

A P P L I C A T I O N   N O T E

HYDRO-ELECTRIC  
POWER PLANTS

SOLINA  
MYCZKOWCE  
ROŻNÓW

Supervisory and control systems  
for Hydro-Electric Power Plants

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ASKOM has delivered process control systems for the following hydro-electric power plants:

- ROŻNÓW
- MYCZKOWCE
- SOLINA

The control systems cover almost all control functions in each of the plants. The system configuration consists of a separate PLC for each hydro-generator plus one or two PLC's for the remaining installations i.e. high/medium/low voltage switchgear, de-watering systems, dam control systems etc. The PLC's are linked by the Profibus control network with 2 to 5 operator workstations and an engineering /supervisory station.

Each hydro-generator PLC controls the turbine and its entire environment (oil system, cooling system, power output systems). All start-up, stop and shut-down sequences are performed automatically. Additionally, the controller runs algorithms of protective functions responsible for safe shut-down of the turbine in emergency situations. Data transmitted to the PLC from other specialized devices of the hydro-generator (turbine governor, electrical protection devices, multifunctional transmitters of electrical measures, vibration measure system) provide the system with full information on state of each of the devices and facilitate extensive turbine diagnostics in emergency situations. The turbine may be operated in the ARCM mode since the system is equipped with an ARCM remote command receiver.

The process control system releases the operator from the responsibility to constantly supervise normal operation of the turbine and manually control its individual devices. During normal operation, his/her duties are limited to initiating the turbine start-up and stop sequences, and possibly changing the active power set value and the power coefficient set value. The process control system delivered to the Rożnów hydro-electric power plant additionally takes care of the operation of the entire plant – it starts the turbines up, sets the desired power level, and shuts the turbines down at pre-set times according to an earlier-defined schedule.

High/medium/low voltage switchgear is controlled by a separate PLC (or PLC's). The control system run all necessary interlock algorithms (both within the given field as well as interlocks between the fields) enabling safe control of the switchgear. All switches, circuit breakers, and earthing switches of the thoroughly modernized 110 kV switchgear at the Solina hydro-electric power plant may be controlled remotely.

Communication with electrical protections provides full operational control and diagnostics of the switchgear. Control system reads and stores in its databases all disturbances registered by the protections. Additional software package AsLogger developed by ASKOM allows to read data from the electrical protection, to store in database and to analyze signal waveforms with  $\mu$ s accuracy.

### Rożnów hydro-electric power plant

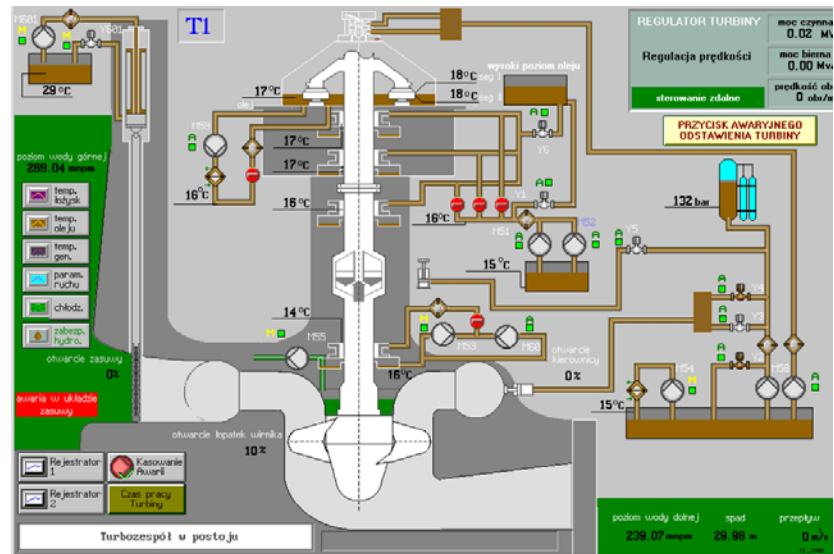
The process control system for the Rożnów hydro-electric power plant was delivered by ASKOM between 1997 and 2000.

The executed system provides:

- control of four hydro-generators of 14 MW power each
- control of 0.4 kV switchgear for internal power supply needs of the plant
- measurement of the level to which dam gates are opened
- control of plant auxiliary systems.



**Fig.1 View of the Rożnów hydro-electric power plant.**



**Fig.2 Rożnów hydro-electric power plant – control diagram of the turbine oil system**

The control system elements include:

- 5 SIMATIC S5-135U PLC's (one per power unit plus one for plant internal power supply switchgear and auxiliary systems)
- 2 SIMATIC S7-300 PLC's located at dam penstock and spills that measure dam gate opening level (the controllers operate as DP-slave fields of the general controller)
- 2 PC-based operator workstations equipped with the **asix** visualization system
- 1 engineering/supervisory station.

PLC's and computers are linked with a redundant fiber optic Profibus network.

**The power unit PLC** controls all devices of the generator electrical system and the turbine hydraulic system. It exchanges (over serial links) data with the SULZER turbine governor. This PLC is responsible for hydro-generator start-up, stop and shut-down sequences in normal operation and in emergency situations as well as for turbine protections.

**The auxiliary systems PLC** reads via serial interfaces data generated by electrical protections of all units (total 12 Alstom devices) and data generated by water level gauges.

## Myczkowce hydro-electric power plant

The process control system for the Myczkowce hydro-electric power plant was delivered between 1999 and 2001. The system is used to control:

- two hydro-generators of 4.2 MW power each
- 30 kV switchgear
- 0.4 kV switchgear for plant internal power supply
- plant de-watering pumps
- auxiliary systems of the plant.

The system consists of:

- 3 SIMATIC S7-400 PLC's (one per unit plus one 30 kV switchgear, plant internal 0.4kV power supply and auxiliary systems)
- 2 PC-based operator workstations equipped with the **asix** visualization system
- 1 engineering/supervisory workstation.

PLC's and computers are linked together with a redundant fiber optic Profibus network.

**The power unit PLC** controls all devices of the generator electrical system and the turbine hydraulic system. It exchanges data over serial link with the VOITH turbine governor, Alstom and Siemens electrical protections and with the multifunctional transmitters of electrical measures. The unit PLC is responsible for hydro-generator start-up, stop and shut-down sequences both in normal operation and in emergency situations as well as for turbine protections.

**The 30 kV switchgear, plant internal power supply and auxiliary systems PLC** controls all 30 kV circuit breakers, visualizes the status of 30 kV disconnectors and earthing switches, reads via serial links data measured by multifunctional transmitters of electrical measures in the switchgear fields and data from electrical protections (current status and the registered data of disturbances, the latter are stored in the asix system database), controls 0.4 kV switchgear for the plant's internal power supply needs, 220V DC/24V DC switchgears, uninterruptible 220V AC system and plant de-watering pumps.

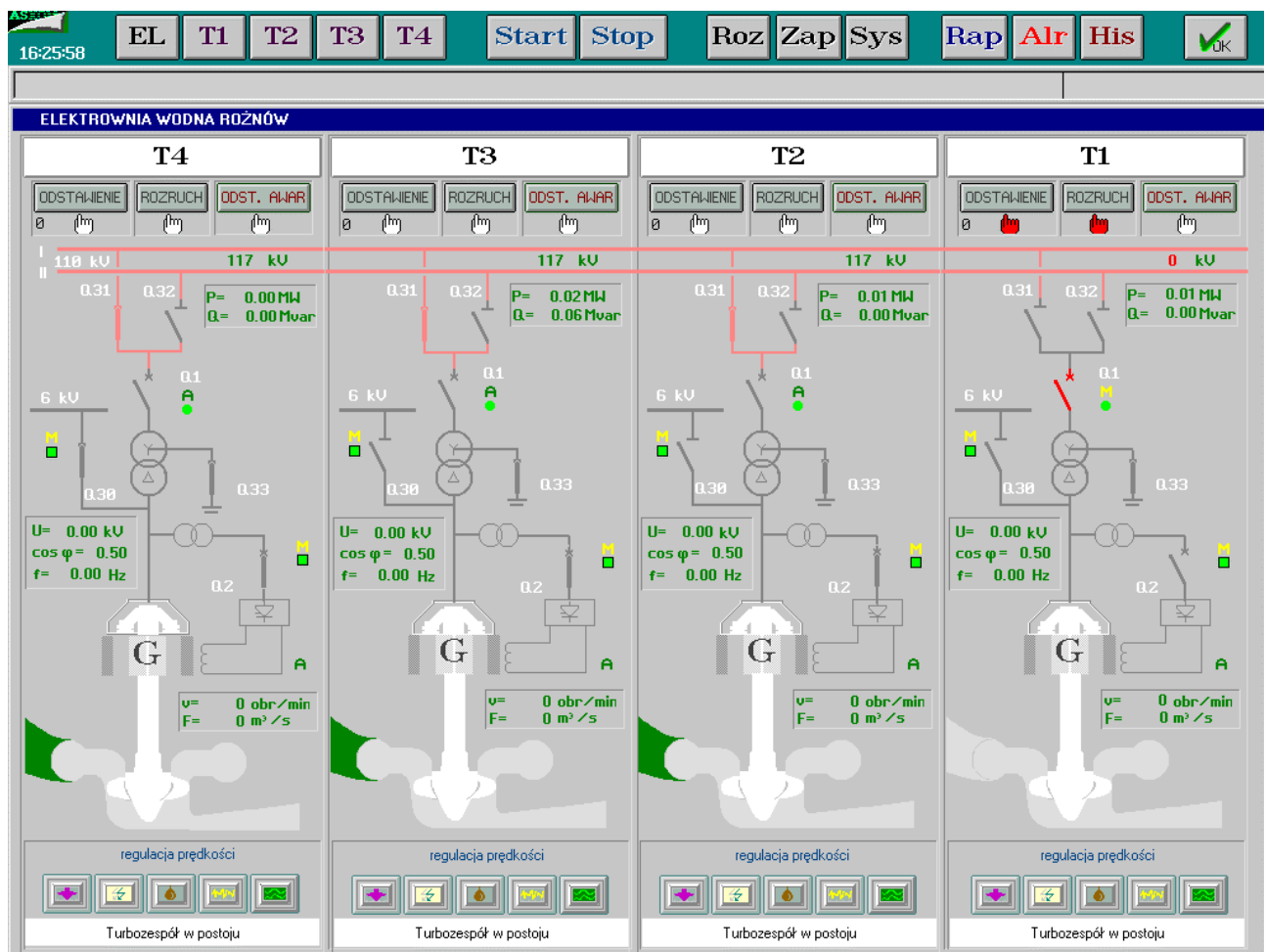


Fig.3 Rożnów hydro-electric power plant - main plant control diagram

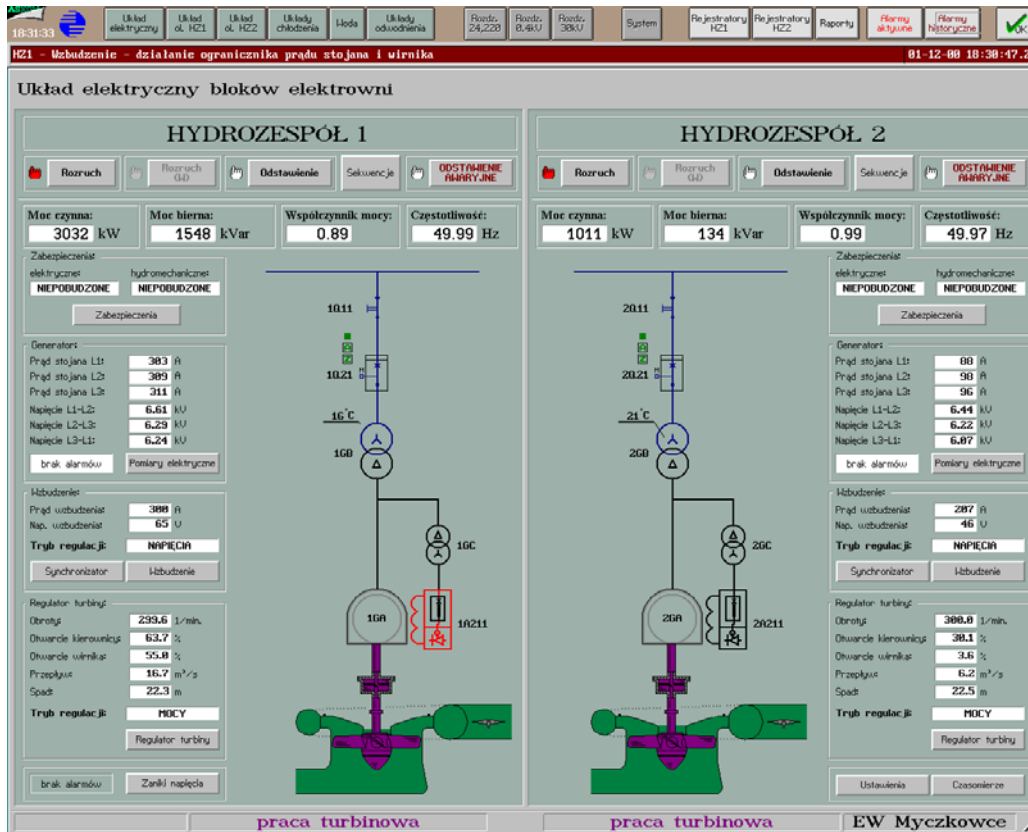


Fig.4 Myczkowce hydro-electric power plant - main plant control diagram

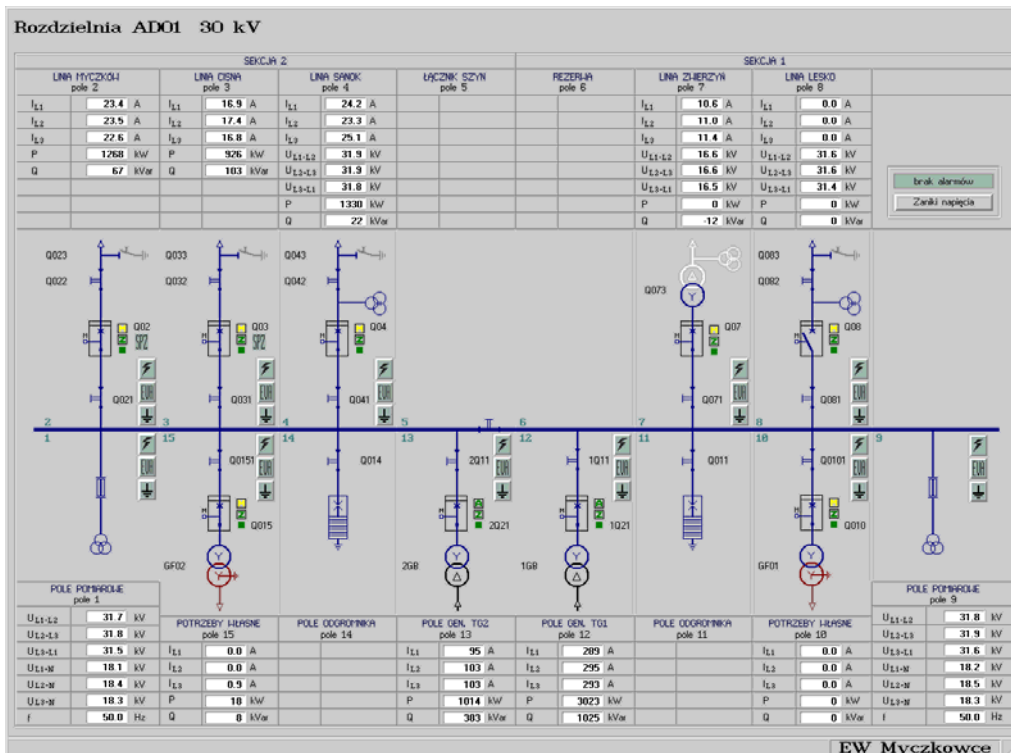


Fig.5 Myczkowce hydro-electric power plant - 30 kV switchgear control diagram

## Solina hydro-electric power plant

The process control system for the Solina hydro-electric power plant was delivered between 2000 and 2002.

The system is used to control:

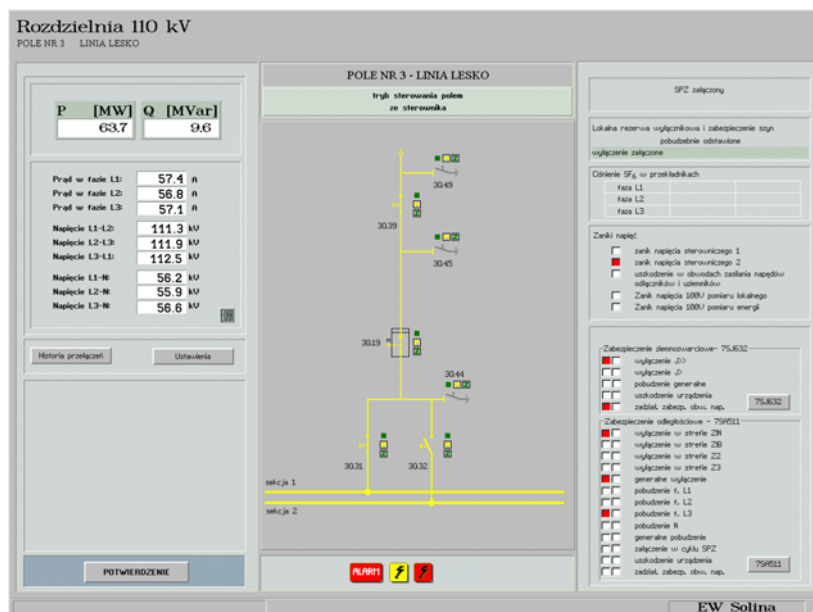
- two hydro-generators of 68 MW power each
- two hydro-generators / pumps of 30 MW power each
- 110 kV switchgear
- 15 kV switchgear
- 10.5 kV switchgear
- 0.4 kV switchgear for plant internal power supply needs (one main and 12 local switchgears)
- plant de-watering pumps
- auxiliary systems of the plant.

The system consists of:

- 6 SIMATIC S7-400 PLC's (one per power unit, one for the 110 kV switchgear and one common for the 15 kV switchgear, the 10.5 kV switchgear, the plant internal power supply 0.4 kV switchgear and auxiliary systems)
- 5 PC-based operator workstations equipped with the **asix** visualization system
- 1 engineering station
- 1 supervisory workstation.

PLC's and computers are linked together with a redundant fiber optic Profibus network.

**The power unit PLC** controls all devices of the generator's electrical system and the turbine's hydraulic system. It exchanges data over serial links with the VOITH or VATECH turbine governor, Siemens electrical protections, and with the multifunctional transmitters of electrical measures. The unit PLC is responsible for hydro-generator start-up, stop and shut-down sequences both in normal operation and in emergency situations as well as for turbine protections.



**Fig.6 Solina hydro-electric power plant – control diagram of a 110 kV switchgear field.**

**The 110kV switchgear PLC** fully controls all circuit breakers, disconnectors and earthing switches in every switchgear field, controls all interlocks, reads (via serial links) data measured by multifunctional transmitters of electrical measures in the switchgear fields and both current status and the registered data of disturbances (the latter are stored in the **asix** system database) and fast signal waveforms recorded during disturbances (stored in AsLogger database).

The MV/LV switchgear and auxiliary system PLC controls circuit breakers of the 15 kV, 10.5 kV, and 0.4 kV switchgears, visualizes status of the switchgears (measurements, read-out of data from electrical protections), controls 220V DC switchgear, uninterruptible 220V AC system, plant de-watering pumps and auxiliary systems of the plant.

The process control system of the Myczkowce hydro-electric power plant is connected with the Solina plant control system. That way the Myczkowce plant, located about 10 km away from the Solina plant can be remotely controlled from the Solina. The connection, based on redundant fiber optic Profibus and Ethernet links, provides operator workstations in the Solina plant the same functionality and reaction time as for local workstations in the Myczkowce plant. This allows operation of the Myczkowce hydro-electric power plant in the unattended mode.

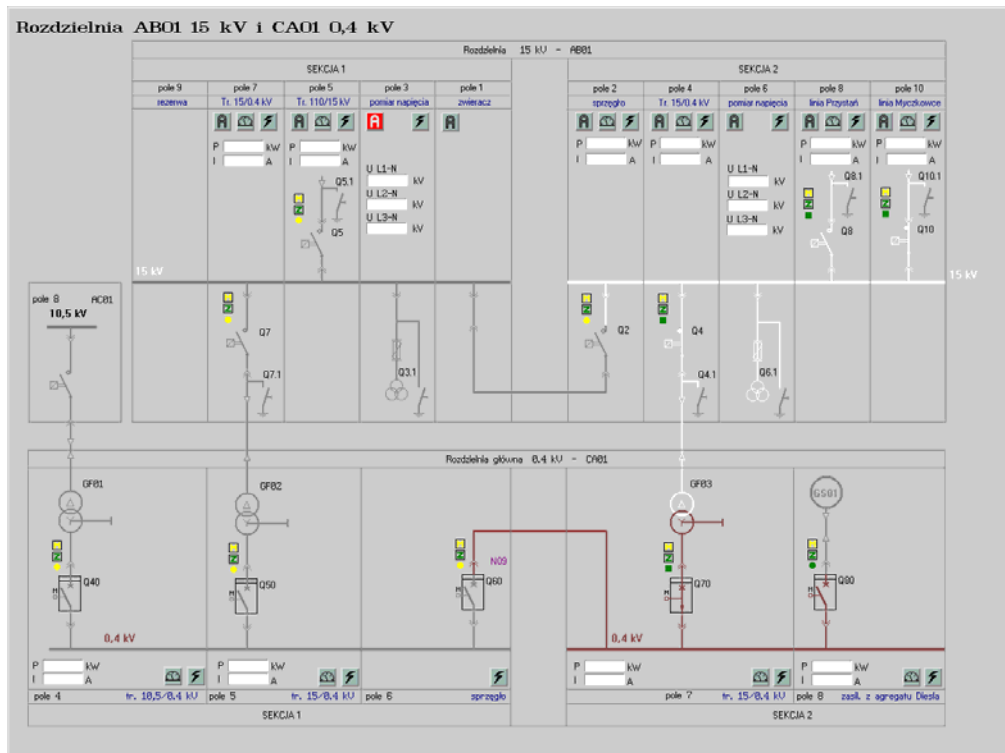


Fig.7 Solina hydro-electric power plant - control diagram of the 15 kV switchgear

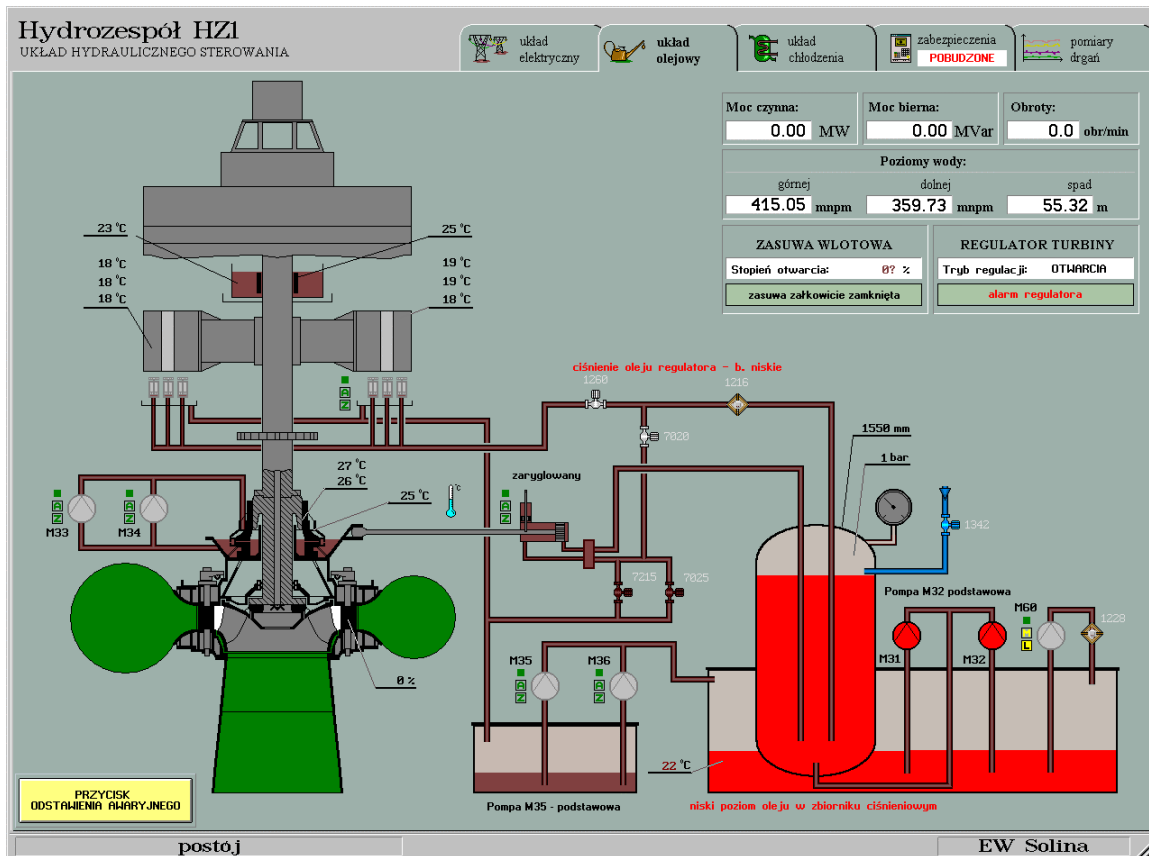


Fig.8 Solina hydro-electric power plant – control diagram of the turbine oil system