ARS-AMEG
SIMULATOR – TRAINING SYSTEM

institute **MIHAILO PUPIN**

Investor: CE "Thermal Power Plant Nikola Tesla" Ltd. Obrenovac, Serbia
Object: TPP „Nikola Tesla A" Obrenovac, Unit 4
Year of project completion: 2013

DESCRIPTION

The Thermal Power Plant "Nikola Tesla A" (TPPNT-A), which consists of 6 units with total installed power of 1.650 MW, is not only the biggest thermal power plant in Serbia, but also a leader in successful implementation of modern technologies in exploitation and maintenance of the productive facilities. Successful long-lasting cooperation between the Institute Mihajlo Pupin (IMP) and TPP "Nikola Tesla" in the modernization of measuring – regulation – control system for the thermal power plant units A1, A2, A4 and A6 has been continued with the realization of the development project for design of the simulator of technological process and control system for the complete thermal power plant. The Unit A4 is chosen to be a reference unit for simulator design for several reasons:

- units A3, A4 are A5 are of the same type, thus the developed simulator can be implemented on all three units with minimum modifications,
- the Unit A4 is controlled by the VIEW® T-POWER Distributed control system (DCS), manufactured by IMP, with which the plant professional personnel have already had experience in exploitation and IMP experts in installation, modification, setting and maintenance of the system,
- the long exploitation period of the unit A4 is predicted owing to the good condition of the equipment and applied modern technology in the electricity generation.

The Unit A4 consists of two main technology units:

- Benson circulating steam boiler (steam flow 920 t/h, under the pressure 186 bar and temperåture 543o C),
- steam turbine with one cylinder of high, medium and low pressure of nominal power 308.5MW

The master DCS of the Unit A4, which controls boiler unit and integrates all other control systems into one single unit, is VIEW® T-POWER DCS, produced by the Institute Mihajlo Pupin. It is realized by integration of the process industrial controllers (types ATLAS® MAX and ATLAS® RTL) and software package SCADA VIEW6000®. The ALSTOM P320 TGC electronic turbine regulator controls turbine unit and low pressure bypass, while the CCI Sulzer system AV6+ controls high pressure bypass unit.

Electrical part of the system, synchronizer and generator excitation are produced by the Institute Nikola Tesla, whereas electrical protections are products of many specialized suppliers of these systems.

The main technical requirement which the simulator has to fulfil is **to model the entire process of the electricity production on the unit A4.** Hence it is necessary to encompass the following unit modes: boiler feedwater supply, ventilation, ignition and parameters setting via high and low pressure bypass, turbine run-up to 3000 rpm and synchronization, raising load to the low and high pressure bypass closure, continuation of increasing/decreasing load with desired gradient to the nominal power/technical minimum, unit operation in boiler-turbine coordinated mode and fresh steam pressure control mode, as well as, unloading block until turbine turns off. In addition, it is also necessary to simulate **specific critical modes,** such as rejecting load due to failure of one of the unit vital units: flue gas or fresh air fan, one of the feeding pumps, disconnecting generator from the grid due to electrical protection and leaving turbine idle, opening 400 kV switch – island work, as well as, turbine protection trip. All other regulation circuits on the unit, which are not included in the above items, should be simulated. Also one of the requirements is that **the operator display (HMI) must be identical to the real unit,** retaining all manipulative specificities, complete alarm signalization, measurement graphics, etc.

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APPLIED TECHNOLOGY

ARS-AMEG simulator-training system of the thermal power unit presents 1:1 simulation of the unit technological process with complete control system.

The complete simulator hardware consists of computer with enough powerful hardware configurations for demanding simulator software packages function. All DCS components are configured on the computer as virtual machines of the Real Time Linux operative system. ARS-AMEG simulator-training system applications and VIEW® T-POWER DCS are run on virtual SCADA and HMI servers and RTU's, resulting in a simulation of the real DCS and controlled technological process. For the purposes of ARS–AMEG simulator of TPP "Nikola Tesla" A4 Unit, the following is implemented:

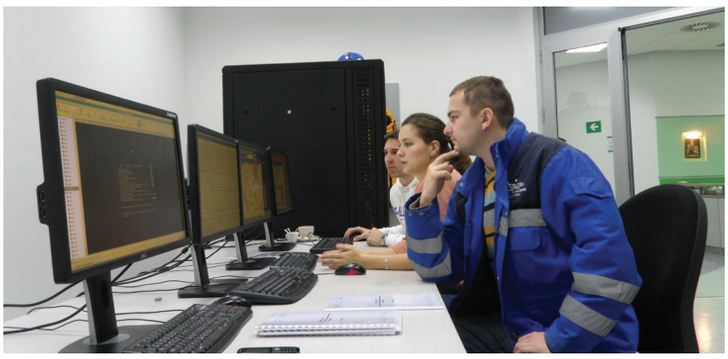
- one SCADA server VIEW6000®, which is at the same time an engineering station,
- two HMI operator stations and
- one ARS-AMEG simulation server where the complete unit technological process is simulated and all unit control systems are emulated.

Control system emulation implies the identical implementation of RTU stations for boiler control (ATLAS® MAX). Afterwards, the ALSTOM system for turbine control and SULZER system for BPVP control are emulated, as well as systems for controlling power plant electrical installations. Emulations of these systems are interconnected with identical communication protocols, the same as on the real unit (MODBUS RTU). Emulation of the systems that are not in the original IMP delivery is done on the basis of available documentations of the equipment supplier.

The designed simulator is modular, because the basic hardware version can be expanded with additional operator and engineering stations, which provide an increased number of jobs according to users' needs.

The model of the thermal power unit is based on the physical laws which define operation of the real object, primarily on the laws of conservation of mass and energy and thermal dynamic calculations.

All processes in the plant are modelled: transport, fuel processing and combustion, air supply to furnace and further flow of the flue gas to the stack exit, water heating, evaporation and superheating, condensation after passing through the turbine, turbine unit, and heat transfer through the system. Also, all actuators in the plant are modelled: valves, pumps, damper, fans, mills, passers, etc. All measurements of the physical quantities which exist in the real system are obtained from the model: pressure, flow, temperature, feedback from the actuators, etc. Unit A4 process model simulates from the plant the following: 2112 analogue measurements, 4648 digital input signals, 1174 digital and 148 analogue command signal. It is even possible to calculate measurements on arbitrary points in the process without real sensors providing detailed insight in the system operation. As a basis for process modelling the archive measurement data from the real unit are used enabling thus the precise process model setting in order to obtain as precise responses as possible which are characteristic for each thermal power plant.



SYSTEM ADVANTAGES AND JUSTIFIABILITY

The complete development project of the simulator-training system was done in 14 months in cooperation between engineers from TPP "Nikola Tesla" and IMP. Thanks to this cooperation in the area of process control, it is possible to offer to the PE "Electric Power Industry of Serbia" a simulator as a unique software package. In this way we make a product that is a result of a national development necessary for improvement of the future exploitation of the thermal power units which can be delivered only by a few institutions in the world at much higher prices with closed technology and solutions. The realized simulator reflects behaviour of the system in all operating modes, and its use is indispensible for training operators to control the real power plants. Staff training on the simulator provides the increased degree of stability in the real power plant operation. Also, the engineers use the thermal power unit simulator to test the operation of the new control algorithms and automatic systems before implementation in the real unit. The analysis of the technological systems using simulator enables efficient development of the advanced control algorithms and optimisation of the thermal power unit process.

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