

STEAM GENERATOR WATER LEVEL CONTROL SYSTEM (SGWLCS)

One of the most important for the normal unit operation systems, related to the safety and reliability of the units. The main objective is automatic maintaining of the SG level within acceptable limits (below protections and interlocks) from 0% to 100% of the power in normal operation conditions and in case of transients in the SG control parameters - level, steam flow, feedwater flow and/or pressure/temperature. To achieve this objective selection is made for:

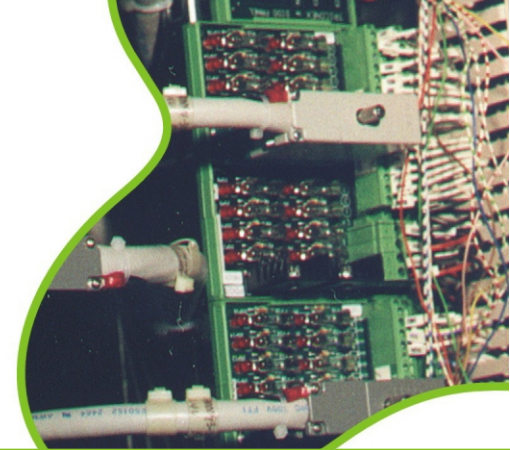
- Programmable controller of last generation, with successful reference class 1E application
- Cold overpressurization protection systems for units 1 to 4, Nuclear Power Plant, Kozloduy, Bulgaria;
- Efficient feed water control valve, and modern instrumentation.



The steam generator water level control system, cabinet

The new SGWLCS System overcomes the deficiencies of the old system:

- Very low accuracy of flow measurements (a proper indication of flow can be obtained from 25% FS upwards);
- Absence of pressure and the temperature compensation of SF and FWF measurements;
- Valve long response time -full opening/closing -35s to 40s, which causes problems in maintaining the SG level during some transients;
- Low reliability of the valve position sensors;
- Absence of automatic detection of a transmitter failure;
- Low reliability of transmission of signals from the PI controller to the valve actuator.



Proposed features

The new system utilizes

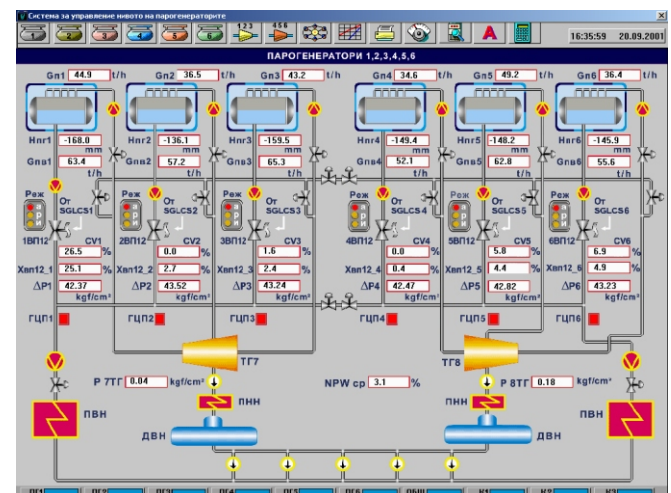
- Modern technology, overcoming the identified problems by using reliable transmitters, triple modular redundancy and automatic validation facilities;
- Proven microprocessor technology for control functions;
- fast response control valves with adequate capacity
- automatic control of SG level, from 0% to 100% of the load, covering also the design transients;
- The equipment is "maintenance free" between refuelling outages

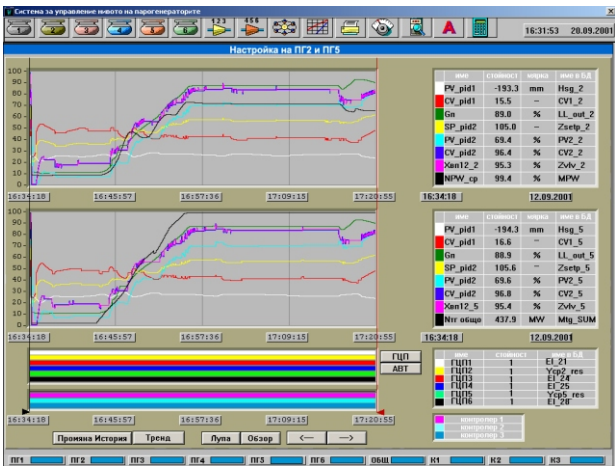
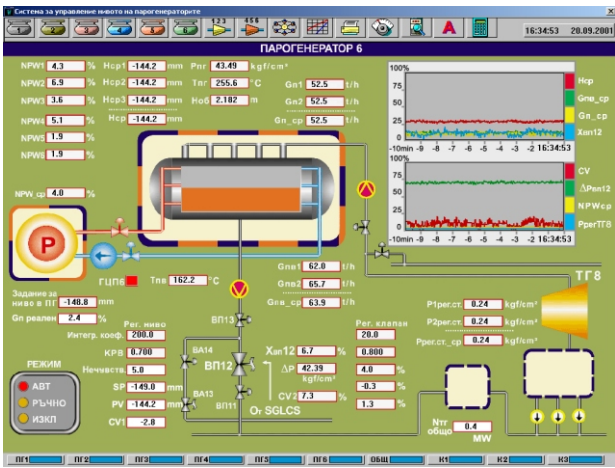
The system also has the following functions:

- Fault detection and appropriate automatic actions;
- Shrink and swell compensation due to pressure variations;
- Smooth transfer functions when switching from manual to automatic operating mode or backward;
- Suppression of hunting between steam generators

System structure and parameters

The system is based on Triple modular redundant controller TRICON, ver. 9, class 1E certified. The controller ensures 100% availability, which eliminates stoppages, caused by system failure. The powerful processing and data storage capability of the controller enables flexible and adaptive control algorithm to be performed. These unique features will allow new diagnostic and control functions to be integrated in the future. The system provides sensor dual and triple redundancy, which is distinguishing feature, compared to the old control systems. The measurements of the water level are triple redundant. Water and steam flows and the pressure on the first stage of the turbo generators are dual redundant. Special algorithm allows removal of a failed transmitter and replacement with a new one online. All transmitters are provided with dual power supply. The actuators are class 1. The 380V AC Supply to the actuators is in accordance with the Power supply system in the nuclear unit.

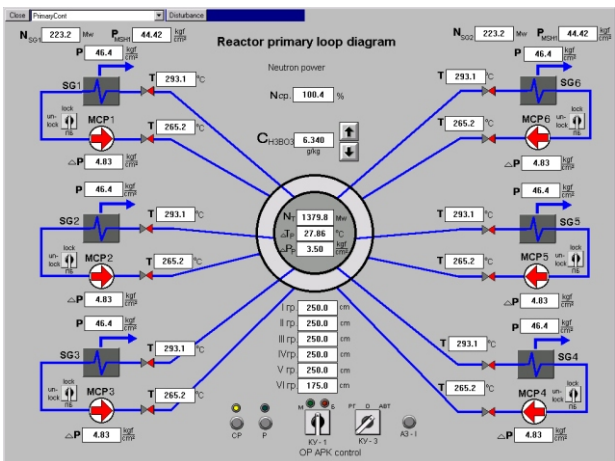




Software

The modern structure of the basic software of platform is another distinguishing feature of the system. It is based on the IEC 1131 standard function block programming. The basic software and the configuring module are proven through thousands of applications, most of them critical process control and protection applications. It is certified by TUV and has finished successfully the tests for 1E applications, required by NRC.

This truly universal control platform provides excellent means for developing and applying adaptive algorithms for this application. Dual and triple redundancy of the instrumentation, together with reliable algorithms for assessing and isolating the bad input signals prevent the system from erroneous control and indicate the failed transmitter on time, restructure the control algorithm accordingly and permit replacement of the failed transmitter online.



Simulating facilities

The simulating facilities, used for development, were implemented, in two directions:

- Static testing
- Dynamic testing

The dynamic simulator contains the models of:

Six steam generators and the associated equipment, including:

- The nuclear reactor
- The primary coolant loops
- and
- The corresponding controllers.

Standards, erection and installation

THE SYSTEMS ARE QUALIFIED in accordance with the STANDARDS :

ПН АЕ Г-1-011-89,

ANSI /IEEE 323,

ANSI /IEEE344 AND ANSI/IEEE 382,

including seismic qualification.

Seismic reinforcement of the SGWLCs cabinets and their supports is foreseen.

