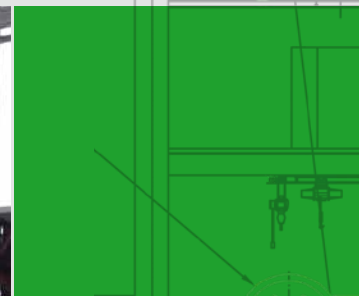


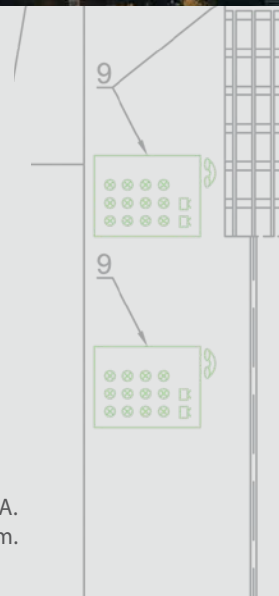


MWM ELEKTRO

## COMPLETED PROJECTS



## COMPREHENSIVE MODERNISATION OF THE SKIP MINE SHAFT HOIST IN SHAFT R-III AT THE KGHM POLSKA MIEDŹ S.A. "RUDNA" MINING PLANT BRANCH



Zakłady Górnicze "Rudna" ("Rudna" Mining Plant) is one of the three branches of KGHM Polska Miedź S.A. – a global leader in mining and processing copper, precious metals (gold and silver), molybdenum and rhenium. KGHM Polska Miedź S.A. is a global leader in owned copper resources.



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## Objective of the project

The main objective of the modernisation project was the replacement of the elements of the mine shaft hoist used for many years with modern, more functional and energy-effective solutions and to increase the output haulage capacity of the hoist containers from 17 to 23 Mg.

## Scope of the project

In July 2013, MWM Elektro Sp. z o.o. won the tender for the modernisation of the mine shaft hoist installed in the skip compartment of shaft R-III at "Rudna" MP in the following scope:

- replacement of the hoisting machine,
- replacement of the control and signalling equipment,
- replacement of the guiding pulleys,
- modernisation of the loading equipment,
- adaptation and renovation of the civil structures,
- preparation of the technical documentation for the entire project,
- supply and installation of the equipment,
- overseeing the procedures related to the approval of equipment for use in the mining plants,
- start-up of the supplied equipment.

The comprehensive modernisation of the machines, structures and systems for the mine shaft hoist was provided in the "turn-key" system.

## 4L-4000/3900 hoisting machine

The 4L-4000/3900 hoisting machine is a 4-rope machine with a 4,000 mm Koepe winder, driven by the DC electric motor with a direct drive transfer to the shaft. It is founded on the bearing beams of the hoisting tower of shaft R-III on level 7 (+53 a.s.l.). Given the condition of the surface of the bearing beams, chemically bonded EPY pads were made to enable precise levelling of the machine elements and dampen the vibrations transferred to the tower structure. The hoisting machine is intended to haul output in skips.

The machine is controlled:

- manually or automatically (operation mode – haulage) from the operator's panel,
- remotely from control panels at stations or with an ECHO-S radio device.

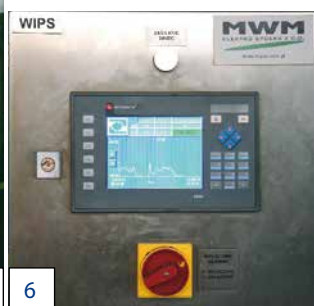
The main components of the machine:

- main shaft unit with roller bearings and Koepe winder,
- LU 5 lubrication unit for the hoisting the machine's bearings,
- main DC motor,
- disc brake unit with the H-C MWM-4/VER.III control and supply unit,
- inverter transformers,
- inverter drive,
- control, monitoring and safety systems,
- ergonomic hoisting machine operator's station with a system for displaying the statuses of individual components of the mine shaft hoist and emergency signalling.

photo 1 – 4L-4000/3900 hoisting machine



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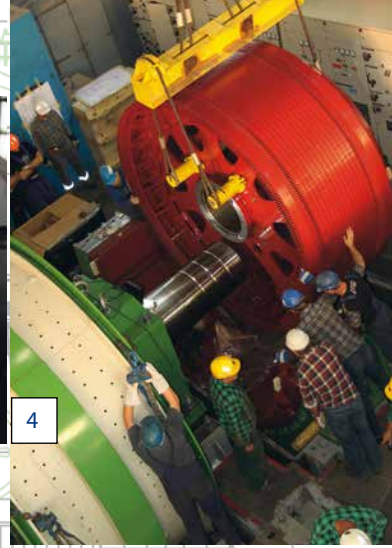
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In order to ensure the highest quality of the supplied elements and services, inter-stage inspections, investor acceptance and industry designers' supervision were provided during the production.

photo 2 – Test installation of the main shaft assembly in the production plant

The installation of the main motor rotor and installation of bearings on the shaft was hydraulic. This method enables easy future disassembly and installation of these elements.

photo 3 – Main shaft with bearing

photo 4 – Hydraulic installation of the main motor rotor with shaft

The hoisting machine is equipped with two-row barrel rolling bearings. A vibration monitoring system was employed in order to provide actual monitoring of the wear of bearing nodes. Furthermore, the measurement of the vibrations envelope provides information on the technical condition of the main shaft elements. This information enables detailed inspections and overhauls to be planned in advance.

The bearings of the hoisting machine are provided with circulating lubrication by the LU 5 lubrication unit. The unit enables setting the appropriate flow value individually for each bearing.

In order to correctly prepare the working medium, the machine is equipped with heating, cooling and filtration systems. Furthermore, the machine is equipped with a magnetic grate on the oil drain to catch metallic contamination from bearing housings.

photo 5 – LU 5

photo 6 – Vibrations monitoring system screen

The hoisting machine is equipped with a hydraulic-controlled disc brake system, which includes the following elements:

- two brake discs,
- four brake columns,
- 10 pairs of BSG 408-A00-02-00 brake actuators – two columns with 3 pairs and two columns with 2 pairs of actuators,
- H-C MWM-4/VER.III electrohydraulic control and supply unit, manufactured by MWM Elektro Sp. z o.o., comprising two hydraulic units: primary and backup, authorised for operation by a hydraulic distributor as well as the supply and control system.

The hydraulic units with the selection of two values of braking force during emergency braking are equipped with a system enabling emergency braking with a variable braking moment. The application of this type of braking guarantees the alleviation of the emergency braking effect on the mine shaft hoist elements, such as wire ropes, container guides, suspensions, etc.

Furthermore, the braking system is equipped with "UWDSO" – an additional oil flow forcing device. The device is intended for the declogging of additional oil drains and reducing the pressure resulting in the safe stopping of the mine hoist.

photo 7 – H-C MWM-4/VER.III electrohydraulic control and power unit

The inverter drive comprises two main circuit DCS800-S01-4000-04 non-reversing thyristor inverters connected in a series and a reversing DCS800-S02-0350-05 for the main motor activation. In order to limit the interferences and occurrence of higher harmonics, a 12-impulse system impact was provided by supplying the main circuit inverters from two dry transformers with an appropriate configuration of hourly connections.



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## Shaft tower

The applied configuration enables the possibility of hoist operation with half the rated speed and full overload in case one of the inverters or main transformers is damaged.

[photo 8 – Thyristor drive system](#)

Highly efficient ventilation of the inverters was provided using an air treatment station with a compressor air cooling module. The main motor is cooled using a fan with the capacity of 72,000 m<sup>3</sup>/h. The fan power supply system provides a stepless regulation of its capacity.

[photo 9 – Ventilation systems](#)

The control and safety system as well as the digital hoisting machine travel regulator are based on a redundant system of logical controllers.

The GRZ-08 digital travel regulator is another solution successfully implemented in over a dozen previous hoisting machines. GRZ-08 enables the control of hoisting machine's travel diagram according to the requirements of the user, taking the nature of the mine shaft hoist into account. GRZ-08 works as the continuous and end speeds control system simultaneously.

[photo 10 – Safety and control system](#)

The functional and ergonomic machine operator's station, equipped with the hoisting machine's status display system as well as signalling and communication equipment, is installed in an air-conditioned and soundproof booth.

[photo 11 – Hoisting machine operator's station](#)

[photo 12 – View of one of the display system screens](#)

Meeting the technical assumptions related to the adaptation of new equipment and increasing the transport capacity of the hoist required construction modifications of the shaft tower. For this purpose, a building design was prepared – which included, among others, construction of additional bearing beams for the brake columns of the hoisting machine (the previous hoisting machine had shoe brakes) and demolition of the unused rooms on levels in order to install new machines.

[photo 13 – Shaft tower photo](#)

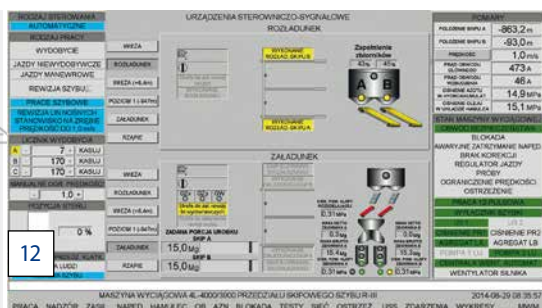
## Guiding pulleys

The previously used pulleys with the diameter of Ø3,500 mm were replaced with Ø3,500 mm pulleys with a Becorit lining. The set of guiding rope pulleys includes:

- 4 Guiding pulleys with axle and bearings,
- groove turning device.

The pulleys use a Becorit lining which extends the life of the lifting ropes. The device for turning grooves in the Becorit lining is used to adjust the geometry of the rope grooves and collect the excess grease from the lifting ropes.

[photo 14 – Guiding pulleys](#)



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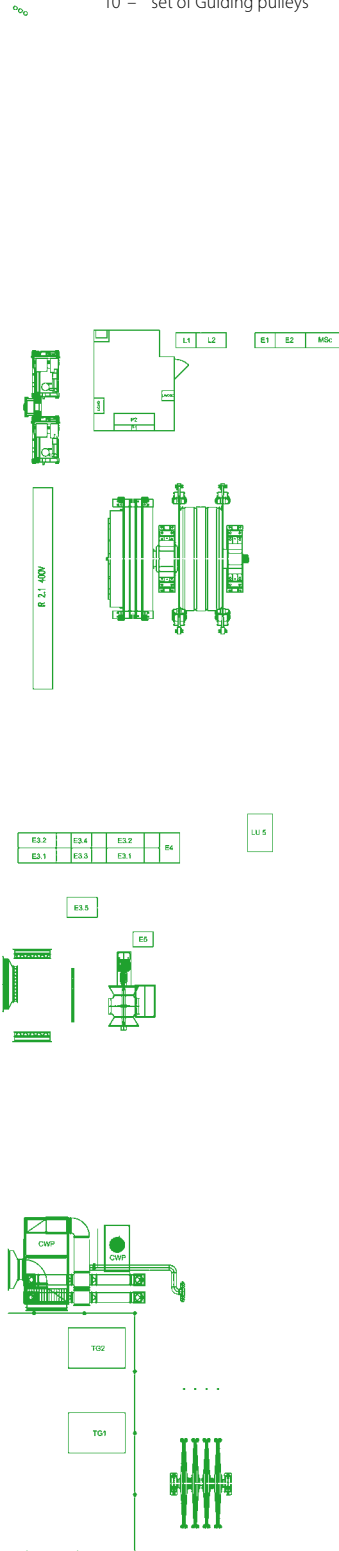
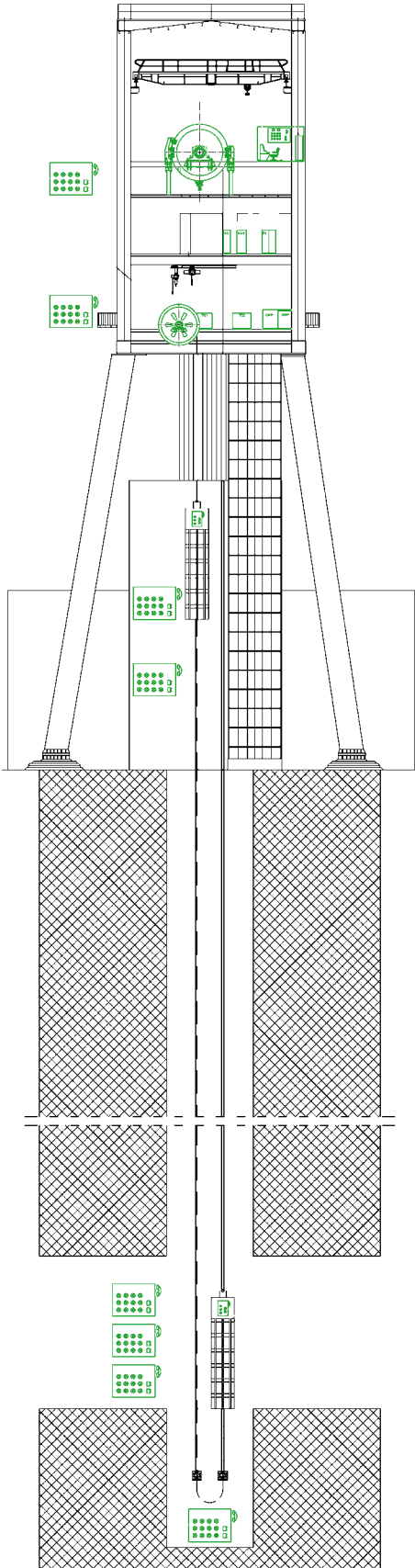


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# Mine shaft hoist

Cross-sectional drawing of the shaft and hoist building, modernised elements highlighted:

- 1 – hoisting machine
- 2 – operator's station
- 3 – lubrication unit for the rolling bearings of the hoisting machine
- 4 – H-C MWM-4/VER.III electrohydraulic control and power unit
- 5 – drive system
- 6 – hoisting machine motor ventilation system
- 7 – drive system ventilation – central unit
- 8 – hoisting machine's control and safety cabinet
- 9 – control and signalling equipment
- 10 – set of Guiding pulleys



## Control and signalling equipment

The applied control and signalling equipment is constructed using a system of redundant logical controllers exchanging data with local stations using optical fibre cables.

Features of the control and signalling equipment:

- all system communication nodes are connected with two independent Profibus DP networks,
- each of the Profibus DP networks works in a closed loop configuration, allowing for undisturbed system operation in the event of breaking,
- two-channel supply to the equipment installed in the shaft allowing for undisturbed operation in the event of breaks in one of the supply voltages,
- modular design for easy expansion and replacement of damaged components,
- clear visualisation of all device elements on the screen of the industrial computer.

The modernised control and signalling equipment provides duplex sound communication between the control and signalling stations of the mine shaft hoist. Due to the aggressive environment conditions, the housings of all signalling stations are made of stainless steel.

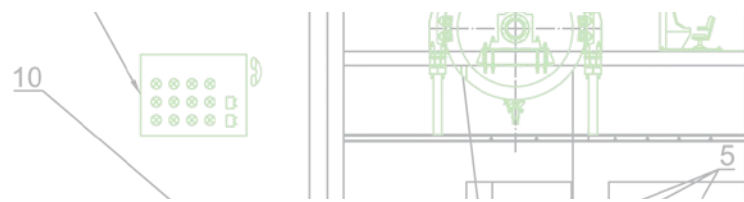
## Loading equipment

The contract included the modernisation of loading equipment at level -950 m. The modernised equipment was as follows:

- measurement pockets weighing system,
- set of equipment and elements required for air control in the loading equipment.

## Civil structures

The modernisation required a number of construction modifications. The unused platforms and rooms on levels 5, 6 and 7 of the R-III tower were demolished, additional bearing beams were installed on level 7 as a foundation for the brake columns. After the completion of the assembly and commissioning works, a new methacrylic resin floor was provided on the hoisting machine's level.



## Technical specifications of the mine shaft hoist after modernisation

intended use	output haulage
container guiding	rigid
hoist containers	skips
number and diameter of lifting ropes	4 x 40 mm
travel route length	985.7 m
transported output weight	23 Mg
hoisting machine type	4L-4,000/3,900 (4-rope with Koepe winder and direct drive)
maximum travel speed	16 m/s
maximum static overload	250 kN
drive type	inverter with direct current motor 3,900 kW power
brake type	disc, hydraulic control
brake control and supply system	H-C MWM-4/VER. III

## Summary

The applied technical solutions enabled us to provide the customer with a modern product, compliant with the highest quality and safety standards.

All the ordered works were provided according to the project schedule within one calendar year. The end stage, involving the reconstruction and commissioning of the modernised mine shaft hoist equipment was completed within just 14 days of shaft hoist downtime.

Due to the technical and organisational solutions developed by the engineers of MWM Elektro Sp. z o.o., the main objective of the modernisation was achieved within the assumed time-frame.

MWM Elektro Sp. z o.o. is a leader in hoisting machines and shaft signalling systems based on cutting edge technologies. Our engineering base enables us to design and produce equipment custom fit to the individual requirements of any investor. MWM Elektro is trust based on experience.



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