drivers. (Photo: Wenco)

KOMATSU

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Mining and the Earth's minerals are essential to develop modern infrastructure, transform technology, and make possible millions of products we use every day. Because we value the Earth in the same way we value all people, we must ensure that mining practices continue to evolve to better protect our precious natural resources and priceless human lives.

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Power Play

An on-site source of power offers miners the chance to keep control of their operating costs through wavering energy prices and changing market conditions

By Carly Leonida, European Editor

On-site power solutions can include diesel generation technologies, like the reciprocating engine pictured, as well as cleaner or renewable sources of power. (Photo: Burns & McDonnell)

For mines that are situated in established jurisdictions, just far enough from the hustle and bustle of society, a grid connection is often the most cost effective and reliable source of power. How that power is generated (coal, gas, solar, wind, whatever) is another matter. But, for mines in more remote locations, areas with less reliable connections (or none), and for those where mains supply is too expensive or not as sustainable over the long term as they would like, there is another way, one that can incorporate both traditional fuels and renewable ones.

The term "on-site power" covers a multitude of different options. From mobile, diesel-powered gensets to hybrid microgrids and owned and operated solar plants, there are technologies available to suit every site and budget. The endless potential setups and combinations also allow solutions to be tailored depending upon the specific business drivers and goals of each mining company. All that is needed is a little expert planning…

"On-site power encompasses any and, in some cases, many, forms of technology that allow a facility to generate its own power. Whether that's electrical power or thermal or some combination of the two," said Justin Schnegelberger, manager of development engineering at Burns & McDonnell's Energy Group.

"Typical generation technologies like gensets can be a component of that but, as you start getting into the specifics of the facility, and as those vary from site to site, that can change significantly. So, it could be generators, it could be larger reciprocating engines, you could be looking at combustion turbines. Of course, you can throw renewable energy sources into the mix and some types of biofuels as well.

"There are a lot of different considerations. Really, it's a case of drawing a box around the facility and understanding its needs and energy inputs, and then matching those up with potential generation technologies."

Of course, grid connections can also play a part in that energy supply mix; a mine doesn't need to rely fully on an on-site power supply. In many cases, on-site power plants, or microgrids, are used to backup unreliable grid connections or to supplement grid power during times of high loading or unfavorable pricing.

By choosing to incorporate an on-site source of power, mines are able to gain a greater degree of autonomy over their energy supply; something that is infinitely valuable given the amount of uncertainty operations are likely to face over their life of mine.

Why Opt for On-site Power?

But before we delve into different technologies and their drivers, let's look at some of the concerns that are driving mines towards these solutions in the first place.

Schnegelberger's colleague, David McLane, mining projects manager at Burns & McDonnell, explained that cost is one of the leading concerns they see from mining clients. "In the exploration phase of a mining project, it's usually acceptable to have a higher cost for temporary power as you evaluate the property and before any large capital outlays for power infrastructure," McLane said. "But, even early on, the cost of power is a large driver for project economics from the prefeasibility level all the way through execution of the project."

It's rare for mining power costs to comprise less than 15% of the overall project cost and, in some cases, it can be as high as 40%, so energy supply options can be a deciding factor in whether a project gets the go ahead or not.

Availability and reliability of power are also key concerns as they link directly to safety; halting mobile or fixed assets mid-operation and without warning can endanger people working in the vicinity. Some surface and most underground mines have backup power, but that doesn't cover everything, only the essentials like ventilation and pumping equipment.

"You've really got to be careful with ventilation and restarting fans," cautioned McLane. "It's easy to stall them out. Critical pumping items as well… any large fixed infrastructure items that go down quickly or often can cause major concerns."

And speaking of fixed infrastructure, if mills shutdown unexpectedly when full of rock, it can be very difficult and costly to restart them. The power draw required is phenomenal and there can be significant implications for revenue and maintenance costs or even loss of product.

The shutdown of complex processes mean that power outages can cost mines upward of a million dollars a day.

The Tolerance Factor

Miner's tolerance for power supply issues varies widely depending on the location of their operations, available infrastructure, and the reliability and quality of their power supply. But, regardless, interruption of power supply can seriously impact an operation, from critical processes all the way through the supply chain; intermittent and inefficient operations are rarely profitable ones.

McLane said: "When talking about different localities, whether it's how remote these mines are or which country they're located in, it definitely plays a role in how mining operations are going to plan for this. When companies are operating in an environment with less stable power, they've got to plan for that and allow their working days to reflect that in the cost of mining.

"Most mining operations are run year-round, 24 hours a day. It's very seldom that a mining operation is shut down, and realistically, they can't be shut down often. You at least have to have a skeleton crew on the site to man critical pumping and power operations.

"When evaluating the economics and cutoff grades, it would be typical to see mines with less reliable power operating 340 or 350 days a year, whereas those with a more reliable power source would plan for more."

And power supply issues don't just impact mining companies' wallets; disruptions can also seriously affect workforce morale and retention.

"Typically, compensation in the mining industry is tied to production and, as you can imagine, if a mine site doesn't have reliable power, that can be pretty detrimental to the folks working on-site," McLane said.

"Which circles back around to the safety aspect. When you do have issues and lose production, it's hard to get away from that push to make up production. Things can go wrong when you get into 'hurry up mode' on a mine site, which is something that mining companies should take into consideration when looking at power options."

New Ground, New Technologies

With the majority of new mining projects being built in remote, harder to access locations and, with new technologies such as electric fleets in mind, many mining companies are looking to on-site power solutions as a way of securing their operations.

"We've seen exploration and mining technologies advance over the past decade or so, but we are operating in more remote and challenging areas," McLane said. "This technology is also allowing us to develop deeper mines that are more challenging to cool and heat. These are all challenges that rely on power.

"Also, we've seen a big push recently for electrification. As battery technologies advance, as manufacturers put out better electric mining equipment that can perform with the same capabilities of diesel equipment, that is also going to push

First Hydrogen-capable Combined Cycle Units to Curb Carbon Emissions

The Intermountain Power Agency (IPA) has a plan to transition to green hydrogen as it works to substantially decrease and ultimately minimize its carbon footprint across Utah, Nevada and California. The IPA recently selected Black & Veatch as the owner's engineer for its Intermountain Power Project (IPP) Renewal Project, which marks one of the earliest installations of combustion turbine technology designed to use a high percentage of green hydrogen.

With alternative fuels offering new solutions for a carbon-free future, interest in hydrogen is deepening. A zero-emissions clean fuel that emits only water, hydrogen planned to be produced via electrolysis. When this process is powered by a renewable energy source such as solar PV or wind power, the resulting clean hydrogen is known as "green" hydrogen and is 100% carbon-free.

Black & Veatch has a longstanding relationship with IPA, having designed the original coal-fueled IPP in the early 1980s. IPA plans to retire the coal-fueled facility and replace it with an 840-MW natural gas-fueled combined cycle power plant in 2025. The two single-shaft advanced-class combustion turbine combined cycle units will be commercially guaranteed capable of blending 30% green hydrogen at startup, with plans to increase hydrogen utilization to 100% hydrogen by 2045.

In addition to installing the two combined cycle units, Black & Veatch will support expansion of existing switchyards, new HVDC converter stations, and conversion of the two existing 900-MW generators into synchronous condensers. Black & Veatch is assisting IPA with multiple areas of project execution, including system studies, technology selection, design, procurement and construction.

The IPP Renewal Project envisions development of long-duration hydrogen storage in geologic salt caverns that are adjacent to the power plant, which would result in a fully dispatchable resource capable of providing highly reliable and resilient power on demand.

The plant will generate power with advanced thermal efficiencies across its full operating range and is being designed with high flexibility that will allow it to quickly ramp up and down in response to California's challenging "duck curve." Whether dispatched for base load power, to follow load and renewable generation swings, or in response to long-duration energy storage needs that far exceed current battery capabilities, the IPP Renewal Project will help support the transforming energy mix in the western United States.

"As with many utilities today, our client needed to bring in an engineering company with the technical expertise and industry experience to tackle a project of this size and magnitude," said Brian Sheets, project manager with Black & Veatch's power business. "Using renewable energy in the form of green hydrogen will help California meet its zero-carbon state goals for 2045. The location in central Utah is also significant because the local geology provides the capability to store excess hydrogen in large underground caverns, and existing regional transmission infrastructure will serve as a hub for collecting and transporting renewable energy to southern California. The IPP Renewal Project will help lead the way to a carbonless future."

more operations into looking at options for on-site generation."

Remote locations are a prime candidate for on-site power, but the combination of aging infrastructure (both for on-site generation and grid transmission) and greater pressure on grids in some long-standing jurisdictions is another key driver.

"There comes a point where money has to be spent to either maintain that existing infrastructure or replace it," Schnegelberger said. "When you're looking at big capital expenditures to maintain and upgrade equipment, that presents a prime opportunity to look at introducing new generation sources and maybe going partly or all down the path of onsite generation, rather than just spending money to maintain what is already there."

McLane added: "Mining is very much a global business. A lot of mine operators operate in multiple countries in different environments. And it's not just the capital cost or the operating cost for these operations that concerns them. It's the variability in cost as well.

"When mining companies are operating in areas where they are unsure on the reliability, they do take that into consideration. Although it might mean higher capital costs upfront, in the long run we do see that variability — being able to project what type of power reliability mines are going to have in the future — goes a long way. It can definitely persuade them one way or another."

Thorough Evaluation is Key

Schnegelberger explained that the first step when investigating on-site power as a potential supply option, is to properly assess and understand the unique drivers for a given site or facility.

"Those include the expected life of the facility, what the operation looks like, whether it needs electrical and/or thermal power, and really understanding what the key drivers are," he said. "From there, we would identify potential generation technologies, whether those are fossil fuel based or renewable, and look at how those options fit the needs of the facility.

"Things such as cost, environmental considerations, reliability, availability, water usage, fuel consumption goals, all of those aspects need to be evaluated to put together an overall picture on what specific generation options look like from an overall lifecycle cost standpoint.

"Then we home in on the options that make the most sense for that facility as it moves through the development process. This is especially important when it comes to larger on-site generation options, because mining companies may not be interested in taking on ownership or operation of a power generation facility.

"So, we also look at alternative structures that will still allow them to meet their power requirements, but not necessarily have to assume the entire burden of the project cost and operation. For example, by incorporating partnerships with utilities or other independent power producers (IPPs) that could own and operate those facilities and sell the energy to the mine site."

There are other considerations that play into that, too, like identifying the right types of partnerships, and if there are opportunities for whoever owns or operates the facility to upsize the project or make it more cost effective for the mine, potentially with excess generation being sold back into the utility power grid.

"Initially, assessment is about taking a look at what the facility needs, but then looking at the bigger picture too to see if there are opportunities to make the proj-

ect more viable for all parties involved," Schnegelberger said.

"Mining companies also take their social license to operate very seriously," McLane added. "It's important when consultants are looking at solutions for individual sites, because we do have the opportunity to present some of these larger power generation projects to companies, to factor in where they can add value for local communities. Particularly in areas that don't have reliable power or accessibility to power.

"Mining companies have the opportunity to work with utilities and communities to establish that, and often they can leave that area much better off than they were from a power standpoint."

Incorporating Renewables

Schnegelberger pointed out the social license piece plays back into miner's sustainability and decarbonization efforts.

"Everybody is feeling the pressure to go with greener technologies, and some of these remote locations lend themselves well to the integration of renewables," he said. "Again, it all comes down to finding the right fit. The cost and economics are the biggest deciding factors."

McLane jumped in: "I have seen more push towards renewable energy in the mining environment, coming from a couple different points of view. One being, mining companies own a lot of land, and I've seen power generation from renewables on mine sites, but also offsite.

"For example, the company might be putting in renewable energy installations elsewhere on their land as a way of reducing the overall carbon footprint from their mining operations.

"On the actual property, it might not make sense, but they might have an exploration property where they have a great area for hydro or solar generation. I think that trend will continue to increase as a lot of renewable power sources come down in cost."

"I agree," Schnegelberger said. "I think everybody's probably seen forward-looking cost curves for renewable technologies. All of those are becoming more prevalent and cost competitive.

"Five years ago, what may not have made sense from a renewable energy point, might make sense now... It's not the same environment that it was five years ago or that it will be in five years from now. That is having a big impact on the viability of renewable technologies in specific applications as costs continue to decrease."

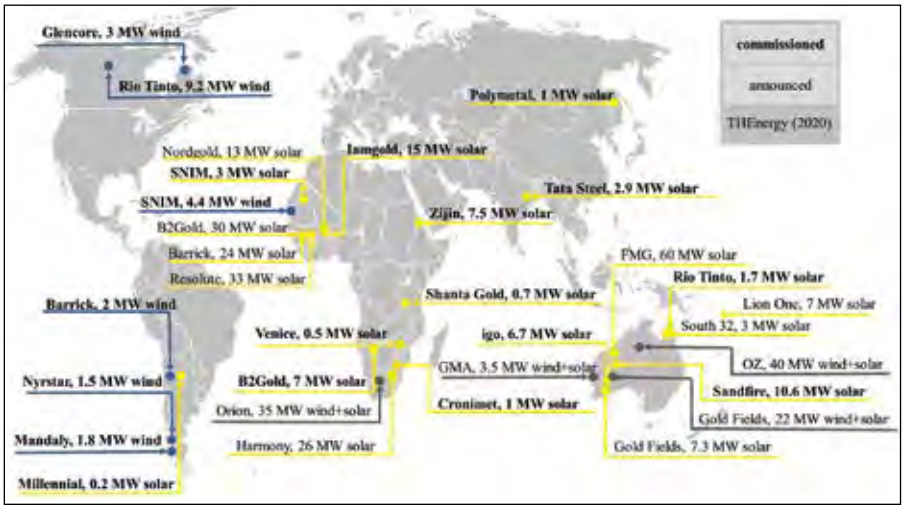
Building a Business Case

To learn more about renewables and how they can contribute to on-site power solutions for mines, *E&MJ* spoke to Dr. Thomas Hillig, managing director of THEnergy.

"The viability of renewables, from a cost standpoint, is linked to diesel pricing," he said. "Seven or eight years ago, everyone was talking about solar power for mining, the figures were really good. But then the price of diesel fell, and nothing worked. Even though there was an investment case on paper, the people who were driving the decisions were in a pretty comfortable position. And there was no pressure on them.

"During the past 12-18 months, we've seen a lot of pressure on mining decision makers to do something regarding renewables. Plannability and cost are very important for mine power supply. Whenever diesel contracts run out, then renewables become an option for cost improvement."

Renewable technologies require a different investment model than more



Map shows commissioned and announced on-site renewable power installations at mine sites globally. (Photo: THEnergy, 2020)

traditional sources of mine power. Technologies like diesel gensets and coal fired power plants require greater OPEX, factoring in the cost of diesel or coal. While for renewables like wind or solar, the business model is very much CAPEX driven. Companies must lay out for the generating equipment and storage capacity, or, in the case of power purchase agreements (PPAs), pay the electricity bill for the contract period upfront. Equipment warranties are generally in the region of 20-25 years, and there are very few associated operational or maintenance costs.

While the upfront cost for an onsite renewable solution can be staggering, in the long run, mines are distancing themselves from uncertainty in diesel or coal prices, and also the impact of regulations on carbon emissions.

The feasibility of such a long-term investment depend very much on the life of mine, its resource base and how long the mining company is willing to commit to a contract.

"Is that mining company in a position to sign a 20-year contract?" Hillig asked. "In some jurisdictions, you even have to put the power purchase agreement (PPA) on the balance sheet with commitments that are this long. There are no early exit clauses in these contracts. It's very different to committing to a two-year diesel supply agreement. If you don't use diesel you can store it. You cannot store solar electricity in the same way.

"The downside of technologies like solar is that it takes away some of the mining company's flexibility," he explained. "On the other hand, if there are no significant interruptions, the business case is very favorable. For example, for an off-grid mine in Africa, payback time can be four or five years or even less.

"If a mine experiences a significant interruption to operations, for example,

due to a pandemic, it's not the end of the world if it loses 2-3 months of prepaid solar generated electricity.

"If you want to build a 15-megawatt solar plant in say, Africa… not too remote (very remote locations carry extra logistics costs), pricing would be in the range of 4-6 cents per kilowatt hour (kWh) if you use the equipment fully over its lifetime. Compared to electricity prices from diesel that's very low.

"Even if you only use the equipment for five years, you would have a price of roughly 12-15 cents. Which is still very competitive."

There are also leasing options for mobile (containerized) solar plants, but these tend to be more expensive because the equipment cannot be utilized as fully — the price depends on the internal calculation of the renewable energy IPP and the expected lifetime of a mine.

"With mobile options there's a plan B if operations at a particular mine do not continue or, if a PPA is not signed or prolonged, then they have the theoretical option to relocate the solar plant. However, there are not that many projects out there to relocate to," Hillig stated.

"Right now, committing long term is difficult for mining companies. It's the solar business model that is not fully compatible with the mining business model really."

Risk Versus Reward

Solar is the most widely applicable on-site renewable option for mines at present and, when it comes to experience with the technology, there are two markets that are leading the way: Africa, with the exception of South Africa, because most of the mines there are grid connected and there is still no legislation to allow IPPs to sell electricity through the grid to mines. And the other is Australia, particularly western Australia and Queensland.

Because humans like to err on the side of caution, every renewable installation thus far has been a hybrid plant incorporating both diesel and solar/wind/hydro power to guarantee supply in all scenarios.

"Almost all the projects we see at the moment are pretty basic," explains Hillig. "They mostly do not have storage and the diesel always runs as a backup. So, diesel at a low load provides spinning reserve in case, for instance, a solar area is shaded during the daytime; the diesel engines don't have to be switched on, you just ramp them up to fill the deficit.

"The next step would be to add a little bit of storage and say, okay during sunny days, or during daytime, you switch the diesel gensets off and the storage is a bridge to back up. If the solar area is shaded, then storage is used for a couple of minutes to provide a buffer for the time that you need to restart the diesel gensets.

"The next step, which we don't see in mining at the moment, would be to add significant storage and run a mine 24 hours on renewable energy. To get there, you have to have 24 hours of energy supplied to a mine through solar or wind storage. It's a question of price and also seasonality. If you are in areas where, if you have plenty of rain and no sunshine for a couple of months, then you will always need backup gensets."

The viability of the final option depends very much on storage prices decreasing in the future. It also requires a significant element of trust; for mines to de-risk such a setup they would still require diesel capacity on site to provide a fallback in case the solar plant or storage technologies fail.

Superior Continues to Grow Mining Product Portfolio

In 2017, after several acquisitions and internal development projects, Superior debuted a new group of crushing, screening and washing equipment. These products joined an existing conveyor and custom plant portfolio to form a complete offering from Rock Face to Load Out®.

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About Superior Industries

Superior engineers and manufactures groundbreaking bulk material processing and handling equipment and cutting-edge machinery components. From its headquarters in Morris, Minnesota, the manufacturing firm supplies mining customers with bulk crushing, screening and conveying systems. In addition to its home plant in Minnesota, the 48-year-old Superior operates from additional U.S. facilities in Arizona, Georgia and Nebraska, plus internationally-based operations in Canada, Brazil and China.

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Dedication Runs Deep

Knight Hawk Coal and IWT partnership focuses on productivity, asset management and safety

Family-owned Knight Hawk has experienced growth and success, and it remains committed to the community and focused on safety and productivity.

In the mid-1990s, the once-thriving Illinois coal industry had been reduced to a shadow of its glory days. Demand for coal was flagging, and the large companies all but pulled up stakes in the region.

Four partners, Steve Carter, F.D. Robertson, James Bunn and James Bunn Jr., understood there were still markets for southern Illinois' high-quality, low-chlorine coal. In 1998, family-owned Knight Hawk Coal LLC was created, initially focusing exclusively on surface mining. In 2006, Knight Hawk opened its first underground mine and began a partnership with Arch Coal, which now holds a 49% interest in the company. Today, Knight Hawk runs a mix of operations, including five surface mines, one underground mine and two carbon recovery plants. The operations have grown from a crew of 17 to about 400 and nearly as many contractors. Knight Hawk produces more than 5 million tons of coal annually.

Despite growth and success, the company remains family-owned, rooted in the community, and focused on safety and productivity. In 2019, Knight Hawk purchased a communications and tracking system from Innovative Wireless Technologies (IWT). "Knight Hawk's procurement process was very thorough," said Brad Hartwick, IWT's Midwest mining sales director. "They asked the right questions, made a very comprehensive comparison of competitors, followed up with our references, and visited our headquarters. They wanted to be sure that our system fit with their operations."

"We really focused on the benefits and the total cost of ownership. We evaluated systems, aside of the cost, making a determination on functionality," Knight Hawk Mine Superintendent Tom Hasenstab said. "What does each system provide us? Are there advantages to the system in safety, production, and maintenance? Some systems we looked at were two-way; some were canned text only, or radio communications. You have to look at the backbone. How do companies invest in and maintain their technology? How much training is required?"

"Everything Knight Hawk believes in revolves around the concept, 'keep it simple,'" Underground Maintenance Superintendent Brian Wallace said. "The technology has to have a goal. It has to have safety, productivity and longevity to prove out. It's like buying a tool. You don't want to buy a tool you just use once and then it gathers dust. You want something that provides value day in and day out. It has to make sense and be the right fit for Knight Hawk."

"We spent a lot of time looking at communications and tracking systems to be sure we chose the right one for our culture and operations. We wanted to understand the functionality and options because every solution is different. We talked to people to be sure the technology could be used in multiple ways too as it was integrated into our system. After really researching the field, we chose IWT Sentinel because the technology was the best fit for our operations."

Wallace explained the challenge was to provide voice communication to each of the five units. Knight Hawk has miles of infrastructure underground, and efficient operations require keeping information flowing to every aspect of the operation from the surface to the underground, as well as the four-mile-long overland conveyor.

"Our system is battery RF-based," Wallace said. "There's no wiring involved. There's an external antenna. You can move equipment very quickly and efficiently."

IWT designed a system that allowed full, real-time, two-way communication between surface and underground operations. Installation finished ahead of schedule.

"It's amazing how fast and easy Sentinel is to integrate," Wallace said. "It took a lot of work on our part and IWT's part. We have a system that works very well. I am very proud to talk to people about how we can talk throughout operations, from our roof bolters to our prep plant."

"When we started looking at the IWT system, there was some concern that the ease of conversation might be used in an unproductive manner," Hasenstab said. "Our miners, however, have utilized the system in a very professional manner, leading to improved safety as well as productivity. The majority of the conversation is relevant to the job. We are very impressed with the way it immediately became a part of the way we work."

Improving Mine Efficiency

The Sentinel system has improved Knight Hawk's efficiency and profitability in a number of ways, according to Wallace. In the event of equipment failure or breakdown, maintenance arrives with the right equipment, reducing downtime. Incremental improvements in communication between operators have added up to significant improvements in production. Asset tracking allows for precise and immediate location of equipment. Sentinel provides tools to allow supervisors the ability to more quickly reply to an inspector's question. The improved communication adds up to significant time savings and real tonnage.

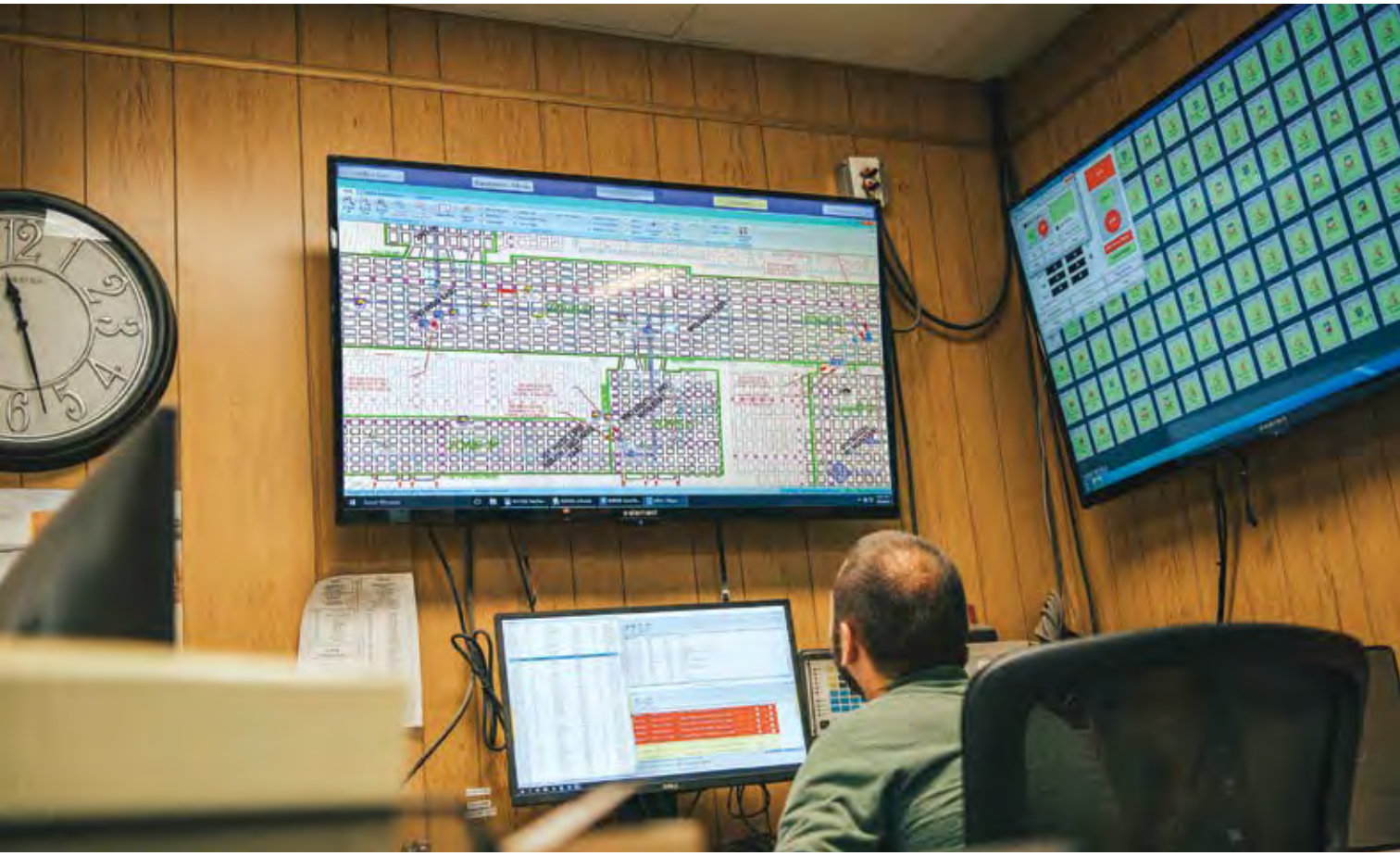
While production has to be a focus of every operator, safety is a cornerstone of Knight Hawk's success.

"Our attitude toward safety is about creating a culture," Hasenstab said. "Everyone is passionate about safety at Knight Hawk, including Knight Hawk President Steve Carter. He recognized the Sentinal system as a tool that would enhance the safety of the miners and assist in the creation of a culture of safety. Nothing is more important to him than our miners' safety."

"Mr. Carter says safety is 100% about putting a barrier between you and a hazard," Wallace said. "Whether it's a physical barrier or a technology."

A recent mine injury underscored the value of the Sentinel system. The Knight Hawk team's fast action saved a miner's life and the ability to communicate in real time gave the team an important tool in a critical situation.

"In an emergency situation like that, every second counts," Hasenstab said. "Sentinel gave us a system that allowed ev-



Coordination between paramedics underground and the central control room operator (above) on the surface allow them to transport an injured miner from the face to a helicopter in less than 30 minutes.

THE NETWORK EFFECT FOR BATTERY ELECTRIC UNDERGROUND MINING VEHICLES

Since the launch of its full-fleet electrification program back in 2015, MacLean Engineering has gone on to manufacture and commission over 30 battery electric mining vehicles (BEVs) – all now working underground in Canada, at ten minesites, across four provinces, with 50,000+ operating hours amassed to date. MacLean is building on this BEV 'network effect' as the push for diesel-free underground mobile fleets continues to gain momentum around the globe.

The company's approach to engineering battery powered mobile equipment for the underground mining environment starts with onboard charging, which has been integrated across the company's product suite of diesel-free units in the ground support, secondary reduction, and utility vehicle product categories. The onboard charging design philosophy behind the MacLean EV SeriesTM has been proven out in the years since the launch of the product line, as it eliminates barriers to introduction (no additional charging infrastructure required) and provides the highest degree of flexibility for production support duty cycle requirements in underground mining.

MacLean will be unveiling the next chapter in its BEV product development at the recently rescheduled MINExpo convention now slated for September 2021, building on the unveiling of one of its earliest battery powered units, a MacLean rock bolter, at the last MINExpo.

"A lot has changed around the world since MINExpo 2016, but the one thing that hasn't changed is the business case for the EV switch," noted MacLean VP of Marketing and Communications, Stuart Lister. "If the total cost of ownership of a battery powered MacLean unit compared to an identical diesel-powered unit is essentially identical over the full life of that mining vehicle, why wouldn't you make the switch to a zero emissions, low heat, lower maintenance option, one that performs just as well the diesel version?"

MacLean
Performance. Reliability. Innovation.

eryone to communicate efficiently. When we were evaluating communication and tracking systems, it was clear to us that voice was superior to text. It has absolutely proven itself."

Wallace said the IWT system was critical in assisting not just where the incident occurred, but in other areas as the facility responded to the emergency. For example, it could be communicated and confirmed that roads were clear. Information could be shared with the paramedics while they were in route. The paramedics could communicate with the surface and be sure that emergency transport vehicles were positioned properly. In this situation, the paramedics had to call in a helicopter and the Sentinel system helped them make sure that the transport was as efficient as possible. From the time of the incident until the miner was on the helicopter, only 25 to 30 minutes elapsed. Wallace said he didn't think that kind of response would have been possible with the old system.

"We work in one of the most hazardous environments of any industry," Wallace said. "We acknowledge that. But it doesn't give us an excuse not to have the best tools available to protect our people. It's important our industry understands how big an advantage voice presents in emergency situations."

Hasenstab and Wallace emphasize that the workforce and structure of Knight Hawk is unique because the company promotes personal accountability and the freedom and trust for people to make decisions that will benefit the company. The goal is to give as much responsibility to someone shoveling the belt as an executive.

"We have a saying that underground, a section face boss should have the easiest job in the mine because everyone should be trained and do their job properly," Wallace said.

Fine Tuning the Network

IWT continues to work with Knight Hawk to fine-tune the network and enhance features. "IWT has been quick to address situations," Wallace said. "They spend time after a call looking back at the history on the server, suggesting improvements to our process. It helps me look back to see if something is

The Sentinel system is MSHA (ATEX) approved and requires little or no maintenance.

equipment- or weather-related. IWT is very forward-thinking in maintenance and operation."

"With Knight Hawk, we are versatile and employees are always ready to step into multiple roles," Hasenstab said. "From the top down, people just simply do anything that needs to be done to make Knight Hawk a success. The coal companies that are likely to succeed in this market are those companies that are the safest and most productive."

Sentinel: IWT Communications and Tracking Solutions

IWT communications and tracking systems are designed for underground applications. Engineered to be highly reliable and extremely durable, the networks require little maintenance and make work safer and easier. Sentinel significantly outperforms Wi-Fi, leaky feeder and text-based systems. The reusability, expandability, stronger signal and low maintenance provide an overall lower cost of ownership, making IWT systems the best engineered choice in comms and tracking.

The Sentinel system delivers the features and benefits that matter most to mine safety and operations:

Features

- Scalable with software: tracking, text and tracking, voice/text and tracking;
- Crystal clear voice: choose from two handset models;
- Handsets and tags enable continuous tracking of people and assets;
- Battery- or line-powered wireless infrastructure;
- Up to 2,000 feet or more between infrastructure devices means less infrastructure is required; and
- MSHA and ATEX approved — Intrinsically Safe.

Benefits

- Low installation and maintenance costs;
- Reusability;
- No cabling in the working sections;
- Fastest section moves;
- Remote troubleshooting;
- Easy maintainability; and
- Seamless integration with other IWT products and services, allowing users to add to the system as needs change.

Deployment Scenarios

Sentinel provides wireless voice, text, tracking, atmospheric monitoring, performance metrics and much more.

- Coal mining, including longwall moves;
- Hard rock mining;
- Metal/non-metal mining; and
- Tunnels.

The rugged push-to-talk radios provide clear voice, text and tracking — all in one device. Tracking can also be achieved with small, battery-powered Tracking Beacons or with Tracking Tags depending on individual mine scenarios. Each device has emergency alert capabilities and reports back to dispatch to provide real-time, continuous tracking.

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The Hilliard Corporation has been a world leader in motion control, filtration technology, and braking systems since 1905. We are currently offering a line of caliper brakes under the trade name Hilliard Brake Systems. These brakes and braking systems broaden our product line offerings, which include a full line of mechanical clutches and electric brakes. As an established business for over 110 years with robust engineering and manufacturing strengths, this line of caliper brakes seamlessly integrates into our product mix. Hilliard will be offering complete custom turn-key systems as well as single components with the ability to replace all competitor products, while reducing length of lead times, and costs for our customers. This new venture opens global opportunities to sell braking products, as opposed to our current restriction to the U.S. marketplace only. This product mix for Hilliard translate into reduction of end-users' need to carry critical spares, reduce the costs of their inventory, as well as reduce downtime due to braking components. We are committed to this investment for the future by expanding our manufacturing capacity and service to the industry with our ability to respond to our customers' needs.

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- Amusement/Theater

The Hilliard Corporation makes thousands of unique products, reaching markets globally and serving the needs of both small businesses and Fortune 500 companies. We offer a broad line of motion control products, oil-filtration and reclaiming equipment, and plate and frame filter presses used in the food industry. We also manufacture starters for industrial gas and diesel engines and gas turbines. Our filtration systems are sold under the trade names of HILCO* and Star* Filters.

Our products are designed, manufactured, and sold according to our customer's applications. As a result, we have a large portfolio of custom engineered products that can be modified to meet new applications. At Hilliard, we embrace the challenge of product development. With over 500,000 square feet and more than 500 highly skilled employees, we are able to meet desired requirements cost-competitively, even for short runs. Our experienced technical staff values craftsmanship, manufacturing efficiency, and responsiveness - all of which result in increased bottom line for our customers.

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THEATRICAL / STAGE EQUIPMENT | CRANE HOISTS | MINE HOISTS | ELEVATORS | ESCALATORS | MARINE PROPULSION | MINING CONVEYORS | GENERAL MACHINERY
PAPER MILLS | TEXTILE MACHINERY | PACKAGING MACHINERY | POWER PLANT FANS | CONVEYORS | CAR SHREDDERS | GRINDING MILLS | KILNS | PAPER CONVERTING
WIRE PAYOFFS | STEEL PROCESSING LINES | AMUSEMENT RIDES | MATERIAL HANDLING | DRAGLINES | SKIP HOISTS | MINING CONVEYORS | MARINE | RAIL/CONVEYORS
MARINE/SHIPPING | WIND ENERGY | STEEL/METAL | BUCKET ELEVATORS | BARGE UNLOADERS | RAIL CAR DUMPERS | RAIL CAR POSITIONERS | PEOPLE MOVERS
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Market Traction Grows for Electric Mining Vehicles

Electric power can offer important energy efficiency and environmental benefits over diesel engines in mining applications

By Len Eros

The mining industry has generally taken a conservative approach to the adoption of new technologies. But the many advantages of electric power, combined with the desire of many mine and quarry operators to achieve "zero emission" operations, is driving the development of a new generation of battery electric trucks, front end loaders, drill rigs and excavators.

These new generation battery electric vehicles (BEVs) are adopting even smarter and more advanced technology to make the transition from hybrid diesel-electric designs toward fully electric battery-driven derivatives.

Current Benefits

Smarter converters, more compact motors, and more advanced batteries are bringing the performance of electric vehicles up to the level of their diesel counterparts, and in some areas are even surpassing them. Moreover, while diesel engines are the traditional standard for robust mining conditions, reducing the use of diesel fuel could have significant cost benefits for the industry. Currently as much as 40% of an underground mine's energy outlay is spent on powering enormous ventilation systems that are designed to remove airborne contaminates such as dust, gases and heat, and to supply clean air. When diesel engine heat and exhaust contaminants are added to the mine atmosphere, the ventilation requirements go up and ventilation costs are significantly increased.

In addition to energy efficiency, environmental concerns are another important driver. In Australia, a new report by corporate consultants BDO predicts that within five years, diesel machinery will not be used in new underground mines, and existing underground mines will have begun to phase them out. According to BDO, this push will come from the financiers of new mines and potentially from government bodies too, who may even choose to ban diesel machines from new underground mines because of the health issues.

In contrast to diesel, using regenerative drives and electric motors can help mine operators achieve a reduction in their energy consumption, heat and gas emissions, and ventilation requirements. BEVs increase energy efficiency by using regenerative braking to convert kinetic energy, during deacceleration, and potential energy, when controlling downhill speed, into electrical energy, which is then stored in the batteries.

Furthermore, the efficiency of using electric energy to power equipment is much higher than the efficiency from using diesel, so the amount of heat that an electric vehicle produces is much less. Diesel engines can, at best, achieve around 45% efficiency, whereas electric powertrains can reach energy efficiency of 90% or more with relative ease. The result is a 30% to 50% reduction in the load the mobile equipment is putting on the ventilation system resulting in lower energy costs.

This makes BEVs especially suitable for deep mines where there are high ground temperatures and the working areas can be difficult to ventilate because of their extreme distance from the main fans. In these applications, the added heat load from a diesel-powered machine makes it difficult to mechanize the mining process without increasing the ventilation requirements. Using a BEV with much lower heat emissions can make mechanization feasible, creating a safer work environment without increased ventilation costs.

The conversion of diesel-powered vehicles to battery powered is well proven in many other industrial markets and has been shown to provide numerous benefits. In many cities around the world, battery-powered buses utilizing rapid charging systems are replacing diesel-powered buses. The reduced CO_2 footprint lowered maintenance and power costs and increased user satisfaction continues to drive this conversion. In the automotive industry, the switch to EVs is in the early stages, but it is evident that it is gaining significant traction on a global level. The experience gained in these markets is directly applicable to the mining community and their conversion from diesel to BEVs.

These advances all drive down capital and operational expenditures, providing a substantial return on investment. Safety

In August 2018, Volvo Construction Equipment and Skanska began testing the viability of its Electric Site concept at Skanska's Vikan Kross quarry, near Gothenburg, Sweden.

is also improved through increased mechanization as well as the removal of flammable diesel fuel from underground. At the same time, the health of those working in the mines is improved by the absence of diesel exhaust emissions.

Charging Power and Underground Infrastructure

Maintaining the battery energy levels in BEVs during operation is done either by battery pack swapping or by fast charging systems. For example, with load haul dump vehicles (LHDS), battery pack swapping has been successful when there is not time in the duty cycle for stopping to fast charge. An example of where fast charging is working well is an electric drill rig, which uses battery power to travel between work locations and then uses the in-place electrical grid power for drilling and recharging. Which of these battery charging methods is selected depends on the application as well as OEM preference, but both are being used successfully.

Currently, one of the most important considerations is the charging infrastructure. The ultimate objective is to make recharging and operating battery electric vehicles as simple and convenient as refueling and operating diesel vehicles. Because modern methods of underground mining require high levels of electrical power in the working areas, it's possible to locate BEV charging stations close to the vehicles. But without careful consideration, it would be easy to end up with an array of incompatible charging stations throughout the mine.

In a recent development to meet the demands of particularly large mining vehicles, ABB is participating in defining a new combined charging system (CCS) standard in collaboration with automakers and other stakeholders as part of the Charging Interface Initiative (CharIN), the alliance that defines CCS charging standards. This will take charging capability up to 1 MW and even 2 MW.

Torque and Maintenance of BEVs

The electric drive is the core of the BEV propulsion system and enables sophisticated control of the vehicle. Advanced drives specifically designed for mobile equipment applications, such as ABB's HES880, monitor wheel speed and closely regulate the torque transmitted by the drive wheels. The speed and torque control reduce wheel spin under adverse conditions and provide improved vehicle traction. When tire slip is eliminated the vehicle becomes easier to control and safer to operate. And there are significant cost savings when excessive tire wear is eliminated.

Many BEVs are designed without drive train gearboxes as they produce the required torque with the motors directly powering the drive wheels. Eliminating the gearboxes traditionally used in diesel-powered vehicles provides another reduction in maintenance and operating costs.

A BEV provides the opportunity to decouple the vehicle drive train from the hydraulic system. On diesel-powered vehicles the hydraulics are powered by the engine. But on a BEV, the hydraulics are powered by an electric motor and can be controlled to precisely meet the power demands of the system with resulting higher efficiencies and reduced wear.

Advances in Drives and Motor Design

Along with the converters, the electric motors are also undergoing new developments. Factors such as space limitations, the increasing power demands from larger machines and increasing energy efficien-

To set a new world standard for sustainable mining at great depth, LKAB, ABB, Epiroc, Combitech and the Volvo Group have joined forces in a partnership to start a unique testbed in northern Sweden.

cy requirements needed to prolong battery life are all driving motor innovation.

In applications where high power is needed but space is limited, a water-cooled motor can be a good solution. Water-cooled motors and drives are very power dense compared to air cooled, meaning there can be power rating increases of 25% to more than 50% from the same size motor. Both open and closed loop cooling systems are used.

Design improvements that increase motor efficiencies are also in constant development. Benefits from this include extending battery life, reducing motor heat rejection and increasing the power rating without increasing motor size. Permanent magnet (PM) motors are very efficient designs and recent improvements have reduced their cost and improved availability. Challenges exist with PM motors in some mobile equipment applications, but it's an area of motor design receiving lots of attention.

Social and Environmental Impact

Diesel engines have constant vibration, high ambient temperatures and high noise levels. Electric vehicles (EVs), on the other hand, have significantly less noise and vibration and emit far less heat. These factors make it easier to operate, less fatiguing and less stressful for operators.

Switching to EVs improves the working environment in mines by removing diesel particulate and combustion gas emissions and reducing noise levels. At the same time, safety is improved by removing diesel fuel from the mine. In combination, low emissions, reduced noise and easier operation contribute to a healthier, safer and more pleasant work environment that ultimately helps reduce employee turnover.

To explore the advantages of electrification, in August 2018, Volvo Construction Equipment and its customer Skanska began testing the viability of its Electric Site concept at Skanska's Vikan Kross quarry, near Gothenburg, Sweden. The system, which incorporates electric and

autonomous Volvo machines, ran in a real production environment for 10 weeks — delivering an anticipated 95% reduction in carbon emissions and 25% reduction in total cost of operations.

New Standard for Sustainable Underground Mining

To set a new world standard for sustainable mining at great depth, LKAB, ABB, Epiroc, Combitech and the Volvo Group have joined forces in a partnership to start a unique testbed in the ore fields of northern Sweden. The project is studying the best ways to create an efficient autonomous production system that is both carbon-dioxide-free and with the highest safety levels.

The test bed project is called SUM (sustainable underground mining) and is located in LKAB's underground mines in Kiruna and Malmberget, Sweden, as well as in a virtual mine. ABB is contributing to this project with solutions for underground electrification and an integrated platform for collaborative operations. The SUM project will lay the foundation for decisions to be made into the mid-2020s for one of Sweden's largest ever industrial investments.

Optimized Electric Powertrain for Heavy Vehicles

An important new development for ABB is an optimized electric powertrain that enables heavy special and commercial vehicles, and especially mining vehicles, to transition to fully electric operation. The complete e-drivetrain solution includes the key elements — motor, drive and vehicle control unit — harmonized for maximum performance, reliability and energy efficiency. This approach enables ABB to work alongside vehicle OEMs to design a drive train that suits their specific application needs.

One of several customers to adopt this optimized electric powertrain is Epiroc, one of the world's leading suppliers of underground mining and infrastructure equipment. A number of Epiroc's second-generation battery-powered vehicles are using an ABB electric powertrain, including electric motors and HES880 Mobile Drives, for propulsion and auxiliary applications.

Many OEMs face the challenge that their drive-cycle and performance requirements vary greatly between applications such as drilling, loading and transporting materials. This can make it difficult for designers to identify the best choice in electric powertrains for their specific application. An over-specified e-drivetrain may cost more than necessary and carry a weight penalty. While an under-specified electric powertrain may not deliver the required power, could overheat and as a result will be unreliable with a reduced service life. When the OEM works with a single manufacture like ABB that provides a complete electric powertrain, there is a fast-track route to a solution that delivers both performance and total cost of ownership.

The electric mining vehicle revolution started to take off in 2016. The move to autonomous vehicles in both surface and underground mining operations is made much easier with BEVs whose control systems are highly compatible with autonomous vehicle control systems. The momentum will clearly continue to build as the energy-efficiency, environmental, financial and social benefits of electric power become ever more persuasive

Len Eros is the global mining manager for ABB Motion.

Seeking Balance Between COVID-19 Suppression and Worker Privacy

Miners are used to breaking new ground, whether as part of the exploration process or executing a pit-wall pushback, but the COVID-19 pandemic has thrust the industry deep into hostile and unforgiving territory where the wrong decisions can lead to calamitous consequences, in both human and business terms.

Working to maintain the necessities of business survival in the face of incomplete medical knowledge about the specific nature of COVID-19's symptoms, disease progression and standard treatment protocols — plus the absence of plentiful and reliable testing supplies — mining companies have been scrambling since early March to piece together strategies that ensure employee safety, preserve operational infrastructure and comply with government regulations in a tense environment complicated by workers' apprehensions, cultural distinctions and political pressure.

Few companies were initially prepared to deal with the pandemic. Most have had to hastily implement ad hoc methods for assessing and identifying employees that carried or had possibly been exposed to the coronavirus, and for containing the spread of the virus within the workforce and nearby communities. Some of these procedures may also have inadvertently violated employees' rights to privacy. As business consulting company PwC noted in a recent advisory bulletin, "A regulatory obstacle course has already emerged, with governments around the world issuing more than 60 directives regarding protecting data privacy while responding to the COVID-19 pandemic."

Following a comprehensive review of these directives and identifying the key components that regulators will look for in future pandemic-response plans, PwC suggested companies consider a three-phase approach for navigating the course: mobilization, stabilization and strategizing. For the mobilization phase, PwC recommends:

- Narrowly tailoring health-screening questionnaires;
- Designating authorized individuals to handle the questionnaires;

As mining companies gear up for gradual or full restarts at mine sites around the world, they'll need to pay attention to local and national policies governing the screening and testing of employees — what PwC calls a 'regulatory obstacle course' — to avoid violating workers' rights to privacy.

- Informing screened employees of their rights; and
- Not disclosing names of positive-testing individuals outside the response team.

For companies entering the stabilization phase, PwC poses the question: "To what extent can employers systematically collect information about employee morale or monitor their productivity?" The answer is that, as with many things, it depends mostly on the details of the monitoring and where it occurs. For example, employers in most Middle Eastern countries, as well as Brazil, China, Cyprus, Singapore and the U.S., can require employees to allow their productivity to be monitored, while in Russia, voluntary participation is permissible.

Employers in Colombia and the U.S. can require employees to take a mandatory, personally identifiable survey about their general level of energy or confidence in the company. In contrast, those in Australia, Brazil, Canada, Czech Republic and Germany must take a voluntary approach to identifiable surveys. In France, Hong Kong, India, Italy, South Africa and the UK, participation must be both voluntary and anonymous.

Companies will reach a point where they need to strategize about ways to allow workers and visitors to return to the site without endangering anyone. Again, it depends on location as to what strategies might work and what isn't permitted. The study noted that "Some companies are considering whether to require a 'health passport' — a certification from a physician or other healthcare source that the holder has tested negative to COVID-19 or

has not recently presented symptoms — to allow access to company facilities.

"This approach may work in countries such as Singapore, for example, where its Personal Data Protection Act allows employers to collect personal data through various means — and without employee consent — during public emergencies that threaten the life, health or safety of individuals," the report stated.

The same goes for instituting temperature checks at entrances to their facilities once they reopen, according to PwC. Multinationals could face difficulty adopting one approach globally. In China, the law requires that employers report on confirmed and suspected infections of a contagious disease to Chinese health authorities in a timely manner. Accordingly, employers are required to regularly and frequently conduct temperature checks on employees and workplace visitors, and they also can require employees to report any health issues to a team designated to handle workplace safety.

In the U.S., federal guidance from the Equal Employment Opportunity Commission (EEOC) and Occupational Safety and Health Administration (OSHA) permits employers to conduct temperature checks for use during a widespread pandemic before allowing them to enter a work site. Certain states and counties also have implemented orders or guidance that urges or requires temperature checks to be performed before workers are allowed to enter a site. International law firm Wilmer-Hale published a client advisory aimed at pointing out best practices for conducting temperature screening. Employers should:

- Communicate clearly in advance with their workforces regarding temperature checks and related implications (e.g., being sent home).
- Set a temperature screening threshold over which employees will not be permitted to enter the workplace. The CDC considers a person to have a fever when he or she has a measured temperature of at least 100.4°F; many employers have adopted screening thresholds in the 100°F-100.4°F range.
- Seek to facilitate testing in the least invasive way possible, including by attempting to procure devices that can register temperature without exposure to bodily fluids (e.g., no-contact thermometers).
- Appoint someone with proper training — ideally an on-site medical staff person or other medical professional if possible — to facilitate or administer on-site temperature checks.
- Maintain social distancing (e.g., by establishing multiple temperature check stations at large facilities to minimize crowding), clean and disinfect medical equipment, and take other COVID-19 related precautions.

The law firm advised that in light of the many complexities associated with taking employee temperatures, employers should carefully review the terms of local and state orders recommending or requiring temperature checks. If an employer elects to administer the tests, it should consider engaging a third-party healthcare vendor or other medical professional to advise on, and potentially run, such a program.

PwC also pointed out that it's likely mobile device app-based contact tracing, offering a way to find and warn people they may have been exposed to the coronavirus, will become more prevalent — if accepted by workers. These apps may be provided or administered through local health agencies or in some cases by employers or even cell phone product and service providers. Management considerations that should be regarded as mandatory for successful use of these apps include:

Getting employee buy-in. Workers need to be sold on the benefits that tracing will bring, even though use of the app may require them to get tested or retested, self-report the results and possibly be sent home to quarantine themselves.

PwC said employers may not need to take a mandatory approach to achieve that objective if they can win over employees with clear and frequent communications about how it all works, appealing to the worker's interest in helping to make the workplace safe and productive for everyone.

Keeping geolocation data anonymous and encrypted. Employees should be able to trust that employers, coworkers, neighbors, and hackers can't trace their whereabouts while using an app.

Not feeding data to government authorities. Exercise all available rights to keep the workforce data confidential in order to build and sustain employee trust.

Making everything temporary. The app and all of the data associated with it should be deleted once a company has returned to a predefined and communicated state of acceptable risk of contagion.

BHS Sends Biggest Mixer to India

The largest twin-shaft mixer ever built by BHS, with a capacity of 28,000 liters, is completed in August 2019 and installed at a mine in India before 2020. (Photo: BHS-Sonthofen)

BHS-Sonthofen reported it built, shipped and oversaw the installation of the largest Combimix mixer system in company history for a zinc miner in India. The company reported its high-quality customizable technology and support helped it win the contract.

The mixer will be used on overburden and filter cakes to create a homogenous mass, free of clumping, for use as backfill.

The customer sought a mixer offering a longer retention time and a filling level below the mixing shaft. BHS-Sonthofen said that, to meet the requirements, the company first did extensive testing. "With a throughput of 263 m^3/hr, we arrived at a retention time of about 137 seconds," Sebastian Poppel, design engineer, BHS-Sonthofen, said. "During this time, lumps are dissolved to our satisfaction thanks to the high-performance mixing unit."

The customer also wanted a solution that offered easy cleaning and maintenance.

Production of the unit was completed in August 2019, the company reported. It was transported on a ship. Installation occurred in late 2019 with the assistance of BHS-Sonthofen personnel.

Stage V Truck Tested at Tara

Sandvik said it is testing a Stage-V compliant TH663i truck at Boliden's Tara mine in Ireland.

Sandvik reported it is testing Stage V-compliant engine technology at Boliden's Tara underground mine in Ireland. (Photo: Sandvik)

Sandvik said the tests are to iron out kinks prior to commercial production of the engine technology, which could be used with other truck models.

"Based on the feedback that we receive, we are able to do some modifications if necessary and thereby make sure the TH663i meets expectations when it is released to the market with the latest engine technology at a later stage," Pia Sundberg, product line manager, trucks, Sandvik, said. "There is also some new technology on the test truck that we are testing at the same time."

The new engine system includes built-in fire prevention solutions, increased wiring protection with shrink mesh wiring harness and electric hardware resistant to corrosion, heat and water. The new engine requires ultra-low-sulphur fuel and low-ash engine oil.

The test TH663i is equipped with Sandvik's Automine for Trucks, which enables autonomous truck haulage underground and on the surface.

MINExpo Postponed to 2021

The National Mining Association (NMA) postponed MINExpo INTERNATIONAL 2020 until September 2021 due to the coronavirus (COVID-19). The NMA said its highest priority is the health, well-being and safety of exhibitors, attendees, stakeholders and their respective families and colleagues, as well as event partners in Las Vegas, Nevada (U.S.), and the pandemic has made holding MINExpo in September 2020 impracticable.

The NMA said it is working with event partners to identify and secure exhibition facilities and hotel accommodations in Las Vegas for a successful MINExpo INTERNATIONAL 2021. Once logistical arrangements have been confirmed, new dates will be announced.

More information about MINExpo will be posted on the show's website.

Epiroc Exits Shotcrete Biz

Epiroc announced it is ending its concrete spraying business in 2020.

Epiroc described the move as a natural part of product life cycle management. "We are constantly reviewing our customer solutions offering to ensure we keep Epiroc strong and agile for the future," Sarah Hoffman, vice president, marketing, underground, Epiroc, said. "We will phase out the concrete spraying line within 2020 while evaluating other alternatives for this portfolio."

Epiroc makes six concrete spraying products. The MEYCO business was acquired in 2013.

The company reported it would "ensure a minimum impact on customers with concrete spraying equipment and will fulfill its obligations," to include warranty and support services.

Outotec, Metso Merger Gains Ground

Outotec Oyj and Mesto Corp. received unconditional merger control clearance from the European Commission.

Previously, the merger was cleared by competition authorities in Canada, Chile and Turkey.

Outotec and Metso reported the merger will be complete on June 30.

Two HD605-8 trucks with Metso bodies, described as up to 30% lighter than the OEM bodies they replaced, were delivered to a quarry in Belgium. (Photo: Metso)

Separately, Metso announced the commencement of full-scale tests of the Metso VPX tailings dewatering filter at its facilities in Sorocaba, Brazil.

The unit will process ore from several operations in Brazil and Latin America. The testing seeks to prove the unit's capacity at processing high volumes, Metso reported.

"Tailings dewatering is technically and economically a viable option for today and the future," Rodrigo Gouveia, vice president, tailings management systems, Metso, said.

"Dry stacking is widely acknowledged to be the safest and most sustainable option for tailings storage," he said. "We see that there is a strong demand for short- and medium-term technical solutions."

The unit could be deployed for applications at legacy dams. "We can develop projects for the dredging and concentration of the tailings," Fausto Rezende, sales director, tailings management systems, Metso, said. "In many cases, it is possible that this operation is more economically viable than virgin ore."

In mid-May, Metso announced a mega-size press is being installed by a dedicated team at its Trelleborg factory in Sweden. The press will offer increased production capacity and expand the range, sizes and types of products manufactured. The press, the first in a series of three with a total value of $10.8 million, can produce mill lining wear parts that weigh up to 8 tons. The installation team is being supported remotely. Metso said the press will give the factory greater flexibility to meet customer needs. "For our customers, the ability to acquire and use larger, high-quality consumables in the process enables a longer operating time and reduces the time required for maintenance work," Sami Takaluoma, president, consumables business, Metso, said.

In late-May, Metso reported two HD605-8 haul trucks with Metso Truck Bodies were delivered to a quarry in Brabant Wallon, Belgium. The bodies are lighter, round-shaped, and feature Trellex rubber linings. They offer up to a 30% lighter body without sacrificing rigidity. That translates to up to 10% additional payload capacity and greater efficiency, Metso reported. The units are the first Metso truck bodies delivered to an operation in Central Europe.

CPS Delivers 72,000 Idlers to Pilbara

CPS Conveyors reported it designed, engineered and fabricated the all-composite idlers for two roughly 26-km conveyors at BHP's South Flank in the Pilbara.

One conveyor runs almost straight north from PC1. The other forms a long curve from PC2 to the transfer station located 2 km south of the coarse ore stockpile.

The conveyors are made from around 24,000 separate conveyor frames, assembled into modules. They are comprised of roughly 14,000 0.5-mm high-tolerance carry idler frames, and around 72,000 of CPS's Yeloroll HD composite rollers.

Unique to this particular project is the 220-mm diameter composite center roll, specifically designed for BHP to further reduce power draw along the conveyor through optimized geometry and material selection, CPS reported.

Design work started in 2017. Fabrication started in July 2019.

CPS said the idlers were completed on time, in April 2020, and within budget. "We believe this is one of the most advanced, reliable and cost-efficient overland conveyors in the world," Matt Einhorn, chief financial officer, CPS, said.

The project was "the single-largest project undertaken by our business," he said. It "required CPS production facilities to run over two shifts for almost 10 months and employ more than 50 additional local staff."

PYBAR Completes Decline Project

PYBAR Mining Services announced the completion of the Warraga Decline Project at Cowal Gold. The project spanned 10 months, the company reported.

Roughly 2,600 meters (m) and roughly 204,000 metric tons (mt) were mined underground, at a 6- x 6-m decline.

Project management described the work completed as a great job. "We can take satisfaction in delivering a high-quality service to our client," Mick Neill, project manager, Cowal Project, PYBAR, said.

The project was completed safely, under budget and by deadline, PYBAR reported.

PYBAR reports the Cowal Project successfully ended on time and under budget. (Photo: PYBAR)

10-m Elevated Thickener Built in Oz

McLanahan reported it completed a 10-meter (m) elevated thickener for managing gold leach tailings at a pure-play gold operation near Bendigo in Victoria, Australia.

A partner consultant specified material and design aspects. Due to the highly acidic and corrosive process streams, a specific sealant was procured for the thickener flanges, McLanahan reported. Coating integrity was proven by, among others, pinhole and holiday testing.

The thickener features integrated lifting attachment points, a completely match-marked assembly system, integrated electrical cable trays and conduits, a local marshaling panel readout of all instruments complete with trending and status, and integrated product sampling points at multiple locations.

The unit was designed in-house at McLanahan's location in New South Wales, Australia.

McLanahan attributed the success in part to having local engineering capability and support. "We felt that a local manufacturer and relatively low overall delivered cost solution would be the best fit for the client," Richard Williams, global product manager, McLanahan, said. "Modular design provides the flexibility to manufacture in more locations and provides more certainty around time-sensitive projects."

RPMGlobal, Modular Mining to Deliver API

RPMGlobal and Modular Mining extended their partnership agreement to deliver an Application Program Interface (API).

The new API will allow information to flow between systems in a computer language that is universally understandable. It is part of an integrated solution designed to close the gap between mine production planning and operations to boost productivity.

RPMGlobal said the API was a key part of the company's enterprise-focused strategy. "The API formalizes a substantial amount of integration work that has been completed since the original partnership was signed," Paul Beesley, chief technology officer, RPMGlobal, said.

"Importantly, this API will support business process improvements for cost-focused miners where a small productivity improvement can translate to considerable bottom line improvements," he said. "In this instance, we are using enhanced collaboration to connect our XECUTE solution with Modular's ProVision High-Precision Machine Guidance system."

XECUTE is RPMGlobal's short-term scheduling solution that connects planning with other departments within a mining operation.

The partnership dates back to April 2016.

Robotics Startup Picked for Innovation Studio

Exyn Technologies announced it is one of the startups selected to participate in Innovation Studio, a 12-month program man-

Footage from an Exyn Technologies A3R drone that is mapping a previously inactive mine. (Photo: Exyn Technologies)

aged by partners Vimson Group and New Lab to develop and pilot new technologies.

Exyn develops autonomous aerial robot systems for complex, GPS-denied environments, to include underground. Applications include development of 3D maps of drifts and stopes, asset location monitoring and mine rescue.

Exyn said the Studio is an opportunity to work with other startups to advance solutions that speak to the foremost issues in mining, like safety, efficiency and data optimization. "We are privileged to be one of the startups invited to join this innovative program," Exyn CEO Nader Elm said.

The focus of the Studio is on enhancing sustainability and closed-loop production, environmental sensing, worker performance and safety, mineral extraction and energy efficiency, and data optimization.

During the program, teams will be matched with resources, giving them the opportunity to fast track development. The teams will also have access to New Lab expertise.

Immersive Awards Badgad's Training Success

Immersive Technologies announced the winner of the 2019 Global Business Improvement Award to be Freeport-McMoRan's Bagdad Operations in Arizona (U.S.).

Previously, the miner partnered with Immersive Technologies on improving per-hour production by reducing load times. With the help of training simulations, the miner achieved a 12% reduction in loading times.

The operators that received the training outperformed control group operators by 19%.

Leadership at the mine said the supplier's simulators helped identify and implement process improvements for greater efficiency. "Our partnership with Immersive Technologies has created a strong team focused on the success of our people and creating value for our business," Freeman Myers, technical training superintendent, Bagdad mine, said.

The other finalists were Codelco's Radomiro Tomic copper mine in Chile and Roy Hill's iron ore operation in Western Australia.

The miners were selected for achievements in continuously improving operational safety, efficiency and productivity through strategic simulator-based training initiatives.

Above, training in an simulator helps Bagdad mine identify needed process improvements. (Photo: Immersive Technologies)

Tips on Using Belt or Apron-Feeder Magnetic Separators With Suspended Electromagnets

By Chris Ramsdell

Strategic placement of a suspended electromagnet can be critical to protect belt- or apron-feeder equipment in high-tonnage plants, according to magnetic separation technology specialist Eriez.

When mineral processing plants producing copper sulphide concentrates and oxide leaching feedstocks began to exceed the operating tonnages of traditional installations, it created a need for larger capacity belt conveyors and apron feeders. Eriez would like to share its knowledge about these types of installations, especially those in which suspended electromagnets are used.

Apron Feeder Magnets

Apron feeders are slow-moving, heavily loaded conveyors that feed a controlled stream, typically a deep bed of ore from a bulk holding location or bunker to a large capacity crusher. Because apron feeders use sprockets and caterpillars, they are replacing belt feeders that use rubber belts with motorized head pulleys to convey the material. We have found the damage to belts and clogging of transfer points from tramp iron now require larger magnetic separators.

Removal of tramp metal can prevent these serious problems. Corrective action is important for two reasons:

- Removing tramp iron early in the ore stream protects downstream equipment from potential costly damage.
- Installing apron feeder magnets before the primary large capacity crusher enables better operating efficiency in secondary and tertiary crushing steps (made up of multiple parallel units) since tramp metal is removed at the onset.

Suspended Electromagnet Protection

Belt and apron feeders have been successfully protected by suspended electromagnets in many industrial applications for years. The sprockets and caterpillars for apron feeders must be nonmagnetic, preferably made of iron with a high manganese content. The nonmagnetic caterpillars — which are typically specified by the customer — should come from the same manufacturer as the apron feeder.

When using a conveyor belt, the shell of the head pulley should be nonmagnetic stainless steel. When feeding pebbles, the head pulley should also be nonmagnetic.

For primary crushing applications in which the ore is normally sized 15.2 to 20.3 cm (6 to 8 in.), the main purpose of the suspended electromagnet is to protect the belts and to avoid the clogging of the chutes. Tramp iron measuring less than 10 cm (4 in.) is not typically harmful to the belts or chutes, so electromagnets are set to capture only the larger pieces of tramp iron.

For copper sulphides processed in SAG mills, downstream suspended magnets are not required after the belt or apron feeder magnets because there are no secondary and tertiary cone crushers. For oxide leaching plants, manual or self-cleaning standard magnets are used on belt conveyors to remove tramp metal after the primary crushers, but before the cone crushers and the leaching piles.

To remove tramp iron smaller than 10 cm (4 in.), a nonmagnetic shell pulley is required, especially for pebble applications. For example, at Chile's Chuquicamata, Pelambres, Esperanza mines and the Antamina mine in Perú, the shell of the pulleys are nonmagnetic.

Belt feeders are used more often at the discharge end of suspended electromagnets because apron feeders are historically more expensive and have limited application (mainly for minerals larger than those found on belt feeders).

For apron feeders in current use, the customer or supplier is not always willing to change the existing magnetic caterpillars to ones that are nonmagnetic.

It is imperative to strategically place a suspended electromagnet to protect belt or apron feeder magnetic separators in mineral processing plants providing copper sulphide concentrates and oxide-leaching feedstocks on high tonnage installations. It is critical to select either a belt or apron-feeder magnetic separator to handle larger capacities.

Chris Ramsdell is product manager of magnetic separation at Eriez.

First Cobalt Considers Refinery Expansion

First Cobalt Corp. reported recently that it received positive results from an independent feasibility study conducted on its permitted cobalt refinery in Ontario, Canada. The study, according to the company, envisages expanding the existing facility and adapting it to produce cobalt sulphate, a component in the manufacturing of batteries for electric vehicles.

The refinery is located north of Toronto, Canada. It was permitted in 1996 with a nominal throughput of 12 metric tons (mt) per day and operated intermittently until 2015, producing a cobalt carbonate product along with nickel carbonate and silver precipitate. The facility is located on 120 acres, with two settling ponds and an autoclave pond. The current footprint also includes a large warehouse building that once housed a conventional mill.

First Cobalt said testing of third-party cobalt hydroxide in 2019 using the refinery flow sheet confirmed suitability of cobalt hydroxide as a source of feed to produce a high purity, battery grade cobalt sulphate. In July 2019, First Cobalt and Glencore AG agreed to a partnership framework providing for a phased approach to recommission the refinery. Subject to certain conditions, including the completion of a positive feasibility study and agreement upon commercial terms, the framework agreement contemplates that First Cobalt will treat cobalt feed material supplied from Glencore's DRC operations for an initial term of up to 4.5 years on a tolling basis, with Glencore providing up to 100% of the capital required to recommission and expand the facility. The objective is to produce approximately 25,000 mt/y of cobalt sulphate.

Ausenco Engineering Canada Inc. completed two studies: (1) a prefeasibility study on an interim recommissioning of the refinery by late 2020 or early 2021, and (2) a feasibility study on an expansion scenario to 55-mt/d nameplate capacity, targeted for commissioning in Q4 2021. The strategic objective is to achieve 5,000 mt/y of cobalt production (55-mt/d nameplate, 50-mt/d average), which would account for approximately 5% of the current global refined cobalt market.

The main refinery gallery in the building complex currently houses the pressure oxidation circuit, solvent extraction circuit (SX), product filtration and a control room. The proposed new layout adds two new structures to the main complex; one for tailings belt filters and the other for crystallization and product bagging. A new external building is also contemplated to house an expanded SX circuit and sodium management infrastructure. Other changes to the site layout include additional tankage for reagent storage in the tank farm area and improvements to the ring-road around the refinery to accommodate transport trucks.

First Cobalt plans to expand an existing cobalt refinery's capacity from 12 metric tons per day throughput to 55 mt/d. Plant feed will come from Glencore's operations in the Democratic Republic of Congo, where cobalt is obtained as a byproduct of copper mining.

An adjacent 80-acre tract held by First Cobalt will be used for a new dry stacked tailings management facility. Tailings from the process are a gypsum that can be dewatered and stacked for permanent dry storage, according to the company.

The study describes the intended plant modifications: Cobalt hydroxide feed material will arrive in bulk bags that will be emptied into a re-pulping system. The slurry is then leached with sulphuric acid under atmospheric conditions. Slurry exiting the leach tanks is pumped to the neutralization circuit where limestone is added to raise the pH and precipitate impurities such as iron. To minimize downstream scaling, the slurry is cooled to 30°C-35°C in a cooling tower, which reduces soluble gypsum content. The precipitated solids are removed through thickening and filtration.

Prior to SX, the solution is reheated to raise gypsum solubility and prevent subsequent precipitation in the mixer settlers. The first SX circuit will remove manganese, copper, zinc, calcium and iron. The extraction raffinate after this step primarily contains cobalt, with nickel and magnesium present as impurities. The strip liquor reports to effluent treatment, where the impurities are precipitated and removed from solution prior to discharge.

The second SX circuit loads cobalt on to the organic solvent while any residual impurities remain in the aqueous phase. The cobalt-loaded organic then proceeds to the scrubbing mixer-settlers where the pH is adjusted to remove impurities such as magnesium and nickel that were loaded in the extraction stage. The scrubbed organic goes to a final stripping stage where the pH is lowered to bring the cobalt out of the organic phase and into the aqueous strip liquor stream. Once filtered to remove entrained organic, the strip liquor enters the crystallization step.

The filtered strip liquor is pumped to a mechanical vapor re-compression forced circulation crystallizer. The crystallizer functions by evaporating water using steam in a heat exchanger, supersaturating the cobalt-rich strip liquor and causing crystallization to occur. The bleed stream of cobalt sulphate crystals reports to a thickener and centrifuge for dewatering. Together they separate the solid and liquid components of the slurry, producing a dewatered product at <3% free moisture. The centrifuged crystals then report to a fluid bed dryer to reduce the moisture content of the crystals to below 0.2% w/w. Once dried, the final product is bagged and is ready for shipment to the end customer.

Stage V Underground Truck

GHH reported the new 45-metric ton (mt) MK-42 dump truck offers a 24-m^3 dump volume, "maximum drive power, great turning radius, large dumping angle, and excellent ergonomics and safety." The MK-42 comes with a Stage V 460-kilowatt (kW) Mercedes OM473 engine as standard. Tier 3 and 4 versions are available. Volvo TAD1651 or 1671 engines are also available.

With Kessler axles and with a Dana 8000 series converter and gearbox combo, the model is designed for use in harsh underground environments. At 3 m wide and high, and 10.5 m long, it is "surprisingly compact," the company reported. It offers a "large dumping angle" of 68° for high efficiencies and optimal cycle times.

The cab is rollover and falling object protection certified and designed to be spacious, quiet, pressurized and air conditioned, GHH reported. It comes with trainer seats.

The MK-42 is best paired with the LF-14 Loader for three-pass loading. The company offers consulting, aftermarket support, parts sales and technical training.

Currently, the truck is available in Russia. Global sales will follow further testing, GHH reported.

www.ghh-fahrzeuge.de

Command Users Haul 2 Billion MT

Caterpillar reported in April that trucks using Cat MineStar Command, combined, had hauled 2 billion metric tons (mt), a doubling of the tonnage hauled as of November 2018.

Command-equipped trucks have driven over 67.6 million kilometers without a lost-time injury, the company reported.

Those achievements were made possible in part by the company improving the speed of implementation, Cat reported. "We're launching Command on more sites and implementing it more quickly, so more of our customers can experience the safety and productivity gains that autonomous hauling delivers," Sean McGinnis, product manager, MineStar Solutions, said.

Caterpillar has 276 autonomous trucks in operation, the company reported.

Separately, Cat added Edge to the MineStar suite. The cloud-based solution is a platform for multiple parties to manage information and build decisions based on data assimilated from separate areas or silos.

Edge automates data collection. It employs artificial intelligence and machine learning for pattern identification.

Combined, the capabilities enable leadership to focus on decisions to improve operations, instead of on collecting and interpreting data.

Edge is a subscription-managed application.

www.cat.com

Complete Screening Solution, Guaranteed

Sandvik released its Peak Screening offering, described as a complete screening solution that includes the screen, screening media and service program.

With the release, the company introduced three new ranges of modular screens that were designed to be maintenance friendly, versatile, reliable, and faster to deploy and operate.

Under a Peak Screening agreement, the customer would be qualified for one of the new screens, screening media, including the WX6500 tensionized rubber screening media, and a service package.

Sandvik guarantees its screening solutions will achieve key performance indicators.

The concept reflects the company's commitment to solving customer needs, Sandvik reported. "We want to help customers benefit from the competitive advantage Peak Screening can provide, while establishing it as the defining screening performance standard of our industry," said Mats Dahlberg, vice president, lifecycle service, stationary crushing and screening, Sandvik.

Separately, Sandvik launched the Guide Adapter, which reportedly can reduce top hammer hole deviation by up to 50%. The solution is designed to help customers achieve greater productivity, longer tool service life and improved safety.

In-depth bench drilling tests showed the solution limited deviation to between 3% and 5%, which is a reduction of up to 50%. It helped to increase the service life of rock tools by up to 40%, Sandvik reported.

The Guide Adapter is available for T51 and GT60 Top Hammer threads in different diameters.

www.rocktechnology.sandvik

Minetruck Updates Nix Emissions, Up Efficiency

Epiroc reported the Minetruck MT65 has been updated to meet Tier 4 and Stage 5 emissions requirements and is CANMET and MSHA certified. NOx and diesel particulates have been lowered by 45% and 80%, respectively, over the Tier 2 model.

The updates include the new Ejector dump box option for compact envelop applications. The modular design is a pin-on solution that attaches to the load frame, the company reported.

A load-weighing display is optional and helps the operator determine if the truck is fully loaded. The data can be used by the company's telematics system, Certiq.

Combined, the updates should help miners improve safety, sustainability and production efficiency, Epiroc reported.

www.epirocgroup.com

Compact, Rugged Motors

ABB reported the AXW 5000 and 5800 motors offer more horsepower per pound than conventional enclosed fan-cooled motors but with a smaller frame size. The motors are ideal for compact installations.

Listed advantages include higher power densities, smaller footprint, noise reduction, and constant cooling on variable-speed drive applications, ABB reported. With a cooling water jacket surrounding the motor, the AXW unit is optimal for continuous operations in harsh, contaminate-filled environments.

The main terminal box and auxiliary box can be installed in several positions for simple installation and efficient maintenance, the company reported. The rigid frame design increases stability so the motor has very low vibrations and can meet strict specifications.

The motors are available with up to an IP56 rating.

www.new.abb.com

Small Crusher Cuts Costs, Ups Production

Metso introduced the Nordberg HP900 Series cone crusher, which, the company reported, is built to increase performance while reducing CAPEX.

The unit is an upgrade to its predecessor, the HP800 cone crusher. Roughly 80% of the parts are compatible between the two models. The HP900 comes with improved kinematics, raised pivot point, and a power increase, which leads to a 15% capacity increase, the company reported. It features a new lubrication system.

The unit is delivered preassembled, pre-wired and factory tested. Installation time is reduced by 50%, Metso reported.

The crusher allows passage of tramp iron. Top service access to the head, shaft, eccentric and other major components make disassembly safe and easy, the company reported. "Metso wear parts can be replaced up to four times faster than similar cone crushers."

The crusher comes standard with Metso's IC70C automation system.

Separately, Metso released the Megaliner for discharge systems, which reportedly speeds up grinding mill relines by up to 50%.

The solution enables the company to offer Megaliner for all sections of horizontal mills: the head, the shell and the discharge system.

Megaliner for discharge systems integrates dischargers, grates, lifter bars and filling segments in one unit. Therefore, it has up to 70% fewer parts. That means quicker and safer changeouts, the company reported.

It has a minimal number of attachment points. The bolts are inserted from the outside of the mill. Maintenance work can be done on steady, safe platforms.

Liner bolts are shorter and protected from dust, corrosion and general mechanical damage, making them longer lasting and easier to remove.

Megaliner is suitable for large AG, SAG and ball mills.

www.metso.com

Modular Aggregate Crushing Platforms

Superior Industries announced Fusion Modular Platforms, pre-engineered modular plants for aggregate crushing, sorting, sizing and washing. The plants are designed to be scalable and expand with the work site, the company reported.

Offerings include jaw, cone and impact crushing platforms, horizontal screening platforms, with two-, three- and four-deck models, and a group of traditional washing and modern low-water washing platforms.

The platforms are meant for customers that want scalability and flexibility; convenient installation and dismantling; and seamless integration with other Superior crushing, screening, washing and conveying machinery.

The platforms offer earlier commissioning, reduced launch costs and relatively simple shipping, Superior reported.

www.superior-ind.com

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Dewatering Pump Moves 1,400 GPM

Thompson Pump debuted its 6-in. rotary wellpoint pump, which features high air handling, water volume capabilities of up to 1,400 gallons per minute, heads of up to 80 ft, operating speeds of up to 2,000 rpm, and a low-horsepower Tier 4 Isuzu engine.

It is designed for wellpoint and sock dewatering applications.

The unit was created to meet high demand and expand the rotary pump series, the company reported. In the series is an 8-in. and a 12-in. rotary wellpoint pump.

www.thompsonpump.com

Set Preassembled Sprockets to Cut Torque

U.S. Tsubaki Power Transmission LLC launched the Torque Limiter Sprocket, a complete assembly. The device provides a powerful and long-lasting torque-limiting solution, the company reported.

Springs, bushings and sprocket come preassembled so customers can install it into the shaft, set the torque limit and move on.

The unit is designed to improve both the customer-ordering process and installation experience over the existing line of Tsubaki Torque Limiters, the company reported.

www.ustsubaki.com

Satellite Connectivity for PTT, Data

Cobham SATCOM launched the EXPLORER 323, a satellite terminal that can be mounted on vehicles to support connectivity anywhere in the world. While offering 99% uptime, it can be used to provide access to the Broadband Global Area Network (BGAN), real-time GPS and telemetry, and push-to-talk (PTT) capabilities.

Supported by EXPLORER, a new Inmarsat Global Government BGAN PTT solution can be seamlessly switched between UHF, VHF, 3G, 4G, and satellite for secure data and communications, the Inmarsat reported. It provides voice, data and streaming services regardless of the situation or conditions on the ground, the company reported.

EXPLORER is equipped with an integrated transceiver and an auto-tracking antenna, and uses one cable to connect power and Ethernet.

The EXPLORER integrates easily into existing radio equipment, the company reported. Inmarsat BGAN PTT can be integrated with existing radio and data networks.

www.inmarsat.com /www.cobham.com

Programmable Logic Controller on a Chip

Divelbiss Corp. announced the second-generation P10 PLC on a Chip, an embedded, single-chip, programmable logic controller. The chip has similar capabilities and performance as the larger P13 PLC on a Chip but in a LQFP144 package.

The chip can be added to any embedded application with no low-level programming required. It has a temperature range of -40° to 85°C and can be embedded in electrohydraulic and mobile equipment, motor drives, telematics, remote field applications and more.

www.divelbiss.com

Microchipped Cable for Inventory Planning

Nexans AmerCable introduced RFID-embedded SHD-GC mining cables. With a small string of passive RFID chips woven into the cable's core prior to jacketing, Nexans AmerCable gives customers the ability to access real-time cable information for inventory management and planning.

Using a scanner and the Nexans Smart Inventory Management (SIM) app on a smartphone, the user can access identification data, repair history, technical data, repair manuals and other important information. History can include damage incidents, repairs and post-repair data. SIM information is easy to access and share, the company reported.

The RFID chips are programed prior to shipping.

nexansamercable.com

Tough Steel Alloy Wear Liners

Tricon Wear Solutions introduced its new high-grade steel alloy Tri-Tuff wear liners, which offer a combination of strength and toughness. The alloy gives users the choice of reducing weight, with thinner liner packages, or increasing wear life, with thicker liner packages.

The liners are available for any model crusher, infeed/outfeed, and convey/bin system. Available up to 3-in. thick, the liners can be customized to any size or shape.

www.triconwearsolutions.com

Vest Cools Core

StaCool Industries announced the StaCool Vest Core Body Cooling System, made from Airprene material and with ThermoPak inserts.

The vest provides up to three hours of cooling per ThermoPak. It comes with four packs.

The vest can be worn either under or over clothing. It weighs less than 5.5 lbs with ThermoPaks installed. It zips up the front, and is available in fire retardant materials.

www.stacoolvest.com

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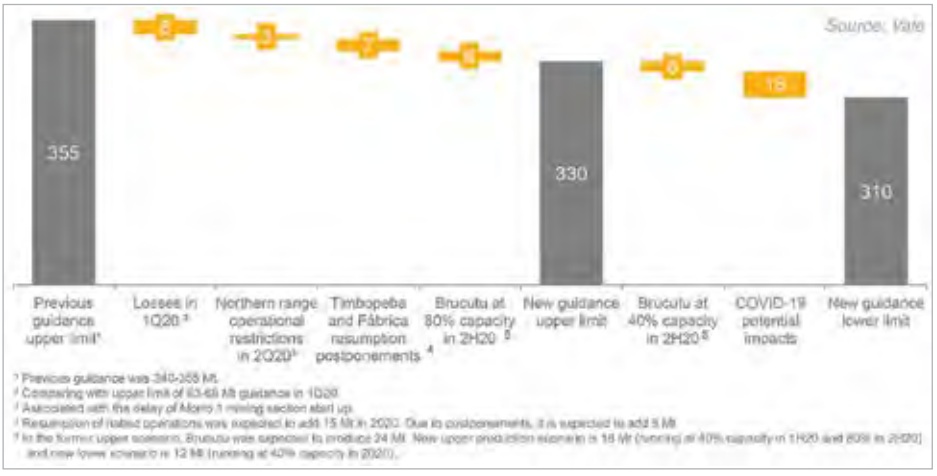
Iron Ore Prices Climb Along With Brazilian COVID-19 Cases

Iron ore prices were approaching $100 per dry metric ton (dmt) after Vale was forced to suspend operations as more of its miners contracted COVID-19. A Brazilian court issued an order to halt mining at the Itabira complex after nearly 200 miners reportedly tested positive. The *E&MJ* Price Index (below) shows iron ore prices increased $15.48/dmt during May to $97.98/dmt.

Vale said it suspended activities at the Itabira mining complex, which includes the Conceição, Cauê and Periquito mines, to comply with a decision issued by the Regional Labor Court of the 3rd Region of Minas Gerais. The company said the ruling will remain in effect until it receives a judgment on the merits of the action or until the implementation of control measures to protect miners from COVID-19 satisfies labor inspectors, under a possible daily penalty of R$500,000 ($100,000).

With most of its population residing in urban centers, the number of COVID-19 cases in Brazil is now reportedly second only to the U.S. This is the latest in a string of supply disruptions for Vale, following the Brumadinho tailings dam failure during January 2019. Analysts believe iron ore prices could sustain the $100/dmt for the next two months.



In April, Vale lowers its iron ore production guidance for 2020 changed to 310 million mt to 330 million mt.

With the world's economy recovering from the COVID-19 lockdown, this is an inopportune situation for Vale. Chinese demand for iron ore is growing with many of the steel mills looking to replenish stockpiles.

In April, Vale reduced its annual production guidance 15 million mt to between 310 million mt and 330 million mt. Production losses due to COVID-19 were part of that equation and the company said it does not believe it needs to revise its guidance. The Itabira mines supply iron ore to the Tubarao pelletizing complex and most of its production is consumed domestically.

Australian iron ore miners, such as BHP Billiton, Rio Tinto, Fortescue Metals Group and Roy Hill, are expected to capitalize on this short-term situation. Australian exports have grown significantly. Exports from Port Hedland, the country's largest iron ore exporting facility, were up in May. According to the Pilbara Ports Authority, Port Hedland achieved a monthly throughput of 48.4 million mt, of which 47.8 million mt was iron ore. That figure was a 4% increase from May 2019.

E&MJ PRICES INDEX

(June 1, 2020)

Precious Metals ($/oz)		Base Metals ($/mt)		Minor Metals ($/mt)		Exchange Rates (U.S.$ Equivalent)	
Gold	$1,739.20	Aluminum	$1,511.50	Molybdenum	$18,500	Euro (€)	1.113
Silver	$18.22	Copper	$5,376.50	Cobalt	$29,500	U.K. (£)	1.249
Platinum	$837.00	Lead	$1,635.00			Canada ($)	0.737
Palladium	$1,943.00	Nickel	$12,418.00	Iron Ore ($/dmt)		Australia ($)	0.678
Rhodium	$9,000.00	Tin	$15,842.00	Fe CFR China	$97.98	South Africa (Rand)	0.057
Ruthenium	$270.00	Zinc	$1,987.50			China (¥)	0.140

Gold and silver prices provided by KITCO Bullion dealers (www.kitco.com). Platinum group metals prices provided by Johnson Matthey (www.platinum.matthey.com). Non-ferrous base and minor metal prices provided by London Metal Exchange (www.lme.co.uk). Iron ore prices provided by Platts Iron Ore Index. Currency exchange rates were provided by www.xe.com.

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