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MV variable frequency drive in heatstation Lublino, Moscow

Solution:

- **Solution provider: SPEL, spol. s r.o. Kolin CZ, Moscow company RETEMP and Rockwell Automation Canada.**
- **MV variable frequency drive with synchronous bypass system to switch motor to the VFD and supply network without pump stop.**
- **MV variable frequency drive PowerFlex7000 with 18 pulse rectifier, 750kW, 6kV**
- **Synchronous transfer provides a low-cost and elegant technical solution for sequence starting and permanent regulation of hydraulic system with more then one pump with one drive system.**

Results:

- **Operation impact: Commissioning of entire system completed in less than 10 days.**
- **Power system impact: Total harmonic distortion of current (THD) at full load was 2,1% - significantly lower than the 5% specified.**
- **Financial impact: Reduced capital casts by using only one small drive with synchronous transfer to operate multiple motors.**

Moscow company MosTeploEnergo reduce capital expenses in conjunction with modernization and maximal utilization of new technologies at construction and reconstruction of its heat stations. The price of energy and maintainance costs are joint with utilization of new modern technologies above all control systems PLC and reliable controllable drive. In heat station Lublino in Moscow were used medium voltage variable frequency drive (VFD) for 6kV.

MV VFD PowerFlex 7000 with in-phase synchronous transfer system is elegant driving system. This system reduce capital expeditures and meet the demands on plant controlled process. This is the main presumption for expressive energy saving in heat station.

MosTeploEnergo´s Lublino heating station in Moscow.

Background

Temperatures rarely rise above freezing between November and April in Moscow. Reliable and efficient delivery of heating energy is essential to improve the quality of life of resident population. Energy provider MosTeploEnergo generates and transfers steam heat to 56 separate district heating stations including Lublino heat station in the new residential region of Moscow called Lublino. Five main pumps of power 630kW, 6kV caters by heat pipeline almost 300,000 inhabitants.

Challenge

The new Lublino heating station was needed to meet customer´s increasing demands. Maintaining efficient energy consumption and low harmonic distortion values were also required to minimize its impact on the electrical distribution system.

Traditionally, water pumps in Moscow were run directly across-the-line and the presure in the system was maintained with a regulation valve arranged either in series with the pumps (throttle method), or in parallel with the pumps (shunt method). While the regulation valve solution is initially economical, because it requires less equipment, its inherent inefficiencies and maintenance requirements add to costs in the long term. Additionally, low mechanical reliability and mechanical and electrical starting stresses limit tjis method.

Main pumps and motors at Lublino heating station.

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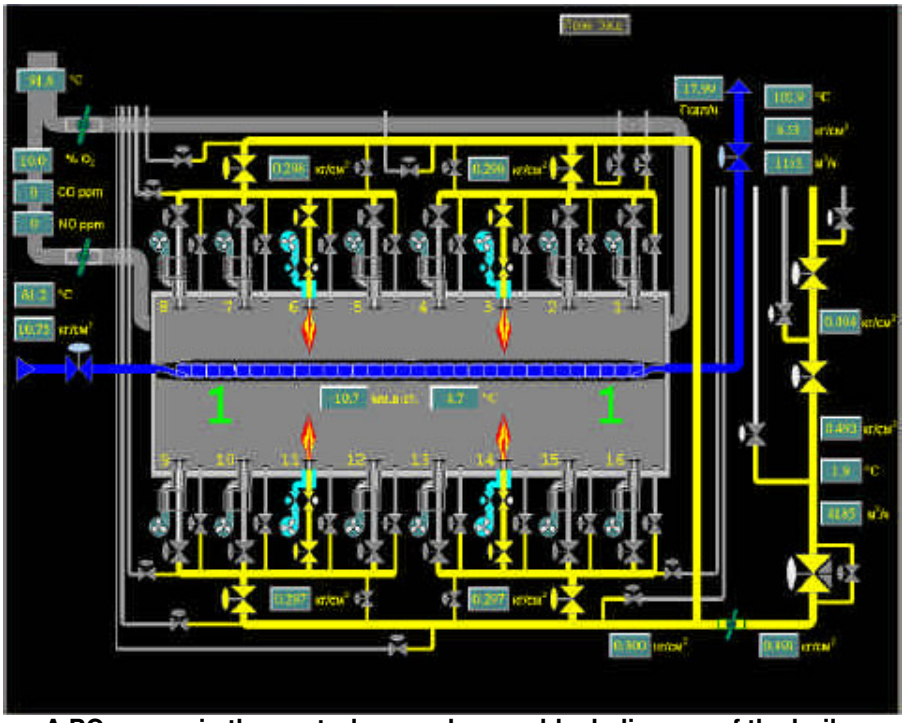
To meet the application demands SPEL, spol, s r.o. cooperated with company RETEMP in Moscow, which were the main provider and sponsor of whole action.

The specific project objectives of the Lublino heating station were to:

- reduce additional losses from throttling valves
- increase operation stability of the heat station
- reduce thermal and mechanical stress on motors that are started frequently
- minimalize the harmonic distortion and influence of VFD to supply network
- reduce the electric energy consumption and related costs
- ensure the recovery of investment in a shortest time as possible

Solution

Instead of using valves, the team decided to use VFD to control pump speed, flow and pressure. They chose the Rockwell Automation PowerFlex 7000 18-pulse medium voltage drive with synchronous transfer as the best solution.



A PC screen in the control room shows a block diagram of the boiler technology used at the Lublino heating station.

The PowerFlex 7000 drive is an ideal soft starting and speed control method for pump motors because it:

- at start up the VFD doesn´t load the supply network by starting current of motor like classic start up without VFD
- reduces mechanical shock of machine set (starting torque is controlled at nominal levels), extends its durability
- makes it possible precise technology control through to better regulation feature of hydraulic system through VFD speed response for pressure and flow control
- provides cost savings and system flexibility by using one VFD with synchronous transfer capability, and several input/output/ bypass contactors for multi-motor operation
- permanent economies of electric power when the pump is run from VFD on lower then nominal speed compared with throttle method
- increases overall reliability and maintainability

Rockwell Automation´s PowerFlex 7000 uses a current source inverter drive technology with a pulse width modulation switching pattern on the inverter. This topology allows the easy connection of power semi-conductors in series for use in the higher range of medium voltage (in this case 6kV) without a step-up transformer. This technology decreases the amount of space required for drive mounting and reduces cost. It also provides near sinusoidal input and output waveforms for current and voltage.

The synchronous transfer solution provides a low-cost and space-efficient system to start and operate more than one motor with one drive system. It allows motor systems to have reduced starting current and be transferred between the drive and a fixed frequency line supply without stopping. Compared to a simple non-synchronous transfer in which power to the motor is interrupted for a significant lenght of time and fall of speed led to system shutdown, the transient drop in motor speed is much less with synchronous transfer.

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In order to perform an in-phase synchronous transfer, both a drive output contactor and a bypass cantactor are required for each motor. The „bypass“ is a contactor tahat connets the motor directly to the fixed frequency supply, bypassing the drive.

This elementary function, synchronous transfer, is use very often and offer permanent demands on controlling of all pumps in system.

The power structure of Lublino heat station is create by 10kV system. For VFD with 18 pulse rectifier power supply is used 4-windings isolation transformer. The secondary windings shift about 120° reduce harmonics transfer to the supply network. The main part of drive is VFD with 6,3kV nominal voltage. VFD makes the conversion from input constant frequency of the constant voltage to the variable frequency of the variable voltage, so that it can control the speed of the pump motor. Then follows the output contactor with isolation switch.

The last part before every motor is power cabinet. This unit can connect the motor direct to the supply network (bypass) or to the VFD.

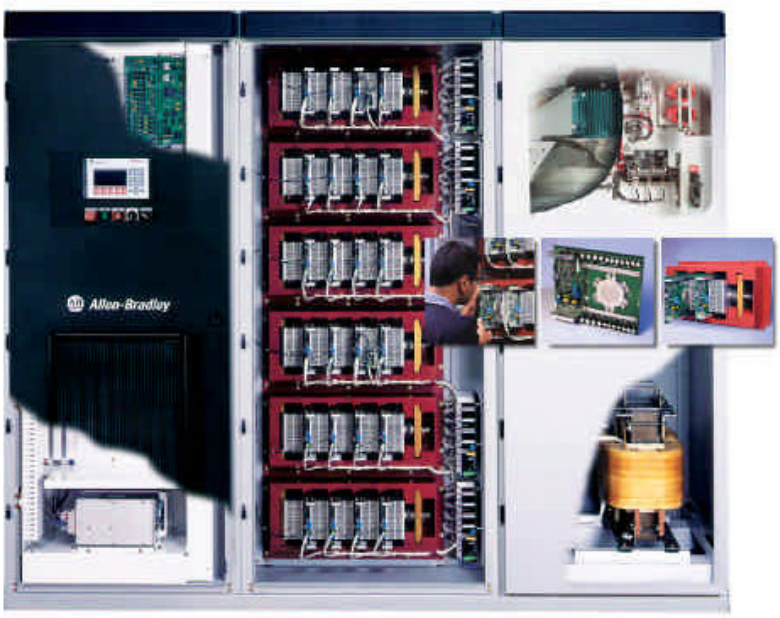
Motor protection protect the motor before overload. Both the hand-control isolation switches are mechanically connect and control by one lever on the cabinet door.

The whole system is controlled by VFD and PLC installed in VFD control blok. PLC control all parts of synchronous transfer. The synchronization must be controlled very precisely when this mode is activated and when the motor is switched from the VFD to the bypass and back.

Control system gives the control over the cabinet of motor to the VFD before execute the transfer and after the transfer execution takes the control over the cabinet back. VFD PowerFlex 7000 is ideal solution in the matter of course of phase and voltage on the motor in execution of synchronous transfer.

Results

The successful commissioning of the entire system was completed in less than ten days, in part to the testing procedure developed by the experienced team of one SPEL, spol. s r.o. engineer, one Rockwell Automation engineer and one RETEMP engineer.



Medium voltage variable frequency drive Power flex 7000.

The project was commissioned on November 8, 2001 Mr. M Korshunov, Technical Manager of Lublino heat station was impressed with the quality of the product and the knowledge of the engineering team. „The new equipment has been used to start and run the pumps and no problems have occured during this initial pariod of operation“ he said. „This satisfactory result demonstrates the good quality of the work done by SPEL, rockwell Automation and RETEMP. Thanks to the exhaustive tests that were carried out in Cambridge, it was possible to commission the installation in short time. The commissioning engineers, Vladimir Kraft, John Lyle and Michael Sypchenko, were first class. We are very satisfied with the way the work was carried out and with the results.“

On November 16, 2001 RETEMP performed the harmonic analysis of the drive system at full speed and full load for one motor. The system met or exceeded the project criteria. The total harmonic disturbance (THD) during motor running was 2.1%. Much less than the published limits for total harmonic current distortion for medium voltage systems, which is generally specified as no greater than 5%.

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Following implementation, Mr. M. Korshunov Technical Manager of LDHS wrote, “Owing to the 18-pulse technology, the line harmonics are a great deal below the limits defined by Russian standards. Rockwell Automation’s installation of the medium voltage drive in the heating station has completely eliminated all potential problems. We are very happy with this excellent solution.”

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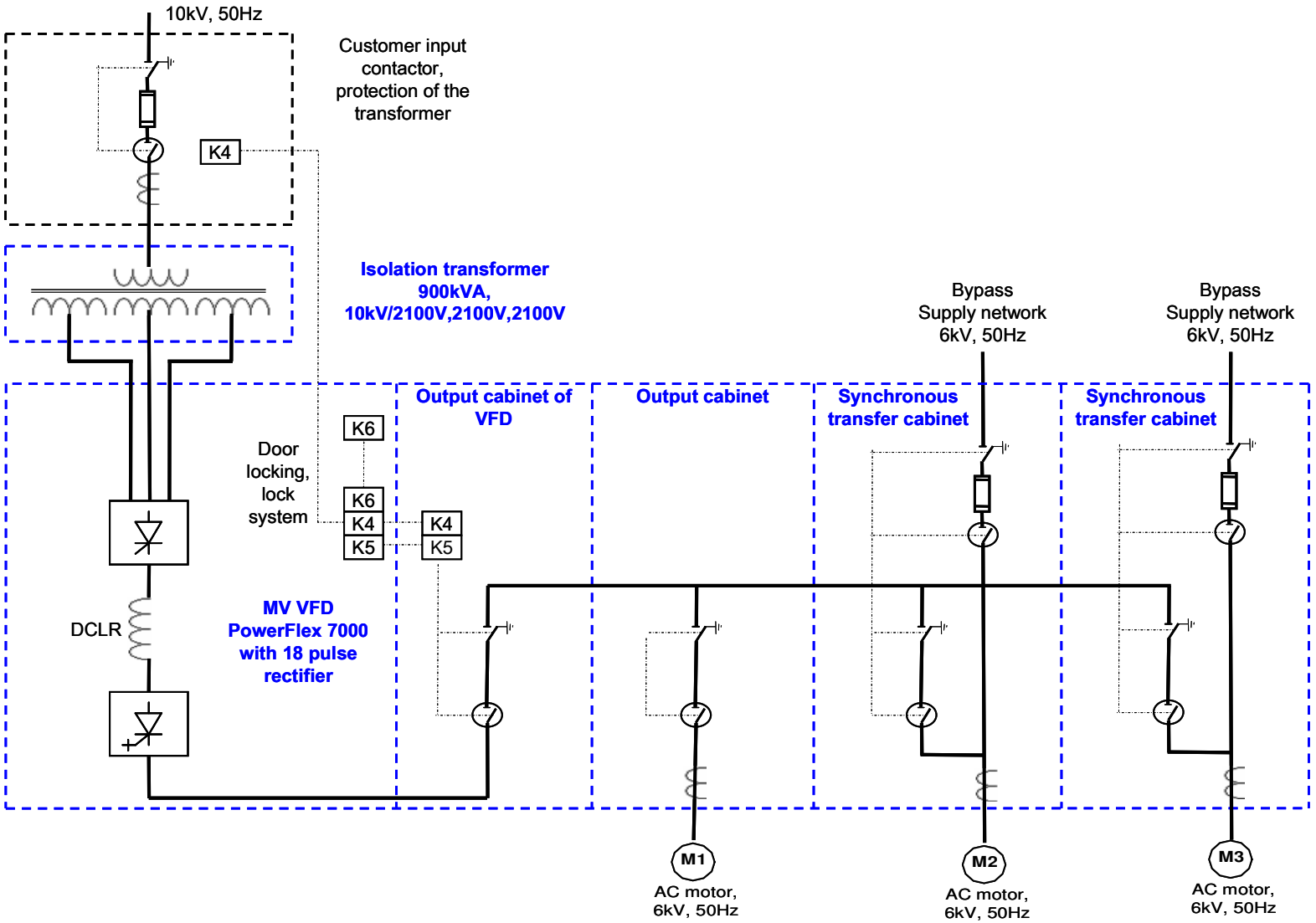

One-line drawing of the topology used in the Lublino heat station.