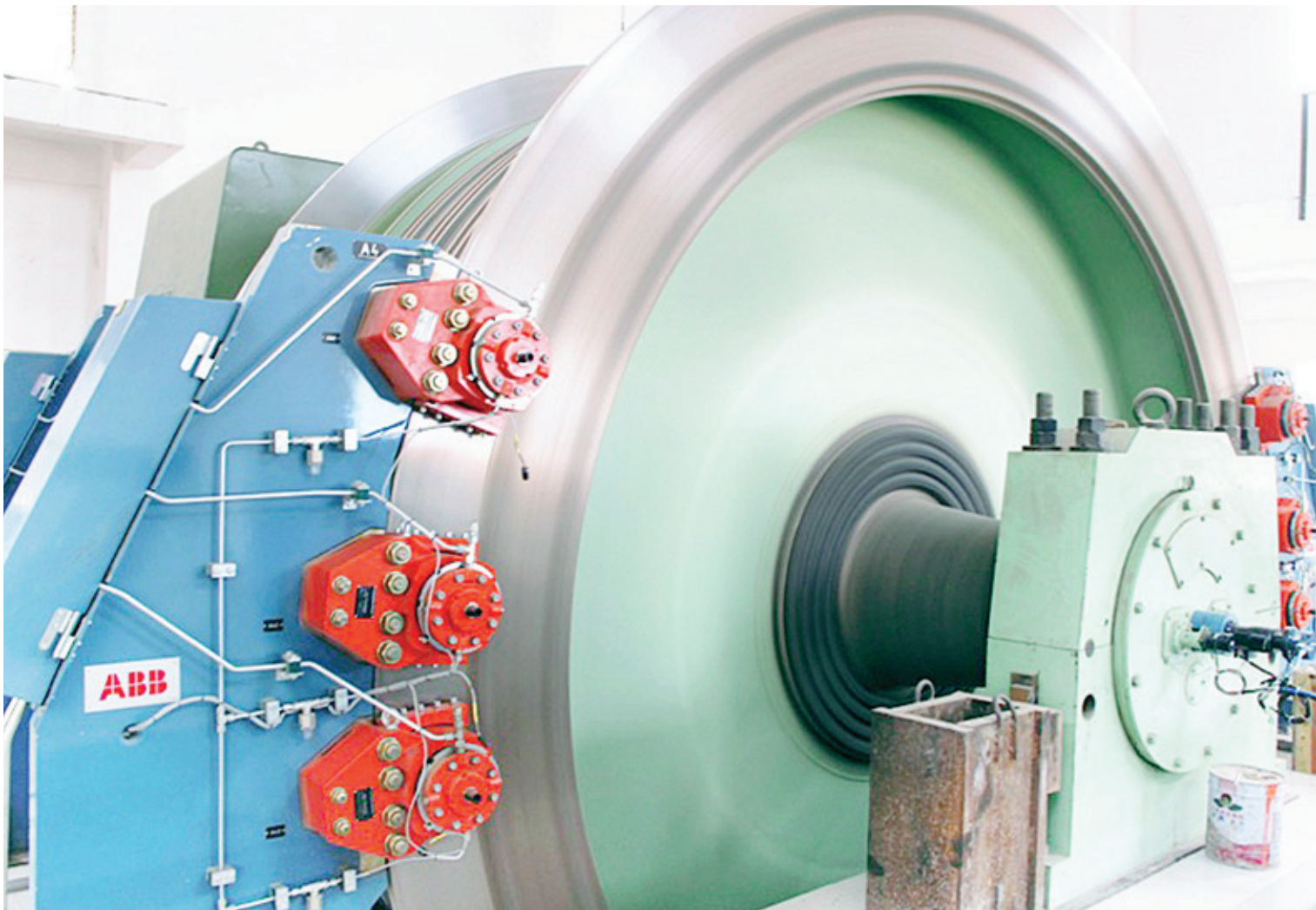


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UNDERGROUND MINING

## Mine hoist disc brake systems

Improved safety, availability  
and productivity



# Mine hoist disc brake systems

## Overview

ABB has been supplying electrical equipment for mine hoists for over 100 years. Since 1937 ABB has also supplied mechanical equipment, where braking systems have played a vital role.

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01 Brake system on ABB  
mine hoisting system  
—  
02 Brake stands

The earliest brake systems consisted of separate service brakes and safety brakes, powered by compressed air or oil pressure. Over the years ABB brake systems have undergone numerous significant developments.

Today's state-of-the-art technology for mine hoist brake systems is based on hydraulically operated disc brakes. ABB started this development in 1962 and has many years of experience in applying this technology to mine hoist systems. ABB's many developments and features on mine hoist disc brake systems have greatly improved the safety, availability and productivity of mine hoist systems.

Currently, many older mine hoists still use the originally supplied brake system. While these original brake systems may have performed admirably during their life, their reliability and safety performance will be far behind that of modern mine hoist brake systems. A new ABB disc brake system is easy to install and will greatly improve safety, availability and productivity of these older mine hoist systems.

### Modernization projects

ABB designs, supplies and commissions complete systems for mine hoists of different makes, types and sizes as well as systems for new projects or modernization projects. The various types of hoists normally involved are:

- Friction hoists
- Single drum hoists
- Double drum hoists
- Shaft sinking hoists

For modernization of mine hoists delivered by other suppliers, ABB can also supply stand-alone disc brake system packages. These packages can then be integrated into the existing mine hoist control system.

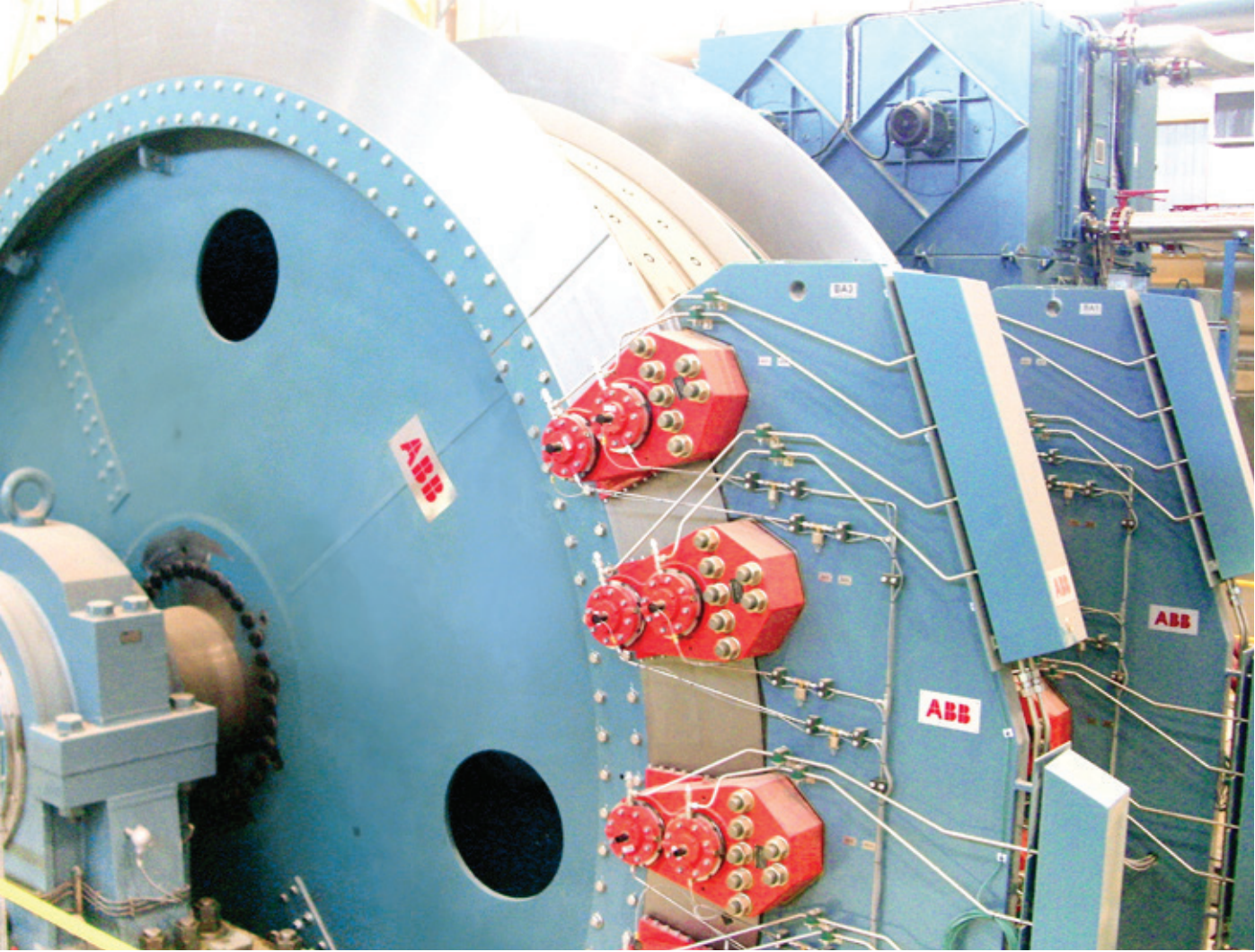
### Brake requirements and functionality

Normal retardation of a hoist from full speed to stop is accomplished electrically with the motor and hoist control system. The hydraulic brake system generally functions as a parking brake at still stand.

However, in case of loss of motor power, overspeed, over travel or any other emergency situation, the braking system serves as the ultimate means for safely bringing the hoist to a full stop with the retardation rate complying to the specific mine safety regulations. The hydraulic brake system is therefore vital for the safe and reliable operation of a mine hoist.

The ABB disc brake system is designed to comply with all principal national mine safety regulations. These safety regulations often stipulate retardation at an emergency stop of minimum  $1.2\text{--}1.5\text{ m/s}^2$  for a full load in the descending direction and of maximum  $5.0\text{ m/s}^2$  in the ascending direction.

In addition, the braking system must have a static holding capacity of 2–3 times the out-of-balance torque. The number of brake units needed for a particular hoist is normally determined by the static braking torque, since the dynamic braking torque needed for a retardation of 3 stipulated  $1.2\text{--}1.5\text{ m/s}^2$  for a full descending load is generally lower than for the braking torque at still stand. One exception is mine hoists in very deep shafts. In these cases, due to the large rotating masses of the hoisting system, the number of brake units might instead be determined by the retardation requirements.



### Brake philosophies

Retardation with constant braking torque at an emergency stop is a common method that has been widely used in mines for many years. With this method the hydraulic pressure in the brake units is reduced in two steps to achieve the preset braking torque. The braking torque limits are determined by the specified minimum and maximum retardation rates. With this method, unfortunately, there exists the possibility of a large variation in hoist retardation rates which is further compounded by the risk of rope slip with a partly loaded or empty conveyance. Additionally, the retardation of a fully loaded ascending conveyance might exceed the safe or permitted safety level stipulated in the relevant mine hoist safety regulations.

To overcome these difficulties, ABB has developed a system that continuously controls the braking torque during emergency stops. The purpose of this system is to control and reduce the retardation to a more suitable and continuously safe level. Furthermore, it will result in considerably reduced stresses on the mechanical parts of the hoist.

For continuously controlled braking torque at an emergency stop, the oil pressure acts against the cup-spring force in the brake caliper units and it is controlled between two pressure limits. The lower limit corresponds to the specified retardation, 1.3–1.5 m/s<sup>2</sup>, for a full descending load, while the upper limit corresponds to a full ascending load which means about 10–15% of the maximum available braking torque.

At an emergency stop the oil pressure quickly drops from full pressure to the upper control limit. It is then further reduced following a ramp function in the control system until the required retardation setpoint, is obtained. The actual retardation level is measured by a speed feedback device connected to the hoist drum.

### Operation

The brake system is normally designed to operate with a controlled braking force to ensure the same retardation levels during all operating situations, regardless of the direction of travel, speed, load or other factors. This greatly improves the safety performance of the mine hoist while reducing mechanical stresses in the equipment.

Normally, there are two braking modes:

- Stopping from creep speed to full stop level (service braking)
- Controlled braking during an emergency situation (emergency stop/safety braking).

### Service braking

During normal stop the hoist speed is reduced by the motor drive system. When the hoist has decelerated to creep speed and the conveyance is located about 0.5 m from the final stop level, the hydraulic pressure in the brake units is reduced to obtain a smooth light contact on the brake discs.

The pressure is then reduced to zero in two steps before the conveyance reaches the final stop level.

### Safety braking (Emergency Braking)

Safety braking is accomplished exclusively by means of the hydraulic disc brake system. There are two possible braking modes:

- Braking based on controlled braking torque to give a constant retardation rate
- Braking based on constant torque.

### Scope of delivery – disc brake system

The standard disc brake system supplied by ABB typically consists of the following main components:

- Brake stands
- Brake units with pads
- Air gap sensors
- Hydraulic power and control unit
- Control system and process interface.

For hoists without brake discs, ABB can supply custom designed, bolt on brake discs to be mounted at site. ABB can also provide Valve Test Units to existing hydraulics to allow for easy maintenance.

#### **Brake stands**

The ABB Disc Brake System includes two or more brake stands where the hydraulic brake units, piping and valves are installed. Each brake stand has a pipe branching system with manually operated valves connected to each hydraulic brake unit. These valves allow the hydraulic brake unit to be held in the open or closed position for operation, testing or maintenance purposes. All valves are mounted under a protective cover, which for safety reasons is locked under normal conditions. The hydraulic brake units offer the optimum solution for high-performance braking of mine hoists. They have a short reaction time due to small moving masses and since several brake units are used in parallel, problems associated with “single-line components” are also eliminated. Each hydraulic brake unit has two caliper halves where nonasbestos brake pads are secured.

The brake pads clamp onto the brake discs with the help of a large number of cup springs and are released from the brake disc by oil pressure, counteracting the cup spring force. For long life and reliable operation the air gap between the brake disc and the brake pad must be adjusted properly. Electronic air gap sensors are provided to assist in this adjustment.

ABB also has special versions of the brake units for use on hoists with sleeve bearings, where a larger air gap is required.

#### **Air gap sensors**

The air gap influences the hydraulic brake unit's clamping force and is very important for the reliable performance of the hoist brake system. If the air gap increases, the clamping force will reduce while lowering spring package life time. The ABB brake system is therefore provided with electronic sensors to monitor the air gap of each brake caliper half.

With a resolution of 0.1 mm, the measurement is very accurate. This allows air-gap values to be presented on the hoist operator's screen in the control room. With this information, the maintenance crew can take appropriate preventive measures to ensure the air gaps are within the recommended levels.

#### **Brake discs and pads**

ABB generally recommends two brake discs for safety reasons. On new winders the brake discs are normally bolted to the drum, however welded brake discs are also available. Brake pads are of nonasbestos type. ABB has undertaken an extensive research program where numerous full scale tests on different pad materials were made. This enabled us to select the most suitable non-asbestos brake pad material. Performance concerning fading at high thermal capacity is very important and the friction coefficient has to fulfill a calculated value of 0.35–0.40.

#### **Valve Test Unit**

ABB has developed a simple yet valuable tool for mine hoist systems. The Valve Test Unit. It is used mainly for maintenance purpose and can be electrically connected to individual valves in the hydraulic station for function control. It can also be used to maneuver the hydraulic brake units while adjusting the air gap sensors or circulating the oil through the filter.

#### **Hydraulic system**

The hydraulic power unit contains an electrically driven variable displacement piston pump mounted under the oil tank with all necessary valves and apparatus required to control the hydraulic brake units. To ensure high safety and reliability, the hydraulic control unit has two parallel valve systems for pressure control. There are three hydraulic connections in the hydraulic station, one to pressurize the brake units and two for the controlled return oil from the brake units. The two separate and independent oil return branches ensure reliable operation of the brake system in case of a fault in one of the branches.

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01 The inside and outside of the hydraulic unit

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02 Brake electric control cubicle

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03 Brake control box for stand alone brake system

An analog hydraulic pressure transducer connected to the hoist control system continuously monitors the system pressure and ensures the proper operation of the disc brake system.

#### **Control system and process interface**

The control and functionality of the brake system is handled in a separate process controller, integrating the necessary hardware and software modules in the disc brake system. Hard-wired safety circuits are implemented with electrical relays and contactors. The control system monitors the hoist speed, supply voltage and hydraulic braking pressure. It is provided with a battery back-up to allow full operation during a short power failure.

The braking system is supervised and maintained by an ABB Process Panel installed in the hoist operator's room. The panel displays the following brake system information:

- Status of the brake equipment, faults and air gaps of the brake calipers
- Brake test functions including drag test, spring test and deceleration supervision test
- Parameter settings for control and monitoring functions.

The interface between the brake control system and the hoist control system is relatively simple and includes a number of process signals. Signals from the hoist control system to brake control system include hoist speed, motor current, safety circuit, brake applied, brake lifted, brake fully lifted, reference for brake pressure, etc.

Signals from brake control system to hoist control system include brake applied, actual brake pressure, braking system in service, brake fault, brake system warning, etc.

The interface between the brake control system and the hoist control system is easily handled thanks to a well defined standardization program of the ABB Disc Brake System.

#### **Mine hoist disc brake systems Advantages**

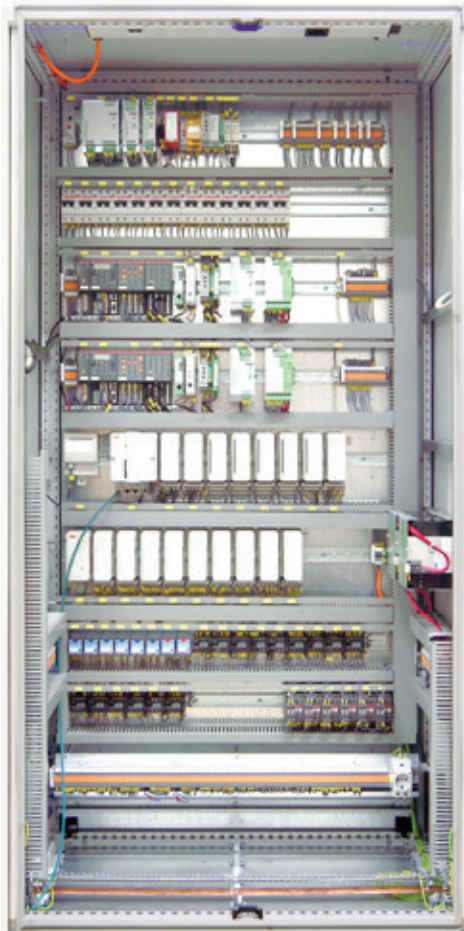
The ABB Disc Brake System provides mine owners and mine operators numerous benefits including:

- Improved safety
- Reduced maintenance
- Improved availability
- Increased productivity
- Controlled braking at emergency stop
- Brake system status and operation monitoring information.



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