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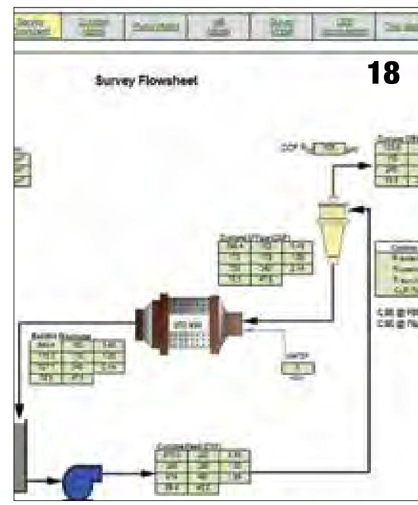

Technical Papers (peer-reviewed and approved)

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Improving conveyor transfer point performance in hard rock mines

by R. Shields

Hard rock mines move large volumes of material, which can cause the conveyors that are essential to this movement to suffer lots of problems, including carryback, spillage, dust and belt wander. Many of these issues are created at the transfer points where the belts are loaded.

This article provides an overview of the latest transfer point systems that incorporate safety and serviceability by design as well as a report on recent projects. One project is the Conveyor B Transfer at the Coeur Rochester silver mine near Lovelock, NV. Here, performance was improved with the installation of belt support cradles, engineered chute walls with external wear liner, and a compact dust collector. A second project is the improvement of belt support idlers and skirtboard sealing in a long loading zone of a conveyor under the concentrator at an Arizona copper mine.

Coeur Mining's Rochester Mine has proven and probable reserves exceeding 2.48 kt (80 million oz) of silver and 15.5 t (500,000 oz) of gold.

The importance of transfer points

Conveyors are essential in mine material handling. Their performance will often make the difference in mine productivity and profitability. A key to conveyor performance is the transfer points where the conveyor belt is loaded and discharges. At these transfer points, many of the problems encountered with the conveyor system are created.

The problems that arise at the transfer stations include off-center and segregated loading, mistracking, blockages and plugging. And there are a variety of problems originating with fugitive material — cargo released in the form of carryback, spillage or airborne dust — that are created or exacerbated in the transfer points. These fugitive materials turn into other conveyor-related problems, including shortened component life, unplanned outages for conveyor maintenance, unexpectedly high labor costs for maintenance and cleanup, worker health and safety problems and issues with community relations. The U.S. Mine Safety and Health Administration estimates that 85 percent of conveyor maintenance is a result of fugitive material at conveyor transfer points.

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Technologies to improve transfer points

A number of techniques to improve the performance of conveyor transfer points have been developed. They include:

- Absorbing impact to prevent damage to the belt, belt-support systems, and conveyor structure, and reducing spillage caused by the impact energy arising from long material drops or large lumps of material loaded onto the receiving belt.
- Stabilizing the belt line to eliminate sag that allows spillage and encourages material entrapment that can damage the belt.
- Protecting the skirtboard seals by sheltering the sealing strips from the mass of cargo pushing material toward the edges of the belt.
- Using self-adjusting, multiple-barrier edge seals to keep material on the belt by providing long-lived seal efficiency with minimum maintenance requirements.
- Controlling and centering the belt's path to eliminate belt wander and the spillage and damage it can cause.
- Allowing dust to settle through the incorporation of chutework that provides an expanded stilling zone and the use of dust curtains at the points where the belt enters and exits the transfer.
- Adding supplemental dust control systems, through the installation of systems for passive dust gathering, water-based dust suppression and/or active dust collection.

While these can be seen as a set of individual, stand-alone techniques, it has been demonstrated that a transfer point will work better when the technologies required to provide these solutions are applied as a part of a unified system, rather than when applied in a piece-meal, one-at-a-time fashion.

Mine transfer points have the additional requirement of being mine-grade. In short, these loading zones must be constructed to withstand the challenges provided by the high volumes (and large lumps) of run-of-mine material and the continuous — often round-the-clock — operating schedules used in mines and their related process plants.

These various techniques can be identified in several recent mine conveyor transfer point improvement projects.

Improvements at Coeur Rochester

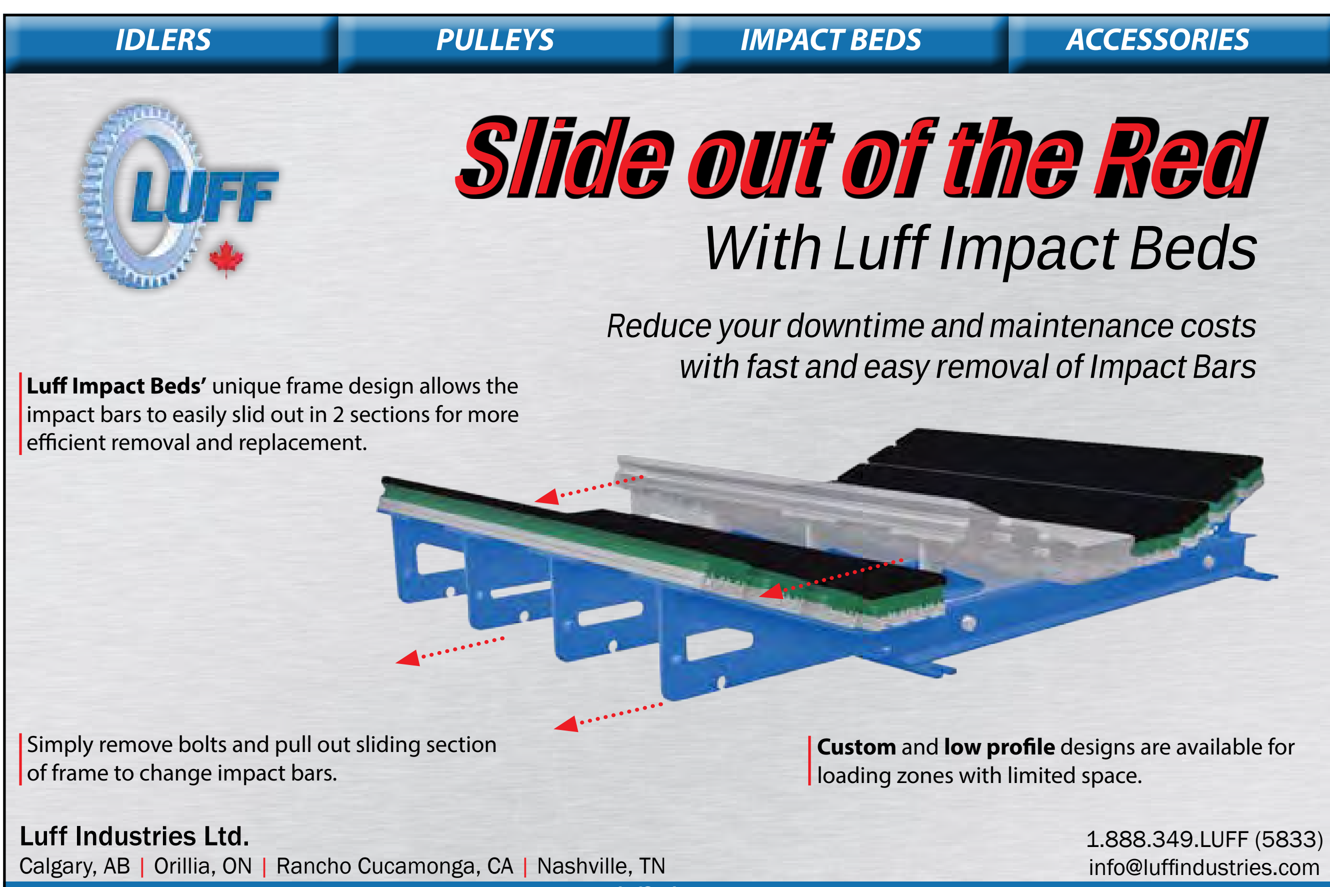
With three wholly owned operations in North America and two in Latin America, Coeur Mining Inc. is the largest primary silver producer in the United States and a significant gold producer.

The company's Rochester Mine and its associated heap leach facilities are located near Lovelock, in Pershing County, NV. The massive Rochester site is spread over 43.7 km^2 (10,800 acres) and includes a network of 20 conveyors, originally designed and installed in 1986. Given the system's age and the levels of usage over nearly 30 years in service, company officials began considering ways to update the conveyors with leading-edge technology to raise efficiency, reduce dust and spillage and improve worker safety.

As part of its commitment to corporate responsibility and continuous improvement, Coeur Rochester recently undertook a comprehensive examination of its bulk material handling processes. Seeing a number of problems with the well-used conveyors, Coeur Rochester management agreed to update the systems, looking to improve efficiency and reduce fugitive material.

The issues with Conveyor B

The plant's Conveyor B was chosen as the starting point, as it seemed to offer the most potential for improvement. Conveyor B handles nearly 1.3 kt/h (1,500 stph) of ore that has been sized to 100-mm (4-in.) -minus, carrying it from



Dust and spillage created a maintenance burden and potential safety hazard for the mine's Conveyor B.

the secondary cone crusher to the surge pile stacker. The conveyor incorporates a 1,220-mm (48-in.)-wide belt troughed at 35 ° and running at 2 m/s (386 ft/min). The 12.2-m (40-ft) transfer point is loaded directly by a vibrating grizzly feeder under the chute and the secondary crusher.

"There's a long material fall going to the secondary crusher, and that creates a huge disturbance in the material flow," explained Wayne Maita, crusher operations/fixed plant maintenance superintendent for the Rochester Mine. "We were seeing a lot of dust and spillage in that area. It not only affected the air quality and presented a potential safety risk from accumulated material on floors and structures, but it also meant putting operational personnel in close proximity to the moving conveyor for cleanup."

Coeur officials also noticed belt damage occurring as a result of fugitive material. As material escapes, it accumulates on idlers and other components, often creating friction points that contribute to excessive wear and premature failure. These wear issues create immediate costs such as belt replacement and seized bearings.

Maita estimated that dealing with the spillage required five to 10 man-hours per day, seven days a week. So, in addition to the safety aspect of the fugitive material, there was a significant cost in wasted labor. "We pay our guys to be operators not to sweep and shovel spilled material," he said. "That time is better spent on core business activities."

The proposal for improving Conveyor B included a number of upgrades to eliminate belt sag, provide effective edge sealing and reduce the escape of airborne dust, while withstanding the heavy loads and near-constant usage. Specific components were recommended for durability under the heavy load and impact at the transfer point.

Coeur managers initiated discussions with HardRok Equipment to conduct a thorough review of the entire conveyor network, followed by a series of five training sessions to review the issues and the technologies available to resolve them. "We've always operated under the belief that high-quality products and services cost less per ton over the life of the product," observed HARDROK President Ted Zebroski. "With proper design, premium components should improve productivity and safety, and that greater efficiency delivers a lower total cost of ownership."

Project work began during a scheduled outage. Work was performed by a team of eight technicians from a local contractor, supported by two supervisors from Martin Engineering, supplier of many of the improved transfer point components. The crew started by leveling out the conveyor structure and adding 100

Impact cradles absorb the force of the falling load, yet slide in and out for easy service.

mm x 100 mm (4 in. x 4 in.) angle-iron reinforcement as needed to straighten out the belt line. The crew removed existing clamps, skirt seals, skirt boards, belt support components and belt cleaner assemblies, and modified the inlet chute to accommodate a new containment system and provide a clean, flat surface at a CEMA standard width.

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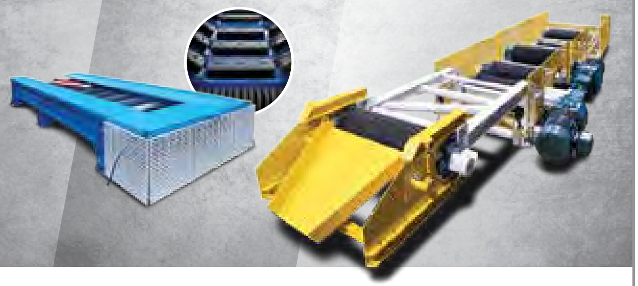

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Improving belt support

A set of five combination cradles (impact cradles with rollers under the center of the belt) were then installed to absorb the impact of the falling load, while minimizing friction and belt wear. These cradles feature steel-reinforced impact bars on adjustable wing supports to match standard trough angles of 20 º, 35 º or 45 º. But rather than the full trough of support bars that appear on a true impact cradle, these combination cradles replace the center bars with an impact idler roll. This design delivers a flat surface for an effective edge seal at the belt edge but minimizes the friction of having sliding bars all the way across the belt. Eccentric cams built into the supports also provide 5 º of wear adjustment, so the alignment between wings and idlers can be customized for a precise fit to provide effective transfer point sealing.

These combination impact cradles employ a track-mounting concept that allows the components of the cradle — the two wings and the center roller — to slide easily in and out of position to allow maintenance or replacement. These modular components are then light enough to be removed by one person, without requiring heavy lifting equipment.

The technicians also installed a set of five slider cradles to support roughly 6 m (20 ft) of the belt just past the impact zone. These siderail cradles feature low-friction bars that support the belt edges and stabilize the belt line, eliminating belt sag and bounce. The slider cradles are also track mounted for ease of installation and maintenance. Located immediately downstream from the combination (impact) cradles, the slider cradles feature double-life slider bars that offer a superior seal with low friction. The bar's proprietary box design allows each bar to be flipped over at the end of its useful life to provide a second wear surface. The result is a flat and stable belt surface throughout the settling zone, reducing fugitive material and extending belt life.

The old transfer point chute structure was replaced with 12.2 m (40 ft) of modular chute wall. The new construction incorporated a tail-sealing box and integrated dust curtains. A chromium carbide overlay on the inside of the chute protects the new containment system from intermittent high cargo depths on the conveyor.

The chute was then fitted with an abrasion-resistant external wear liner, another design upgrade. Previous wear liner designs were welded to the inside of the chute, with only the skirt seal located on the outside. The thinking behind this conventional design is for the wear liner to protect the elastomer skirtboard sealing system, which is not strong enough to withstand the sustained load and abrasion from bulk material. Unfortunately, the wear liner is essentially a sacrificial layer, and the eventual need for replacement of the internal wear liner can require confined space entry, multiple workers and days of downtime.

Instead, the project employed the idea of raising the chute work about 102 mm (4 in.) above the belt and putting the wear liner on the outside. With this external approach, the liner still contains the belt cargo, so the material does not damage the skirtboard sealing system. The result is

The modular chute wall allows easy installation of skirtboard and stilling zone components to manage dust.

The primary seal is clamped to the steel skirtboard and a secondary outrigger strip captures the fines.

significantly reduced installation and service time, with reduced risks for workers during service.

Below the wear liner is the skirtboard sealing system. On each side of the chute is placed a 12.8-m (42-ft) continuous piece of an elastomer sealing strip. The system selected for the Coeur Rochester installation is a dual-sealing system that incorporates a primary seal clamped to the steel skirtboard to keep lumps on the belt and a secondary or outrigger strip to capture any fines or dust particles that pass beneath the primary seal. The secondary seal lies gently on the belt and self-adjusts to maintain consistent strip-to-belt pressure, despite high-speed movement of the belt and material and fluctuations in the belt's line of travel.

In addition, the sealing system is composed of a proprietary double seal that delivers two wear surfaces on a single elastomer sealing strip. When the bottom side of the strip against the belt is worn, the sealing strip can be inverted to provide a second service life.

Preventing carryback with belt cleaning

To address belt carryback and further reduce fugitive material, a dual belt cleaner system was mounted on the face of the conveyor's head pulley. The primary cleaner features a patented constant angle radial pressure (CARP) design to maintain cleaning performance through all stages of blade life. The rugged 9.5-mm (0.375-in.) steel tubing mainframe has a steel bar backbone, and an aluminum extrusion in the base of the molded urethane blade holds the cleaner snugly in place.

Directly after the primary cleaner is a secondary conveyor belt scraper featuring rugged blades installed on a track that slides into position on a rigid steel mandrel. This slide-in/slide-out design allows quick blade replacement which increases the conveyor's availability. The secondary cleaner's individual blade segments slip into a sturdy cartridge, which slides over the stainless steel mainframe for simple installation.

A final belt protection mechanism is a V-plow installed at the tail pulley. This plow fights the potentially damaging effects of lumps of fugitive material carried into the tail pulley on the return side of the belt.

Bulk material may bounce when it lands on a fast-moving conveyor and will often shift in position as the belt travels over carrying idlers. These disturbances can eject small amounts of material from the cargo. Occasionally along its return run, the belt will collect these lumps of spilled material on its noncarrying side. If these objects are not removed, they can become trapped between the tail pulley and the belt and do significant damage to both. Removing these materials is the job for the tail protection plow; in this case, it is a V-plow.

The V-plow is engineered with a unique spring-loaded suspension system that allows the plow to rise and fall with fluctuations in belt tension and travel. The V-plow is attached to the conveyor frame with dual steel crossbars bolted to the conveyor frame a few feet from the tail pulley. Three torsion arms adjust independently, maintaining consistent pressure for effective cleaning in all stages of blade wear.

Adding a dust management system

To complete the containment system, technicians also installed an integrated air cleaner, which contains a suction blower, filtering elements and a filter-cleaning system. Instead of a centrally located unit connected to dust generation points via ductwork, this small air cleaner is incorporated into the dust generation point itself. The particles are not extracted, but are instead collected within the enclosure and periodically discharged back into the material stream. Unlike large central dust collection systems, the integrated approach employs a smaller, independent unit directly at

The V-plow features a spring-loaded suspension to rise and fall with fluctuations in belt tension and travel.

the dust generation point.

The integrated air cleaner contains a self-cleaning system that removes material from the filters using a pulse of compressed air. As material is captured by the filters, it agglomerates against the filter media. When the filter media is pulsed with a backwash of compressed air, the material will fall. If it is agglomerated, it will fall back into the material stream. The pulse system alternates pulses to each filter element. When one filter is being pulsed, the adjacent filter is still drawing air and gathering dust. If a pulsed particle is too small to drop out of the air stream on its own accord, it will be pulled into an active filter.

Like the central system, integrated units use negative pressure, with airflow created by a blower sized to provide the airflow needed for the pickup point. As there is no ducting, there are no pressure losses other than the filters. Thus, the power requirements of an integrated air cleaning system are far lower than for central collection systems.

Rochester results lead to more projects

"We're extremely happy with the system," Maita said. "The installation was well done, and the guys were very professional and safety-conscious. It's changed a nightmare into an extremely functional system that operates at a high level."

As a consequence of this success, Coeur Rochester is currently evaluating five additional conveyor areas for its next upgrade, with a plan currently under development to address those locations in 2018.

The integrated air cleaner is an independent unit positioned directly at a dust generation point.

Improvements at a copper ore mill

A large Arizona copper mine also recently underwent a transfer point upgrade to improve conveyor performance. While the mine's mill was recently upgraded, the conveyors which handled the large quantities of concentrated ore showed problems.

A site visit by conveyor product specialists from Martin Engineering in October 2014 determined that the plant was experiencing problems with carryback, dust, spillage and belt misalignment on the conveyor connecting multiple load zones below the concentrator's crushers.

Located underneath the concentrator building, the conveyor uses a 1,524-mm (60-in.) belt moving at 2.9 m/s (562 ft/min) to transfer 406 t/h (450 stph). The cargo is 50-mm (2-in.) -minus copper ore, with a moisture content ranging from 15 to 25 percent.

It was determined that the dust and spillage were primarily due to inadequate skirtboard and belt support systems. To better control the flow of copper ore and to reduce fugitive material, the mine agreed to undertake a project to incorporate current material handling technology into the loading zone placing material on this belt.

This transfer point was a special challenge due to the length of its skirted area. The chute wall is 67 m (220 ft) long, connecting several loading zones into one long transfer point.

To stabilize the belt line along this extended transfer point, the mine wanted to maintain the rolling characteristics of the previous idler-based belt support. The conveyor used 152-mm- (6-in.) diameter CEMA Class 'E' idlers.

Accordingly, 220 track-mounted idler frames were installed as part of the upgrade. These idler frames allow the spacing of idlers as close as 300-mm (1-ft) centers, without worries about maintenance. The sliding frames mean there is no need to raise the belt or lay additional idlers sets on their sides in order to service a single idler set or roller.

A second portion of the project included the installation of modular chute wall extensions that raised the overall height of the skirtboard to a total of 914 mm (36 in.). This additional height creates a stilling zone, which allows airborne dust driven off from the material loaded on the conveyor to settle back onto the bed of cargo on the moving belt.

In addition, the transfer point's long skirted area was enclosed on both sides with a continuous strip of multiple-barrier skirtboard seal. The project also incorporated the external wear liner system, to keep the weight of cargo from abusing and prematurely wearing the elastomer seal.

Sealing was enhanced with the use of a tail-sealing enclosure. The tail box provides an effective seal at the tail pulley, with a seal that is maintained by the movement of the belt into the loading zone.

Inside the chutework, dust curtains were added to slow air movement and reduce the escape of airborne dust.

Preventing problems from high-speed belts

The speeds at which contemporary belt conveyors operate can create problems. The low-friction UHMW slider bar cradles which are so valuable in improving belt stability in other (slower) applications, can suffer high rates of wear and heat degradation when faced with belt operating speeds approaching or above 3.8 m/s (750 ft/min).

In order to reduce this friction (and heat), these conveyors need closely spaced rollers to provide the stability that bar support systems — both impact and seal support cradles — provide in lower speed installations. But conventional impact rollers can also be abused by high speeds. In addition, the individual impact idlers can suffer point load damage under high-volume, mine-grade applications. But the introduction of a new, high-speed impact roller cradle can address these concerns.

This high-speed impact cradle incorporates impact idlers to absorb the forces of loading. In addition, it utilizes two additional features to improve performance, reduce damage and extend service life. First, it places elastomer impact-absorbing bars under the idler frames to provide additional absorption of loading energy. Secondly, it uses connector brackets that tie the individual idler frames together so that the frames will provide a unified structure.

In addition, the cradle is designed with slide-in/slide-out roller frames to simplify installation and maintenance for the closely spaced rollers.

With these design features, the high speed impact roller cradle impact can be used with belt speeds up to 5 m/s (990 ft/min), depending on the idler roll diameter.

High-speed cradles in a copper mine

A copper mine application has demonstrated the advantages, and durability of these high-speed roller impact cradles. The application was on copper ore, crushed to 19 mm (0.75 in.) minus; the daily load or throughput was 100 kt (110,000 st) that moved through the chute and landed onto the belt.

The problem arose in the long material drop to the conveyor loading zone. There was a 3.67-m (12-ft) fall from a 1,829-mm (72-in.) belt onto the 1,524-in. (60-in.) receiving belt. This proved a challenging application for the belt support systems. The long drop led to damaging levels of impact below the loading zone of the receiving conveyor. The mine had regularly seen failures with conventional impact idlers. It would typically need to change four or five damaged rollers, and one or two broken idler frames in an average month of operation.

These challenging conditions made it seem that the high speed roller impact cradle would be the right equipment for this application.

After installing a series of high-speed impact cradles, the mine put 2.6 Mt (2.9 million st) of copper ore through the transfer point during a two-week period. There were zero idler failures. While this can be seen as a brief trial, the severity of the application holds the promise of improved performance for those installations where high conveyor belt speeds limit the opportunities for improved belt support systems.

In another application, the high-speed impact cradles performed well in a coal mine application in South Africa, demonstrating reduced impact damage and material spillage.

In summary: technologies for mine-grade transfer points

Mines and their mills and processing plants can provide challenging applications for conveyors and the transfer points that are key to controlling fugitive material and conveyor productivity. Now, an array of mine-grade components offer methods to improve the performance of those transfers and of those conveyors. ■

At an Arizona copper mine, a transfer point project included the installation of a taller chutewall to form a stilling zone to allow airborne dust to settle.