

TAKE IT FROM THE TOP

Oswald Deuchar, ABB, Sweden, discusses current industry trends, regulations and standards for coal mine shaft hoisting, and notes key advancements made in safety and technology.

According to the World Coal Association, 6.9 billion t of hard coal is currently being produced worldwide, with the top five hard coal producing countries being China, USA, India, Australia and Indonesia. Among these top producers, ABB has delivered numerous mine hoisting systems to underground mines in China and South Africa, as well as to Poland.

Although there are two types of underground coal mines – access via vertical shafts and drift mines (incline shafts), depending on the depth of the coal seam and the surrounding terrain – this article will concentrate on mine hoist applications that are used in mines that have vertical





Figure 1. Analysis Engineer Magnus Uddman and Global Service Manager Bengt Hedlund discuss increasing KPIs on a remote-controlled hoist at the company's mining Collaborative Operations Center (COC) in Vasteras (Sweden).

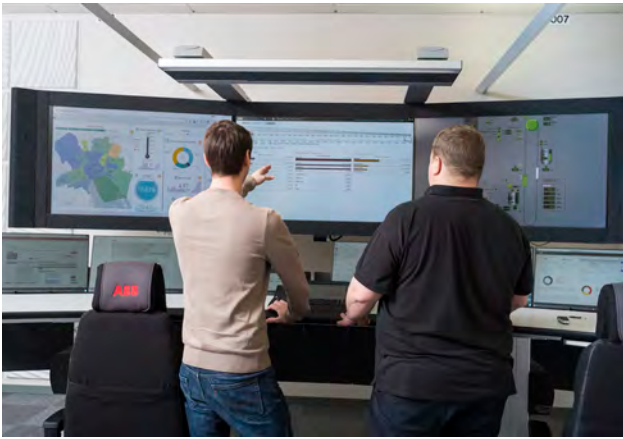


Figure 2. COC engineers at ABB's COC in Vasteras (Sweden) are remotely connected to a hoist to support a mining customer.

access to the coal seam: i.e., the mine hoists that carry workers and equipment into the mine, as well as transport coal to the surface.

Types of mine hoists

Mine hoists are divided into three categories: friction hoists, drum hoists and Blair multi-rope hoists. Both friction and drum hoists are used in coal mines; their selection is dependent upon the mine operator's preference for technology, the mining conditions and the mining traditions in each country.

Friction hoists

Friction hoists, also known as Koepe winders, can be used either for production or service purposes for the transportation of material, equipment and personnel. They are suitable at depths of 150 - 2000 m, although they are most suitable and economical at depths of 150 - 1800 m. Friction hoists can be tower-mounted or ground-mounted, and they typically use between two to six ropes to carry the load. Hoist ropes are not stored on friction hoist drums, but are only transported over it via a principle of friction.

Drum hoists

Both single and double drum hoists serve as production or service hoists. A single drum hoist requires a larger motor than the friction or double drum hoist functional equivalent. There is no counterbalancing on the descending load, as there is with double drum hoists, which generally limits the payload that single drum hoists can carry at depth. Single drum hoists are normally used as auxiliary hoists: for example, in emergencies, at loads of less than 4000 kg or as service hoists to depths of 1500 m.

A double hoist is suitable at any depth up to the current maximum assumed hoist depth (due to the technical limitations of hoist rope) of 2000 m. Normally, one drum raises a full load, while the other drum lowers an empty load. A double drum hoist normally costs more than the friction hoist equivalent and requires a larger motor and stronger electrical network. Double drum hoists are traditionally ground-mounted and each drum of a double drum hoist uses one rope to carry the load.

Blair multi-rope hoists

Blair multi-rope hoists can be used as production or service hoists. Blair multi-rope hoists are also known as multi-rope drum hoists. They can use either one or two drums. A multi-rope drum hoist is similar to a drum hoist – but each drum uses two ropes to handle the load which, in turn, adds certain complications. Two ropes carrying the load provides for a higher payload (but not double the payload). Blair hoists are preferred for depths above 2000 m and payloads above 13 000 kg. Since this type of hoist is an expensive hoisting solution and is only suitable for very deep mines, it is not applicable for use in coal mines.

Case studies: China and South Africa

As mine hoists are a significant capital investment, efficient, safe and reliable systems are of vital importance to coal mining companies. Since most coal mines are at depths of 600 - 1200 m, friction hoists are the first choice worldwide, except in the US, where ABB delivers drum hoists to coal mines. Friction hoists are also less expensive than new drum hoists, while the lead time for delivery may be shorter, as there are more suppliers. What is more, a friction hoist is smaller in diameter than a drum hoist for the same service, making it easier to ship and install than a drum hoist.

ABB has a large installed base of mine hoists and brake systems in China's coal mines. For example, it has delivered two hoisting systems to the Majjaliang coal mine, a subsidiary of Datong Coal Mine Group. The mine hoisting systems, provided by ABB, are China's largest and cover the main units, the motors, the control systems, the ACS 6000 MV drives, the break control systems and related technical service. The two systems have a 5.7 m dia., a payload of 45 t and an

average payload of 1530 tph. They are now used in the main shaft for the Majialang coal mine, significantly improving operational efficiency. More recently, they have won the order to supply four new mine hoists to the Balasu coal mine project.

ABB's ACS 6000 MV drives, using two sets of independent systems, including rectifier units and inverter units, control the entire hoist. Under normal conditions, these two systems work separately, and the hoist operates at full load and full speed. However, when one set of systems stops working, the entire hoisting system can be shifted to urgent mode by using the other system independently. Under these conditions, the hoist will operate at a full load but at half speed. Normally, without adopting ABB's technology, when experiencing a malfunction, the mine hoist has to stop working for examination and repair, compromising the safety and continuity of mine production.

ABB South Africa has been delivering hoisting systems to the coal mining industry since 1961. In recent years, they have delivered friction hoists to the Sasol coal mines and Anglo Coal mines with payloads of up to 80 t.

Key issues: energy efficiency and safety

Energy consumption and storage is set to become a key issue. Through technological development, ABB has developed a new peak-power compensation system for mine hoists. This offers a great number of advantages to customers operating mine hoists on weak networks. The system uses a flywheel connected directly to the hoist motor drive as an energy storage medium. This cost-effectively improves network quality by reducing peak power demand, power sing and power demand charge rate. The flywheel can also reduce the CAPEX and OPEX needed for a local power plant or enable full utilisation of the hoist when the grid network is otherwise too weak.

The safety integrity level (SIL) is an increasingly important concern in the mining industry. As a complete mine hoist supplier, ABB follows IEC standards to build functional safety into mine hoist deliveries, providing the assurance that the safety-related equipment will offer the necessary risk reduction required to achieve safety for the hoists. ABB has delivered SIL-certified hoisting solutions in Australia, Mongolia and Sweden.

The electrical control and drive systems for mine hoists from ABB have been accumulated with decades of experience. ABB (or ASEA, as it was then) launched the first electric drive for a mine hoist IM motor in 1891. Since then, history has seen a lot of firsts in the development of ABB's mine hoists, such as the first Ward-Leonard drive with DV motor, the first digital hoist monitor in 1955, the first thyristor converter driver in 1962, the first cyclo-converter driver in 1987,

the first MV VSI type ACS 6000 SD driver with synchronous motor, and so on. Now, with built-in SIL, ABB's advanced hoist monitors and reliable drive systems offer the company's mining customers maximum hoist availability, reliability and safety.

ABB's hydraulic brake system is used for emergency stops and holding during standstill. The system is split into separate and standardised products, with a hydraulic power unit (HPU) and one or more hydraulic control units (HCU), making it modular and scalable to facilitate multi-channel configurations and hoist room layout. Both products are built with compactness and easy maintenance in mind and can be used in both friction and drum hoist applications. The hydraulic control principles are based on a high performance, safe, servo-hydraulic solution for closed-loop regulated emergency braking, combined with a backup redundant constant brake force solution for unregulated, open-loop braking if needed. The hydraulic pipe configuration of the brake system enables full system circulation of the hydraulic fluid and also creates dual return paths to minimise the duration of initial onset of the brakes at emergency stop. Combined with the ABB stand-alone SIL-certified brake-control system, the hoist brake system meets the requirements IEC standards.

ABB's in-house mechanical hoist design capability makes it possible to optimise hoist design between electrical and mechanical components in a most effective way. This mechanical capability makes ABB capable of designing every mechanical component for all types of mine hoists. With well-proven design philosophy and advanced calculation tools, such as FEM, as well as strict manufacturing supervision and quality control, ABB has delivered a large number of tailor-made hoist systems or brake systems to coal mine customers in China, South Africa, Poland and India, among others.

ABB Ability™ Performance Optimization for hoists is a smart, automatic monitoring service that monitors mine hoists 24 hr/d. It connects customers' hoisting systems to ABB experts, enabling the monitoring and analysis of the hoist's condition and performance from a new ABB Collaborative Operations Centre in Vasteras (Sweden). The service links hardware monitoring with secure remote access options and ABB's expert software from the centre.

ABB Collaborative Operations is a true Internet of Things application and is part of the company's portfolio of ABB Ability of industry-leading digital solutions. ABB Ability Collaborative Operations provides performance management, remote monitoring and preventive analysis technologies to ensure security, and improve efficiency and productivity in various industries. ABB Ability Collaborative Operations centres connect people in enterprise-wide production facilities and headquarters to ABB's technology and expertise. 