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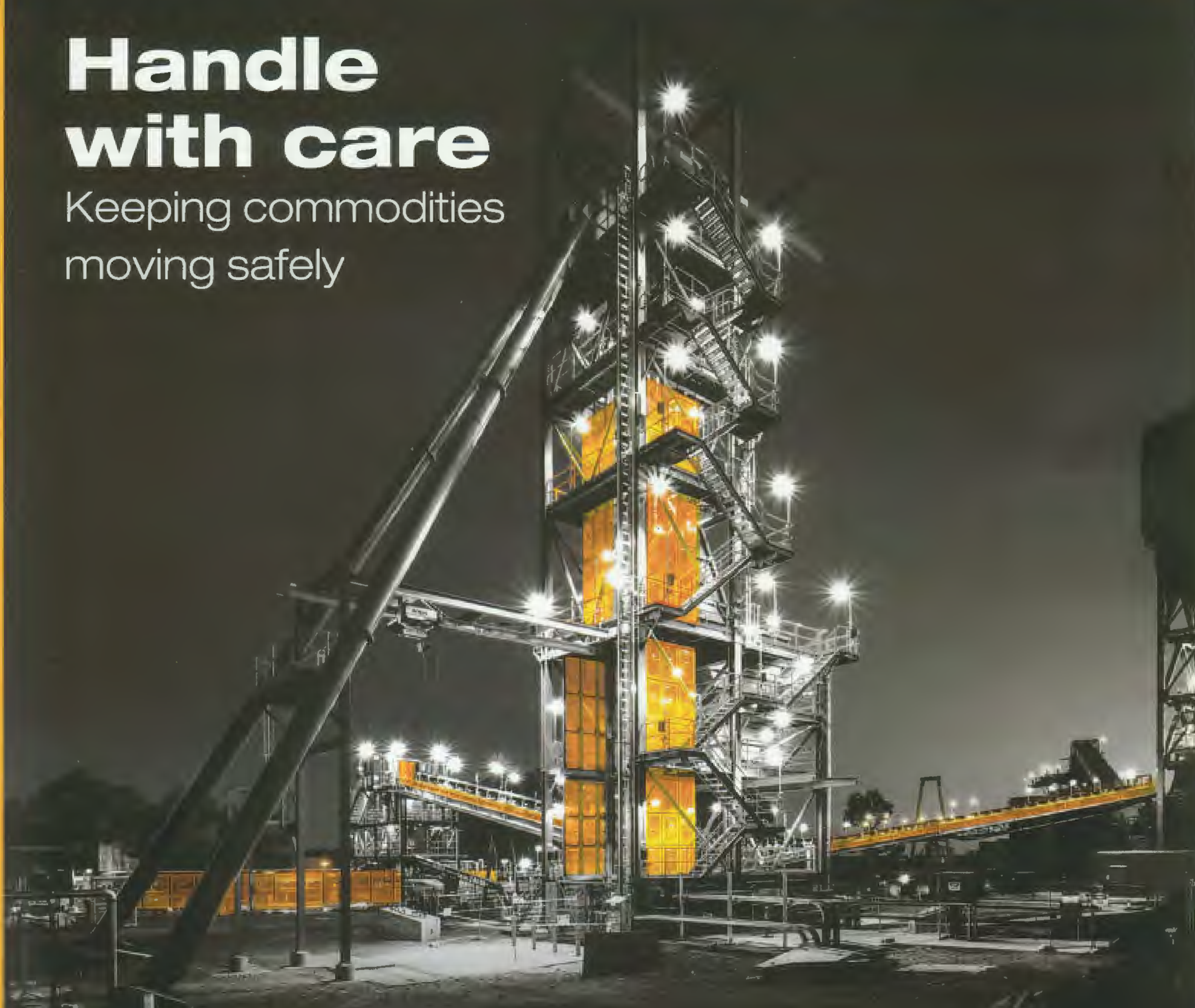

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Engineering safer conveyors: art meets science

ALL NEW CONVEYOR SYSTEMS WILL INEVITABLY SUCCUMB TO THE PUNISHING BULK HANDLING ENVIRONMENT AND BEGIN THE SLOW PROCESS OF DEGRADATION. THE SYSTEM WILL EVENTUALLY REQUIRE MORE TIME AND LABOUR FOR MAINTENANCE, SHORTER SPANS BETWEEN OUTAGES, LONGER PERIODS OF DOWNTIME AND AN EVER-INCREASING COST OF OPERATION.

This period is also accompanied by an increased chance of injury or fatality as workers are progressively exposed to the equipment to perform cleaning, maintenance and to fabricate short-term fixes to long-term problems.

A total system replacement is cost prohibitive, but to remain compliant and/or meet ever-increasing production demands, upgrades and repairs are typically unavoidable.

The consensus among safety professionals is that the most effective way to mitigate risks is to design the hazard out of the component or system.

This usually requires a greater initial capital investment than short-term fixes but yields more cost-effective and durable results.

THE SCIENCE: HIERARCHY OF CONTROL METHODS

Studies have revealed that the highest prevalence of accidents are near locations where cleaning and maintenance activities most frequently take place: take-up pulley, tail pulley and head pulley.

Designing hazards out of the system means alleviating causes with the intent to bolster safety on a conveyor system, but the methods of protecting workers can vary greatly.

In many cases, it will be necessary to use more than one control method, by incorporating lower-ranked controls. However, these lower-ranking approaches are best considered as support measures, rather than solutions in and of themselves.

PPE includes respirators, safety goggles, blast shields, hard hats, hearing protectors, gloves, face shields and footwear, providing a barrier between the wearer and the hazard.

Downsides are that they can be worn improperly, may be uncomfortable to use through an entire shift, can be difficult to monitor and offer a false sense of security. But the bottom line is that they do not address the source of the problem.

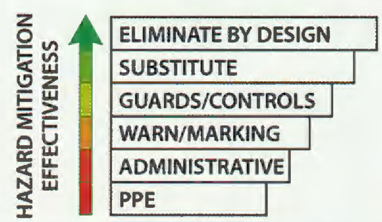
Administrative controls (changes to the way people work) create policy that articulates a commitment to safety, but written guidelines can be easily shelved and forgotten.

These controls can be taken a step further by establishing "active" procedures to minimise the risks.

For example, supervisors can schedule shifts that limit exposure and require more training for personnel, but these positive steps still do not remove the exposure and causes of hazards.

Warning signage is generally required by law, so this is less of a

HIERARCHY OF CONTROL METHODS



Safety improves as the type of hazard control moves higher up the hierarchy of methods.

method than a compliance issue.

It should be posted in plain sight, clearly understood, and washed when dirty or replaced when faded. Like most lower-tier methods, signs do not remove the hazard and are easily ignored.

Installing systems such as **engineering controls** that allow remote monitoring and control of equipment – or guards such as gates and inspection doors that obstruct access – greatly reduce exposure, but again, do not remove the hazard.

Some operators go as far as installing interlocking **guards** connected to switches to discourage removal or proximity sensors to detect workers who break the safety plane of the conveyor.

Using the **substitute** method replaces something that produces a hazard with a piece of equipment or change in material that eliminates the

"The consensus among safety professionals is that the most effective way to mitigate risks is to design the hazard out of the component or system."

hazard. For example, manual clearing of a clogged hopper could be replaced by installing remotely triggered air cannons.

Examples of **eliminate by design** are longer, taller and tightly sealed loading chutes to control dust and spillage or heavy-duty primary and secondary cleaners to minimise carry back.

By using hazard identification and risk-assessment methods early in the design process, engineers can create the safest, most efficient system for the space, budget and application.

These designs alleviate several workplace hazards, while minimising clean-up and maintenance, reducing unscheduled downtime and extending the life of the belt and the system itself.

ECONOMIC ANALYSIS OF PREVENTION THROUGH DESIGN (PTD)

Another way of saying eliminate by design is PtD, the term used by The National Institute of Occupational Safety and Health (NIOSH) in the US which spearheaded the PtD initiative.

In its report, the institute points out that, while the underlying causes vary, studies of workplace accidents implicate "system design" in 37 per cent of job-related fatalities.

Although injuries are the focus of the NIOSH report, the prevention aspect of design also greatly impacts production.

In most cases, workplace hazards produce consequences such as downtime, product loss and reduced efficiency from spillage, dust and early equipment failure.

Cost is most often the main inhibitor to PtD, which is why it's best to implement safer designs in the planning and initial construction stages, rather than retrofitting the system later.

The added engineering cost of PtD is often less than 10 per cent of engineering but has enormous benefits in improved safety and increased productivity.

The biggest cause of expensive retroactive improvements is cutting corners initially by seeking lowest-bid contracts.

LOW-BID PROCESS AND LIFE CYCLE COST

Although the policy is generally not explicitly stated by companies, the low-bid process is usually an implied rule that is baked into a company's culture.

It encourages bidders to follow a belt conveyor design methodology that is based on getting the maximum load on the conveyor belt and the minimum compliance with regulations using the lowest price materials, components and manufacturing processes available.

"When companies buy on price, the benefits are often short-lived, and costs increase over time, eventually resulting in losses," Martin Engineering process engineer Daniel Marshall said.

"In contrast, when purchases are made based on lowest long-term cost (life-cycle cost), benefits usually continue to accrue and costs are lower, resulting in a net savings over time."

THE ART: DESIGN HIERARCHY

To safely maximise production, designers and engineers are urged to approach the project with a specific set of priorities.

Rather than meeting minimum compliance standards, the conveyor system should exceed all code, safety and regulatory requirements using global best practices.

By designing the system to minimise risk and the escape and accumulation of fugitive material, the workplace is made safer, and the equipment is easier to maintain. Life cycle costing should play into all component decisions.

BEST PRACTICES: THE EVOLVED BASIC CONVEYOR

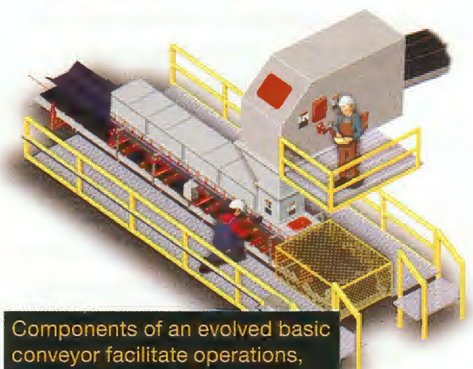
Using the hierarchy of controls along with the design hierarchy, engineers will be able to construct an evolved basic conveyor that meets the needs of modern production and safety demands.

There are several key points that should be considered when designing a safe and efficient conveyor system.

Built competitively with a few modifications in critical areas, an evolved basic conveyor is a standard bulk material handling conveyor designed to allow easy retrofitting of new components that improve operation and solve common maintenance problems.

One key to designing an evolved basic conveyor is knowing the most critical requirements for the current operation and anticipating later production needs.

Installing or providing for



Components of an evolved basic conveyor facilitate operations, maintenance and safety.

An enlarged settling zone retrofitted onto an existing conveyor enhances airflow control at a transfer point.

maintenance-minded solutions in the loading zone can greatly improve safety and reduce man-hours and downtime.

Dust, spillage and belt tracking are top concerns for many safety professionals. Field tests have shown that enlarged skirtboards and engineered settling zones promote dust settling and reduce fugitive material.

Curved loading and discharge chutes control the cargo transfer for centred placement and reduced turbulence. As the load is centred on the belt, guides ensure even travel through the take-up to promote consistent belt tracking.

Any transfer point is prone to build-up and clogging under the right conditions, be it ambient humidity, material wetness, volume or surface grade.

Flow aids such as vibrators or air cannons on chutes can sustain material movement, improve equipment life and reduce the safety hazards associated with manually clearing clogs.

The mounting brackets for flow aids can be included in the original design without a noticeable price increase but greatly reduce retrofit time and cost when they are needed.

CASE STUDY

A mine in north central Mexico was experiencing excessive spillage and dust emissions at the loading zone of its tower-mounted conveyor transporting raw gold, silver, zinc oxide, copper, lead, molybdenum and sulphides.

Despite installing various transfer and loading chute components from a previous supplier, workers found that dust filled the tower and chunks of raw material 51-76 mm in diameter spilled from the transfer chute onto the stairs, partially blocking access to the area and creating a potential workplace hazard.

Twice per month operations had to be disrupted for 12-24 hours so that a 4-to-5-person team could clean spillage and return it to the cargo flow.

Technicians from Martin Engineering Mexico were invited in, and after a thorough inspection designed a conveyor plan based on the principals of Production Done Safely.

It addressed all aspects of the bulk handling process for properly guiding the cargo through the transfer chute.

Impact cradles centred the material and promoted belt health. Slider cradles improved safety for external maintenance.

The project also included skirting and dust bags to contain emissions and spillage throughout the settling zone.

Strategically placed tracking equipment aligned the belt along the entire path, and heavy-duty primary and secondary cleaners that slide in and out for service were installed at the discharge zone to reduce carry back and promote safer blade replacement.

The entire system was designed with innovative safety features and ease of maintenance in mind. Each of the components work together to deliver a comprehensive bulk handling solution that promotes efficiency and a safer workplace.

Following installation, fugitive material was significantly reduced and spillage no longer blocked access to the area.

The air around the transfer point and throughout the tower was much clearer.

"We no longer need scheduled shutdowns just for cleaning," an operations manager said.

CONCLUSION

Engineering safer conveyors is a long-term strategy.

Although design absorbs less than 10 per cent of the total budget of a project, engineering / procurement / construction management (EPCM) services can be as much a 15 per cent of the installed cost of a major project, additional upfront engineering and applying a life cycle-cost methodology to the selection and purchase of conveyor components proves beneficial.

By encouraging the use of the hierarchy of controls at the planning stage, along with the design hierarchy at the design stage, the installation of an evolved basic conveyor can be achieved.

The system will likely meet the demands of modern production and safety regulations, with a longer operational life, fewer stoppages and a lower cost of operation. S

The reconfigured conveyor controls emissions for improved safety and easier maintenance.