

# ARS-TSControl 350 MW

System for regulation and protection of the thermal block steam turbine



## TPP „Kostolac B” Drmno, block 2

Financed by: EA „Thermal Power Plants and Mines” plc- Kostolac, Serbia

Project completion year : 2011

### PROJECT DESCRIPTION

The Block 2 of the thermal power plant “Kostolac B” (TPPKO-B) in Drmno was the youngest thermal power unit in Serbia until 2014. Production in it began in 1991. The basic units which are characteristic for the technology of the electric power generation of the block B2 are:

- one-pass steam boiler, type SULZER (nominal steam flow 1000t/h, pressure 186 bar and temperature 543°C)
- four cylinder - single axel – reaction – axial -condensational steam turbine 18K350, produced by Zamech, Elblag, Poland, by BBC licence, nominal power 350MW (Figure 1).



Figure1 - Block TPPKO B2 steam turbine, 350MW

Many problems occurred at the beginning of the plant operation – frequent block outages, interferences in functioning and operation with the power significantly lower than required by the project.

Owing to the serious mechanical and electrical reconstructions of the boiler and turbine units in the period from 2007 to 2012, a stable block operation was achieved during 2012 at the projected 350MW active electrical power. Thus it became one of the most stable power plants in the Electric Power Industry of Serbia.

In order to solve one of the key problems – the state of the steam turbine stator and rotor blades, this part of the system was reconstructed. The necessity for the modernization of the turbine control system was considered, which included replacement of the steam turbine control valve with the complete hydraulic drives and a part of the system for the oil preparation and also implementation of new turbine control – protection system, based on the digital automatic control systems.

The Institute “Mihajlo Pupin” (IMP) and TPPKO-B have cooperated

successfully for many years in the project of modernisation of the measurement, regulation and control system of the boiler units of the blocks B1 and B2. Such cooperation continued through implementation of the project of replacement of the existing steam turbine control system Turbotrol®4 BBC with the new system ARS TSControl, based on VIEW® T-POWER DCS, manufactured by the Institute “Mihajlo Pupin”.

Some of the basic technical requirements of the Investor TPPKO-B, which should be fulfilled within the modernisation of the turbine control-regulation-protective system, were:

- to possess all functionalities as the former Turbotrol®4 BBC,
- to achieve stable and simple integration with the existing DCS of the boiler plant, using the minimum number of the additional communication modules. Although two similar IMP production systems were integrated, communication was performed by the standard industrial communication protocol IEC 60870-5-104/101,
- that the control system should belong to the third generation of the systems which could function stably in the cases when two and more mistakes occurred in the parts of the control system (such as measurement or regulation actuators failure, module failure, communication failure, etc),
- that modification and setting of the master automatic regulation circles of the boiler units should provide the advanced coordinated boiler-turbine system control and stable regime of the “sliding pressure”. That should include control of the boiler firing and regulation of the fresh steam pressure, as well as regulation of the total air quantity in the boiler and feeding water flow.

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Modernisation of the hydraulic part was entrusted to the Polish company ALSTOM Power from Elblag since it was the successor of the original turbine manufacturer. The complete valve chambers of the high and medium pressure cylinder were replaced. Also, hydraulic control and protective system for 4 high pressure valves, 4 medium pressure valves and 2 low pressure valves of the bypass were reconstructed. The fail-safe proportional valves, produced by Vickers, were used as electro-hydraulic servo drives. By this reconstruction, the mechanical-hydraulic position interdependency per 4 valves in the stated groups was realized in the digital system part, delivered by IMP. Upon the mechanical reconstruction, the hydraulic system was simplified for maintenance due to the smaller number of components.

### APPLIED TECHNOLOGY

ARS-TSControl (Figure 2) is a protective-regulation system of the steam turbine based on the ATLAS MAX-RTL® controllers and VIEW6000® SCADA system, manufactured by the Institute "Mihajlo Pupin". The above mentioned controllers belong to the ATLAS® family of the processing units, but they are specialized for control and protection of the turbine unit by introducing new I/O modules for measuring speed of the turbine ATLAS®-BPC. In the terms of software, the monitoring of the digital modules accuracy has been significantly improved. Thus the ATLAS® unit system has got the subfamily of the units which are able to meet the demanding requirements for controlling such units. The system consists of the following:

- **Protective part of the system**, which is designed using the "2 out of 3" principles in the entire protection circle (from sensors in driver, via I/O modules, controllers to the executive protective hydraulic block). Thus all the requirements of SIL3 reliability are fulfilled completely,
- **Regulatory and control part of the system**, which controls turbine regulation valves. The automatic turbine speed and power controllers are implemented there, as well as fresh steam pressure controllers in front of the turbine. Then, limiter functions, which reduce the load of the plant in case of unallowable vacuum values in condenser, sudden fresh steam pressure fall in front of the turbine, and unallowable thermal load of the rotor of the high or medium pressure turbine (thermal-stress calculator). The "2 out of 2" principle was used in designing regulatory and control part of the system.

The system is implemented modularly so that in case of failure of one of the electronic parts (I/O modules, controllers,...), it is possible to carry out any replacement during the plant operation. The entire application software is realized in graphical environment according to the standard IEC 1131-3, so that it is possible to analyze code simply.

### ACCEPTANCE AND OTHER TESTS

In order to verify the achieved modernisation results, upon the work completion, the acceptance tests of the plant were performed. The Polish company INWAT was engaged for testing with a prior approval by contractor and investor. In April 2011, the performance test was carried out in accordance with the standard EN 60953 - 2:1995 "Rules for steam turbine thermal acceptance tests". The performed testing confirmed that the input power of the modernised plant, for the guaranteed flow of the fresh steam of 277,78 kg/s was 350,453 MW. Based on the obtained results, the official renaming of the turbine type from **18K348** to **18K350** was made.

During 72 hours of the plant trial operation, the internal testing of the turbine control-protection system was performed by contractor and investor according to the recommendations defined in IEC 61064 "Acceptance tests for steam turbine speed control systems". Testing referred to the performances of the turbine automatic rotation speed regulation in the work regime when the block is connected to the grid and beyond it.



Figure 2 - ARS-TSControl

### ADVANTAGES OF THE APPLIED SOLUTION

Considering that 93% of the hardware components and 100% of the software are produced by the "Mihajlo Pupin" Institute, delivery of the spare parts does not depend on other suppliers. Thus, the first-class support is provided even after the warranty period regarding the shortening of the response time to the call, the spare equipment compatibility and system upgrade after the long-term exploitation. Implementation of the ARS-TSControl system provides that the technological units of boiler and turbine function as a unified system which has proved to be optimal in terms of the plant utilization, especially in the plant work regime which is called "sliding parameters". This is particularly important if one takes into account the increasing need for introducing the thermal power plants into the system of the secondary regulation of the Power Industry of Serbia.