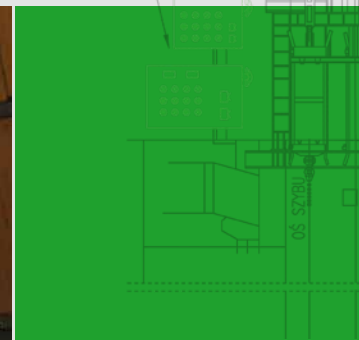




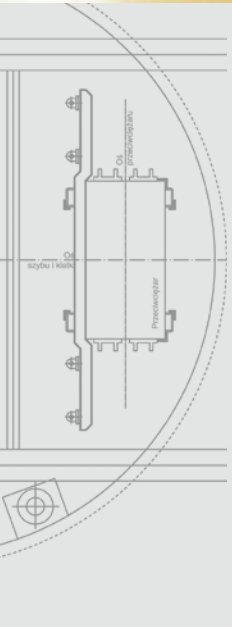
MWM ELEKTRO

## COMPLETED PROJECTS



## COMPREHENSIVE MODERNISATION OF THE CAGE MINE SHAFT HOIST IN SHAFT R-VII 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.





## Objective of the project

The main objective of the modernisation 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 transport capacity of the hoist containers from 12 to 24 Mg as well as increase the number of transported persons from 86 to 94.

## Scope of the project

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

- replacement of the hoisting machine,
- replacement of the shaft signalling and communication equipment,
- replacement of the guiding pulleys,
- reinforcement of the headframe,
- adaptation and renovation of the civil structures,
- technical documentation for the entire project,
- supply and installation of the equipment,
- overseeing the procedures related to the approval of the 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.

## 2L-5000/2400 hoisting machine

The 2L-5,000/2,400 hoisting machine is a 2-rope machine with a 5,000 mm Koepe winder, driven by the DC electric motor with direct drive transfer to the shaft. It is placed on a foundation – part of the hoisting machine building on the level near the shaft entry. It is intended for the transport of personnel and materials.

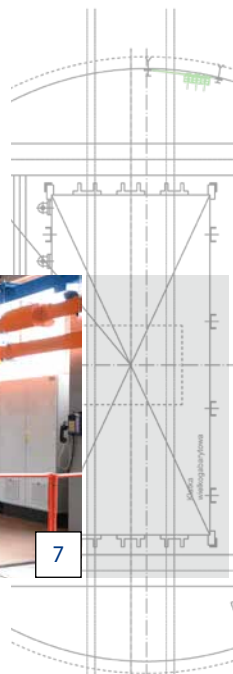
The machine is controlled:

- manually from the machine operator's panel,
- remotely from control panels at the stations or with an ECHO-S radio device.

The main components of the machine:

- main shaft unit with roller bearings and a Koepe winder,
- 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 – 2L-5,000/2,400 hoisting machine



5 - Układ hamulca  
 6 - Urządzenie "GR.  
 7 - Napęd przekaźnik



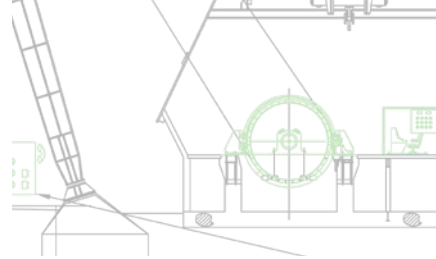
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In order to ensure the highest quality of the supplied elements and services, inter-stage inspections, investor acceptance and industry designers' supervision were provided during production.

photo 2 – Measurement of the run-out of brake discs on the 2L-5000 winding reel

The installation of the main motor rotor and installation of bearings on the shaft was hydraulic. This method enables easy future disassembly and the 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 a hydraulic-controlled disc brake system, which includes the following elements:

- two brake discs,
- four brake columns,
- eight pairs of BSFG 408-A00-02-00 brake actuators – two pairs per column,
- 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 variable braking moments. The application of this type of braking guarantees the alleviation of the emergency braking effect on the elements of the mine shaft hoist, such as wire ropes, container guides, suspensions, etc.

photo 5 – H-C MWM-4/VER.III electrohydraulic control and power unit

Furthermore, the braking system is equipped with the following devices:

- "GRAVIT" – gravitational overload lowering device,
- "UWDSO" – additional oil flow forcing device.

The implementation of the independent "GRAVIT" gravitational overload lowering device for the cases of machine drive damage or lack of power supply voltage enables the safe lowering of the overload in order to evacuate persons from the container to the level.

photo 6 – "GRAVIT" device

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 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.

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

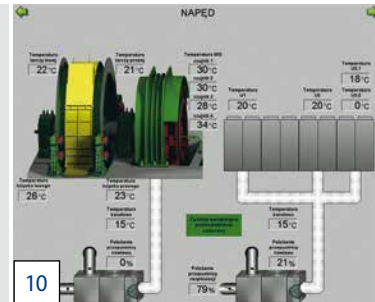
photo 7 – Thyristor drive system



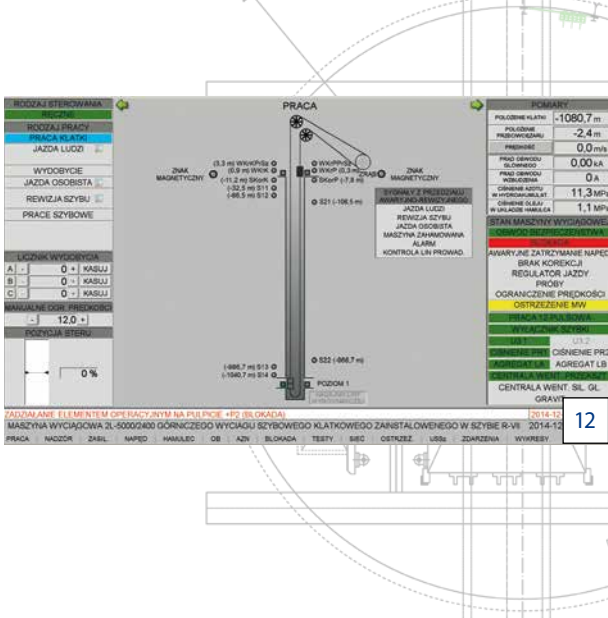
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## Shaft signalling and communication equipment

Both the main motors and thyristor inverters have independent ventilation systems with air mixing chambers for air drawn from the inside and outside of the hoisting machine building. In order to stabilise the temperature working point of the main motor, the adjustment of the ventilation central unit is implemented with a frequency converter.

photo 8 – 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. The GRZ-08 enables the control of the hoisting machine's travel diagram according to the requirements of the user, taking the nature of the mine shaft hoist into account. The GRZ-08 works as the continuous and end speeds control system simultaneously.

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

photo 9 – Hoisting machine operator's station

photo 10 – View of one of the display system screens

A vibration monitoring system was employed in order to provide actual monitoring of the wear of the bearing nodes. Furthermore, the measurement of 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.

photo 11 – Vibrations monitoring system screen



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

The shaft signalling and communication equipment has the following features:

- 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 shaft signalling and communication 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.

photo 12 – View of one of the display system screens of the shaft signalling and communication equipment

photo 13 – Signalling station

## Civil structures

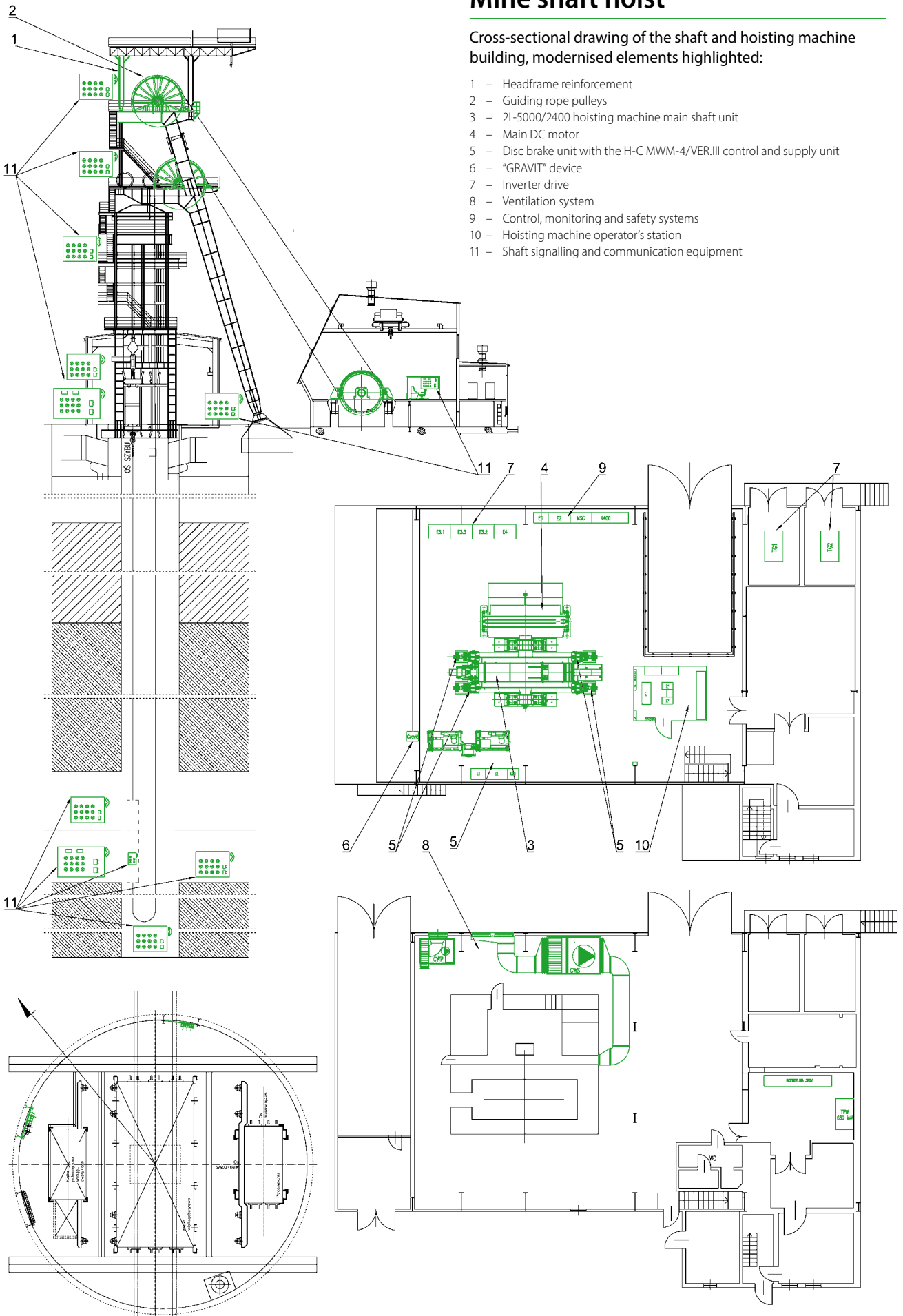
The modernisation required a number of construction modifications – for example, the staff facilities on the level of hoisting machine were decommissioned to provide space for control and supply cabinets. The freed electrical operation rooms were adapted as per the requirements of the user.

After the completion of the assembly and commissioning works, a new methacrylic resin floor was provided on the hoisting machine's level.

# Mine shaft hoist

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

- 1 - Headframe reinforcement
- 2 - Guiding rope pulleys
- 3 - 2L-5000/2400 hoisting machine main shaft unit
- 4 - Main DC motor
- 5 - Disc brake unit with the H-C MWM-4/VER.III control and supply unit
- 6 - "GRAVIT" device
- 7 - Inverter drive
- 8 - Ventilation system
- 9 - Control, monitoring and safety systems
- 10 - Hoisting machine operator's station
- 11 - Shaft signalling and communication equipment





## Headframe

The fulfilment of technical requirements for changing the diameter of the guiding pulleys and increasing the transport capacity of the hoist required the strength analysis of the headframe. Based on its results, the reinforcement of the headframe was designed and provided.

## Guiding rope pulleys

The previously used "bare" pulleys with the diameter of 6,300 mm were replaced with 5,000 mm pulleys with a Becoplast lining. The complete unit of guiding rope pulleys includes two sets of:

- 2 rope pulleys with axle and bearings,
- groove turning device.

The pulleys use a Becoplast lining which extends the life of the lifting ropes.

The device for turning grooves in the Becoplast lining is used to adjust the geometry of the rope grooves and collect the excess grease from the lifting ropes. Additionally, the rope pulleys are equipped with an incremental transducer for controlling the lifting ropes slipping.

photo 14 – Guiding rope pulleys



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## Technical specifications of the mine shaft hoist after modernisation

intended use	personnel and materials transport
container guiding	rope
hoist containers	cage with counterweight
number and diameter of lifting ropes	2 x 52 mm
travel route length	1,080 m
transported material weight	24 Mg
number of transported persons	94
hoisting machine type	2L-5000/2400 (2-rope with Koepe winder and direct drive)
maximum travel speed	12 m/s
maximum static overload	140 kN
drive type	inverter with direct current motor with 2,400 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.



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