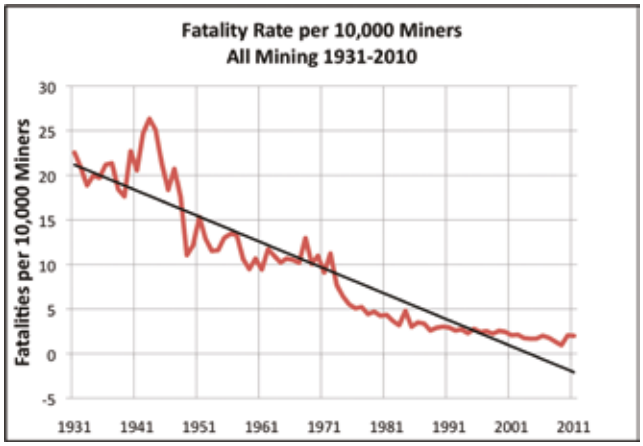
Eliminating the risk: a new approach to conveyor safety

Miners and material processors in the US have made great strides in improving safety over the last 80 years writes ***Jerad Heitzler,*** Product Specialist & Training Manager, Martin Engineering, with fatalities and injuries showing a significant decline since the 1930s.

The fatal accident rate among miners has dropped from a peak of more than 25 deaths per 10,000 workers in the early 1940s to less than five currently. If the rate is plotted graphically, we can see that there have been two significant drops – one in the mid-1940s and another in the mid-70s. But the graph also illustrates that while the overall number has continued to decline slightly in the last 30 years, the rate of improvement has slowed drastically. Despite more money being spent on safety, along with tighter regulation, better training and higher fines, the fatality rate seems to have reached a plateau.

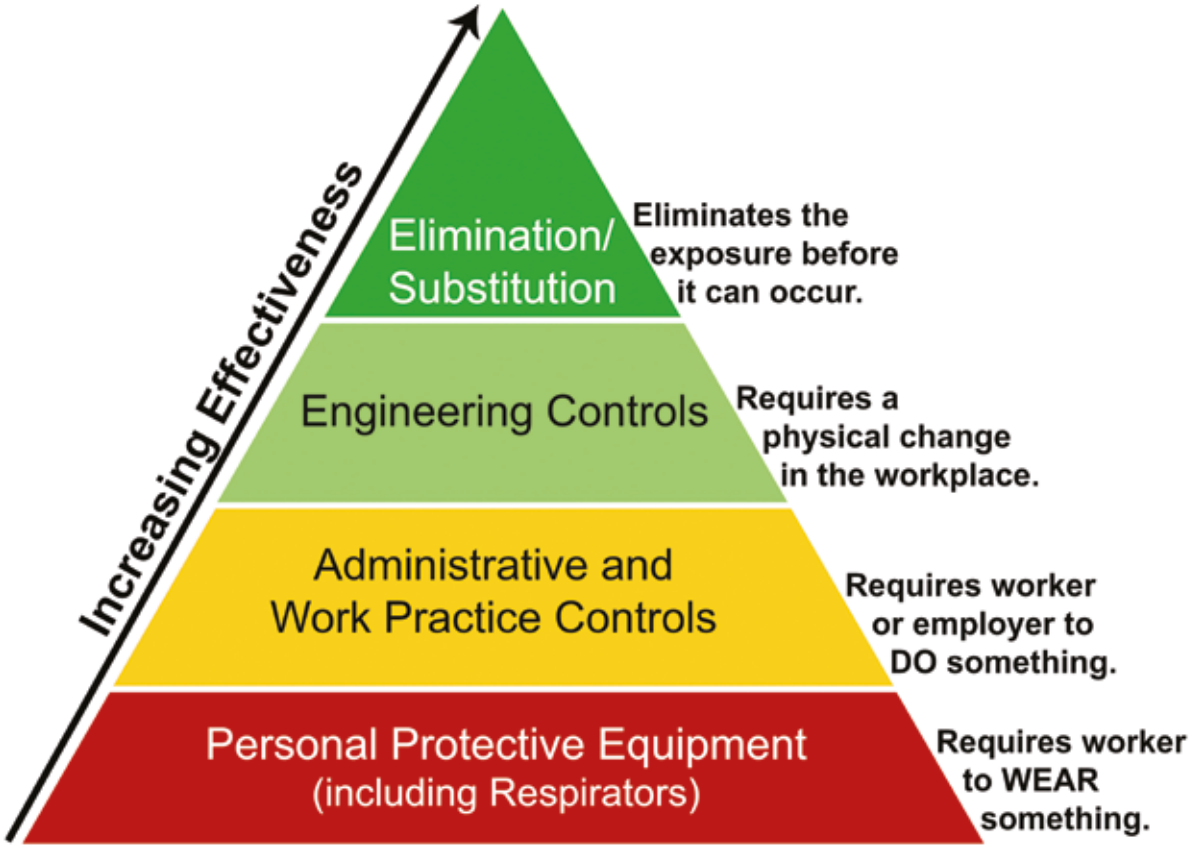


THE KNOWLEDGE GAP

Conveyors are among the most dynamic and potentially dangerous areas of equipment at a mine site. Even though their safety and performance are critical to the plant's success, the impact of their contribution to the plant's efficiency is often unrecognised by management and workers alike. Operational basics of belt conveyor systems are too often a mystery to many employees, who may have little understanding about the hardware installed and the performance required from the components.

The knowledge gap is understandable. The attention of personnel at a mine or material handling operation is centered on the production of the company's main product. The "care and feeding" of belt conveyors – that is, the adjustment, maintenance and troubleshooting that make a huge difference in safety, performance and profitability – is typically outside of their expertise. It is not that they do not care about conveyors, but the ongoing maintenance and service of these systems is often not part of their immediate focus or within their time constraints.

Further, there is often a failure of the retiring workforce to pass along the wisdom which they have gained over the



years. Sometimes making matters worse, when they do provide instruction to less experienced workers, the "old guard" can be communicating outdated information or even unsafe habits that have been ingrained over time.

HOW IMPORTANT IS SAFE CONVEYING?

Conveyors apply large amounts of mechanical energy to what is essentially a giant elastic band, stretched tight and threaded through a maze of components. This stretched band is burdened with a heavy load of material and moved at high speed, sometimes with drive motors as large as 600hp (450kW). Given the inertia and kinetic energy, enormous forces are involved. The human body, able to generate less than 1hp, is simply no match.

A report from the Mine Safety and Health Administration found that over a recent four-year period, more than 40% of injuries were caused while a worker was performing maintenance or checking a conveyor. Nearly as many more were hurt while the subject was cleaning or shoveling near a moving belt.[1]

In another study of more than 200 fatal mining accidents, data compiled by MSHA and the U.S. Department of Labor, observed that 48 of those involved conveyors. Activities most often leading to conveyor-related fatalities were maintenance (such as replacing idlers or clearing blockages) and cleanup (including shoveling or hosing). Together they accounted for more than 50% of the total.

1. Padgett, Harvey L. (2001): Powered Haulage Conveyor Belt Injuries in Surface Areas of Metal/Nonmetal Mines,1996-2001; Denver, Colorado; MSHA Office of Injury and Employment Information.

WHAT WORKS?

OSHA statistics indicate the effectiveness of various approaches to safety, represented here in a pyramid. The least effective method of reducing injury is personal protective equipment (PPE). While no doubt helpful in a worker's ability to withstand accidents and minimise injury, items such as hard hats and steel-toed shoes do nothing to help prevent an accident event.

More effective are administrative and work practice controls, such as creating Standard Operating Procedures and Best Practices for conveyor operation, service and maintenance. An even better approach are engineering controls, which require a physical change in the workplace, such as effective guards and lockouts that bring the system closer to the pinnacle of accident reduction: preventing the exposure to a hazard before an accident can occur.

TRAINING

A critical element of improving conveyor safety and performance is the training of plant personnel in how components work, what problems can interfere with their efficient operation, and what personnel can do to improve those issues. Unfortunately, there are few industry standards that focus on conveyor training, and in light of the number of conveyor-related accidents each year, it appears that existing programs have not accomplished their mission.

The goal of a sound training program is to instruct plant personnel – operators and managers alike – on the principles of conveyor operation, identifying the signs and corrections for common conveyor problems. While some companies recognise that training is a worthwhile investment (rather than an expense), there are many firms that lack focus. Conveyor performance and safety

is a specialised field, and whether it is in-house or from contracted specialists, the most effective training is conducted by full-time safety professionals.

GUARDING

Guarding is a critical element of a safe conveyor. It is also one of the most common reasons government agencies have issued citations over the last several years. Many accidents involving conveyor belts can be attributed directly to the accessibility of danger zones. The majority of these occur during maintenance activities with conveyors still in operation and danger zones unprotected. Preventive measures must be implemented in order that work on or near conveyors can be performed safely.

It is essential that all pinch points be equipped with well-designed guards to prevent accidental or unwise encroachment by employees. This includes rotating components like pulleys and idlers, as well as equipment that may create sudden movement, such as gravity take-ups. Many plants are beginning to totally enclose hazardous spaces as a way of protecting employees and visitors using walkways and secure inspection points, with heavy guards fabricated from metal mesh or screen that permits observation of moving parts without posing an opportunity for injury.

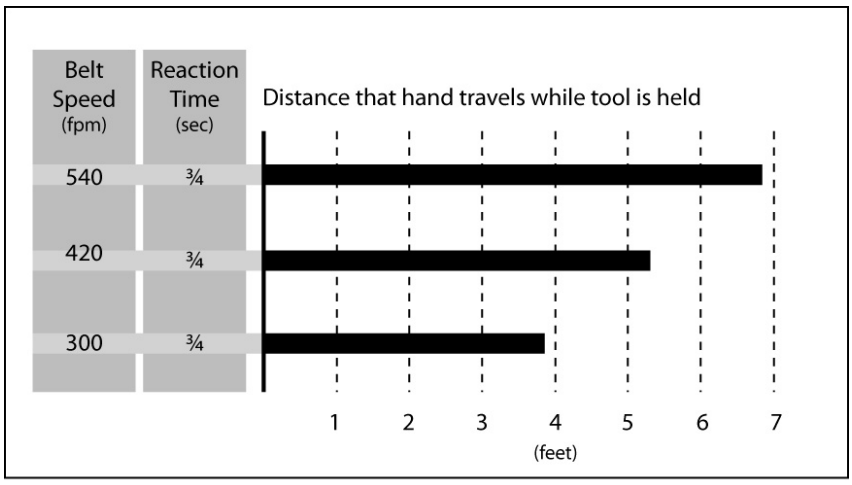
Detailed safety guidelines for the U.S. are published in ASME Standard B-2.1-2006: *Safety Standard for Conveyors and Related Equipment* and in B15.1: *Safety Standard for Mechanical Power Transmission Apparatus*. While virtually every nation has individual requirements that apply to the placement of guards, local and general industry standards should also be consulted and implemented.

LOCKOUT/TAGOUT/BLOCKOUT

Workers may feel confident that they can avoid harm by letting go of whatever tool they might be using around a moving conveyor in time to escape entrapment, but in reality that's extremely unlikely. Even if a person could react in just ¾ of a second (slightly longer than the time it takes for a major league fastball to travel from the pitcher to the hitter), belts traveling at typical speeds would move several feet before the object could be released, likely producing tragic consequences. The key is to prevent the need for the employee to release that tool, by significantly reducing the fugitive material that requires cleanup near a moving conveyor.

Guarding is one of the most common reasons for citations. All pinch points need well-designed guards to prevent access

Because of the potential energy stored in belt tension or elevated bulk materials, a crucial part of an effective conveyor safety program is the lockout/tagout procedure. In the U.S., lockout/tagout is an OSHA requirement, and MSHA has adopted a similar version of this rule. Exact steps for the procedure are very site-specific and will depend on the individual facility's equipment and layout of the computer system. But there are some general features that should be part of every standard operating procedure (SOP).



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Lockout/tagout procedures require that power to the conveyor system (and any accessory equipment) be shut down, locked and tagged by the person who will be performing the service. Only the person(s) performing the work should be able to unlock it, in order to prevent the conveyor from being started by someone else. If the procedure requires multiple staff members, each worker involved should be required to place a personal lock on the de-energizing switch or switches, and only that employee should have a key to remove it. This may require more than one

lock bar, but it is worth the small investment. Each employee should also hang a tag on his/her lock that includes name and contact information.

However, it is not enough that the conveyor be locked out; the belt must also be prevented from moving. Blockout procedures are designed to prevent unintended belt travel after lockout/tagout due to stored tension energy in the belt or potential energy from an elevated load. Lifting gravity take-up counterweights may not release these tensions, and although properly-installed brakes and backstops may help prevent this type of motion, physical restraints on the belt are the only sure method. Belt clamps, chains and ratchet lever hoists ("come-alongs") can be used to physically restrain the belt by securing the blocking device to a structural member of the conveyor that is capable of restraining the expected forces. Equipment engineered to securely clamp the belt is critical to prevent movement and potential injury.

FUGITIVE MATERIAL

Given the number of conveyor-related injuries that occur during routine maintenance and cleanup, controlling fugitive material should be viewed as one of the primary elements in reducing hazards and preventing injuries. Dealing with spillage, dust and carryback typically requires employees to work in close proximity to the moving conveyor, where even incidental contact can result in serious injury in a matter of seconds. Airborne dust can also raise inhalation concerns, primarily when fine, lightweight particles are sufficiently disturbed that their low mass causes them to hang suspended in the air and migrate easily.

Further, spillage can contribute to the risk of fire by interfering with pulleys and idlers and by providing potential fuel. Most conveyor fires are ignited by friction-generated heat from a pulley turning against a stalled belt or a belt moving over a seized idler. A conveyor belt fire of any size is a serious issue, not only because the belt or its contents may burn, but also because the length and movement of the belt can spread a fire a great distance in a very short time. One overheated bearing and a small amount of powdered material can quickly turn into a large-scale event. Even worse, in confined spaces, airborne particles can create the right ingredients for an explosion.

The buildup of fugitive material can occur with surprising speed. As the chart below illustrates, spillage in an amount equal to just one sugar table-packet (about 4 grams) per hour will result in an accumulation of about 1.5 pounds at the end of a week. If the rate of escape is 4 grams per minute, the accumulation will approach

If the spillage rate is just 4 grams per minute, the accumulation will be more than two tons per year

100 pounds per week, or more than two tons per year. If the spillage amounts to just one shovelful per hour (not an uncommon occurrence in some operations), personnel can expect to have to deal with nearly 500 pounds of fugitive material every day.

As material escapes, it accumulates on idlers and other components, contributing to premature failure. Once a bearing seizes, the constant belt movement can wear through an idler shell with surprising speed, leaving a razor-sharp edge that poses a threat to workers and to the belt itself.

CONTAINMENT

There are several technologies available to help contain fugitive material, helping to control ongoing costs and reduce the risk of injury. These include specially-engineered transfer points that channel the material stream to reduce the entrainment of air into the material flow and minimise the release of dust, as well as new component designs to improve belt support and sealing systems that reduce maintenance requirements, allowing service to be performed more safely from outside enclosures and away from moving parts.

Accumulation of Fugitive Material Over Time

Fugitive Material Released	Accumulation				
	Hour (60 minutes)	Day (24 hours)	Week (7 days)	Month (30 days)	Year (360 days)
"packet of sugar" (4 g) per hour	4 g (0.1 oz)	96 g (3.4 oz)	672 g (1.5 lb_m)	2,9 kg (6.3 lb_m)	34,6 kg (75.6 lb_m)
"packet of sugar" (4 g) per minute	240 g (8.5 oz)	6,2 kg (13.8 lb_m)	43,7 kg (96.3 lb_m)	187,2 kg (412.7 lb_m)	2,2 t (2.5 st)
"shovel full" 9 kg (20 lb_m) per hour	9 kg (20 lb_m)	216 kg (480 lb_m)	1,5 t (1.7 st)	6,5 t (7.2 st)	77,8 t (86.4 st)
"bucket full" 20 kg (44 lb_m) per hour	20 kg (44 lb_m)	480 kg (1056 lb_m)	3,4 t (3.7 st)	134,4 t (15.8 st)	172,8 t (190 st)
"shovel full" 9 kg (20 lb_m) per minute	540 kg (1200 lb_m)	13 t (14.4 st)	90,7 t (100.8 st)	388,8 t (432 st)	4665,6 t (5184 st)

Designed for ease of service, modular components allow faster, safer change-outs by one person

Engineered transfer chutes can accomplish conveyor loading and discharge without blockages, while greatly minimising the dust generated. With a design based on testing and computer-based flow studies of the specific material to be handled, these transfer chute systems deliver better material control, more continuous flow at higher capacities and dramatic reductions in material spillage and dust release. By controlling the velocity and force of impact in the load zone to match the belt speed and direction, these engineered systems mitigate material splash, turbulence and dust.

New impact cradle designs are also helping to improve material control, while drastically reducing the time and effort needed for service. Among the newly-introduced components is a cradle engineered so that one person can easily change the rollers, directly reducing downtime and labor.

For years, wear liners have been installed on the inside of the transfer point's skirtboard, to help preserve the steel structure and protect the skirtboard sealing system. But this internal liner proved difficult to install and inspect, and even harder to replace. Today, modern conveyor architects have developed an external wear liner; that is, a liner mounted on the outside of the skirtboard, allowing safer installation and maintenance. External wear liners effectively protect the skirtboards and the sealing system, yet are easily inspected and maintained or replaced without requiring confined space entry.

Modular chute walls, which simplify the design and construction of transfer point skirtboards and stilling zones, help to manage airflow and control dust. Skirtboard covers with a "peaked roof" form a settling zone to prevent escape of airborne dust from the conveyor loading zone, while improving safety by keeping workers away from moving cargo and rolling components.

New innovations include the first dual-sealing skirt system for belt conveyors, incorporating 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 material movement and fluctuations in the belt's line of travel.

Innovations in skirting are also delivering improved material containment, as well as extended service life. One of those designs is a double-sided skirt that delivers two wear surfaces on a single elastomer sealing strip, installed along the bottom of the skirtboard in a loading zone to contain dust, prevent spillage and reduce cleanup expenses. When the bottom side of the strip against the belt is worn, the sealing strip is inverted, providing a second service life.

CONCLUSION

Fugitive material in the form of dust and spillage has always plagued conveyor operators, but it has been considered an unavoidable factor for far too long. In order to truly keep workers safe according to the strategy of hazard elimination, it's critical that the true hazard be understood. While rolling components and pinch points may be the source of injury, in many cases it's fugitive material that places workers in danger. If an operation can reduce fugitive material, it can also reduce injuries.

Mining and bulk handling industries can be rightfully proud of the advancements made in safety over the years, and the tools that have been proven to reduce accident rates should continue to be used. Much has been done to achieve an expectation of safety, but to sustain even lower rates of accident and fatality, the true risk should be identified as exposure to a hazard, rather than the hazard itself. Only by eliminating the possibility of that exposure can we continue our progress toward the holy grail of zero conveyor-related injuries.

Jerad Heitzler, joined Martin Engineering's sales department in 2006. He began teaching Martin Engineering's "Foundation" Workshops in 2010 and now manages that department.

As an instructor for the training program, Heitzler leads seminars, both live and on-line, where he teaches plant and mine personnel about the value of conveyor safety and the techniques to prevent fugitive material. He helps customers improve the efficiency of belt conveyor systems used in the handling of bulk materials. His passion for conveyor performance and helping industries recognise problems in material handling, serves him well in teaching classes.