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ENHACEMENT OF AUTOMATION CONTROL RELIALIBILITY OF ENERGY FACILITIES IN ABNORMAL OPERATION MODES, BASED ON APPLICATION OF MICRPROCESSOR MODULES

For the enhancement of reliable operation of information-control systems of software – hardware complex of automatic control systems of energy facilities technological processes it is suggested to improve software – hardware and engineering tools of microprocessor systems by mean of introduction of the module of failure characteristics determination in the course of abnormal operation modes of electric engineering equipment. Microprocessor systems operation modes are considered: readout, recording, input, output, data exchange, commands selection in conditions of deviation of technological process parameters at nuclear power planst units and thermal power plants units.

Key words: *information-control systems, software-hardware complex, automated systems of technological process control, electric energy facilities.*

Introduction

In “Strategic Program of development and improvement of energy branch of Ukraine for the period till 2030”, approved by the Cabinet of Ministers of Ukraine various measures, aimed at up-grading of automatic control systems (ACS) of various energy facilities, are provided.

One of the main directions of the development of software – hardware complexes of automated control systems of thermal stations and nuclear power plants units of Ukraine (PTC ACS TP) is automation of online control process and timely identification of failure features in abnormal operation modes of the equipment, main reason of their emergence is deviation from the norms of technological process parameters. However, as the analysis of greater part of damages and failures at thermal and nuclear power plants of Ukraine shows, as a result of the lack of the validity check control, false operations and technological equipment failures occur, on the whole this influences the decrease of functional reliability [1 - 4].

As it is known, the increase of reliability is achieved, first of all, at the expense of systematic and quality of on line control over the state of electric equipment, enabling to decrease the possibility of failures or damages in case of emergency situations as well as decrease of the probability of faulty actions of the staff, especially in non-stationary modes and emergency situations. Improvement of the stability of technological processes also contributes to reliable functioning of the equipment [5 – 7].

Provision of high level of ACS TP equipment readiness to perform its functions (probability of failure to perform the protection function - 10^{-7}) is mandatory.

On the level of components: units, equipment the reliability is achieved as a result of high quality of component parts and technology of their manufacture. On system level – reservation is the main method of providing necessary reliability. Generally accepted is to use voting (majority principle) “2” out of “4”, “2” out of “3”, “2” out of “2”, etc., in specific cases for these structures the requirement of failure infeasibility by common reason (supply failure, fire, etc.) is applied. In these cases, system reservation on complexes level is performed.

However, the important feature of complex systems is the asymmetry of failures and voting structures are not sensitive to failures of various types, that is why, the application of fully controllable structures with the function of value selection with the account of validity (result of control) is more promising.

In such structures it is expedient to use the results, obtained in electronics, applying in the architecture of microprocessor systems (MPS).

Functional possibilities of distributive systems of ACS TP NPP

The trend of considerable expansion of functional possibilities of distributive systems ACS TP NPP at the expense of introduction of microprocessor facilities with different operation modes is observed.

Application of microprocessor programmable facilities in the systems of emergency protection of NPP reactor

Until recently high requirements , regarding NPP security limited application of microprocessor freely programmable facilities in the systems of emergency protection and NPP security and stipulated the application of hard-wired logic systems. To overcome this barrier great efforts were made, aimed at elaboration of new principles of emergency protection equipment(EP) development, alarm systems(AS) and control safety systems on the base of programmable microprocessor devices (programmable controllers-PC), development of the methods, intended for control of software quality and reliability analysis.

Nowadays sufficient experience has been accumulated, it shows that the realization of EP, AS, CSS on the base of microprocessor programmable facilities in case of high requirements , concerning reliability is possible and even necessary, as it provides higher technical – economic indices as compared with traditional facilities, based on hard – wired logic, among them such factors should be mentioned as simplicity of algorithms realization, compactness of the construction, configuration flexibility, application of multicomplex communication systems.

Great experience in the sphere of usage of microprocessor – based programmable digital devices in EP, AS, CSS systems has been accumulated in France, Canada, Germany and Japan.

Proceeding from the above-mentioned the conclusion can be made that the advantages of microprocessor – based programmable EP systems as compared with conventional systems, based on hard-wired logic are obvious and do not excite doubts. However, their large-scale introduction is restrained by complex problems, dealing with verification of software reliability and non-availability of the organs of State Supervisory body of Ukraine, to licensing of such systems. But the experience of such countries as France, Canada, the USA, Japan, Great Britain shows that these problems can be solved.

In this connection, it is worth mentioning that, in spite of availability of modern measuring equipment, computing facilities, information technologies up to present software – hardware facilities of ACS TP of thermal units and nuclear power plants units of Ukraine, that enable to perform diagnostics of information and control flows regarding their validity, that is really urgent problem for timely detection of faulty characteristics in abnormal emergency operation modes of power – generating equipment are not sufficiently developing as [8 - 10].

Aim of the research is the solution of the problem, dealing with the enhancement of PTC ACS TP operation reliability on the base of improvement of operation modes of microprocessor – based system of software – hardware facilities of PTC ACS TP applying the module, designed for detection of emergency features in abnormal operation modes of power generation equipment of thermal plants units and nuclear power plants units of Ukraine.

Results of the research

The author suggested in the given research structural – functional diagram (Fig. 1) of microprocessor – based module of information – control system PTS ACS TP of power plant unit for the solution of the problem, dealing with the enhancement of PTS ACS TP operation reliability on the base of improvement of operation modes of microprocessor – based system of software – hardware facilities of PTS ACS TP applying the module, designed for detection of emergency features (MDEF) in abnormal modes of power – generation equipment operation of thermal plants

units and nuclear power plants units.

Let us consider the characteristic features of microprocessor - based system operation while information processing in case of technological process parameters values deviation at power units of thermal and nuclear power plants. Data exchange mode: data, processed in arithmetic – logic unit (ALU) are sent on internal and external data bus, between all the elements of microprocessor and MDEF module.

Read – in mode: technological process parameters (TPP) data and their processing program are sent to ALU from programs memory and data memory, where as current values of TPP arrive into MDEF module for determination of TPP parameters values rate change.

Data recording mode: data, processed in ALU, are sent paralelly by one flow for recording of the information in data memory via the accumulator (common working registers), and by the second flow – into MDEF module.

Command selection mode: for data processing in ALU and MDEF module, commands are selected, correspondingly from programs memory and MDEF module programs memory.

Data input mode: data from the input device are sent paralelly for processing in ALU and MDEF module.

Data output mode: processed data from ALU and MDEF module are sent to the panel of work station in the form of signals: norm, pre – emergency situation, emergency.

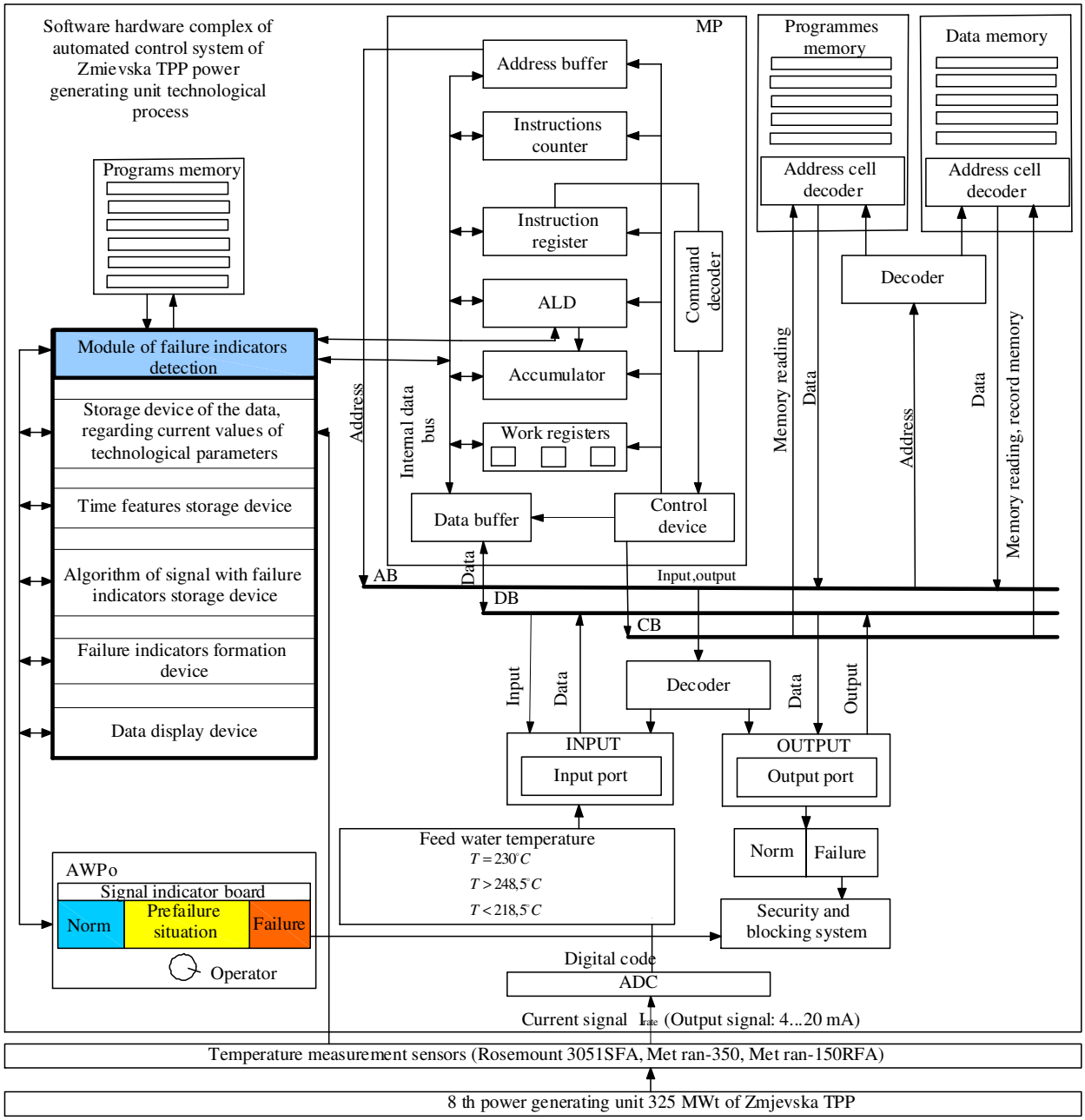

Fig. 1. Structural – functional diagram of microprocessor system of PTC ACS of thermal power plants units, using the module of failure features identification

As it is seen from Fig. 1, collection of information regarding the characteristics of technological parameters of energy facility technological process is performed from control sensors via input/output device and its further processing is carried out in ALU of microprocessor system, where current data of technological parameters of the energy facilities are compared with the data set by limiting value, installed in data memory of microprocessor system. While comparing the current values of parameters, obtained from the sensors and data, read from limiting settings of data memory in ALU of microprocessor system, normative features are formed (signal “norm” on the panel of workstation) and control signal does not arrive via input – output on operating mechanisms and protection and blocking systems. When abnormal operation modes of power generation equipment occur, deviation of the characteristics of technological process parameters, arriving from control sensors via input-output device into microprocessor system occur, where current data regarding the characteristics of technological process parameters are compared with the data

previously set by limitings setting in data memory of microprocessor system. The results of comparison are sent via input-output device on working mechanisms, protection and blocking system, module of emergency features detection in abnormal operation modes of energy facility operation [9, 10].

In MECD module, in emergency situations of energy equipment operation , results of comparison of current emergency deviations of electric physical parameters of technological process with data, previously set by limiting settings in data memory of MPS are processed .

This comparison is performed in order to allocate emergency features on the base of the obtained changes of space – temporal characteristics of each separately taken technological parameter in real – time mode. These calculations are performed, applying the method of fractal detection, the method is based on the dependence of the characteristics of electro physical parameters of energy object technological process on geometric and information dimensionalities of 3D phase volume of information space of technological process, formed in the module of emergency features determination.

On the base of the results of allocation of emergency features in abnormal operation modes of power generation equipment of power plants units, signal ("fault" signal on the panel of AWP) is generated in the module, the signal contains emergency features, further the signal arrives into microprocessor system, where control signal is formed and generated. This signal via input-output device enters blocking and protection systems on energy object in real time mode. This enables to avoid faults and emergency situations and provide normal operation of energy object. Besides , in case of emergency situation alarm information signal is formed in the module, this signal is sent to common information panel of ACS TP operator.

If emergency situation or non reliable information is recorded in the module of emergency situation detection that could result in faulty operation or malfunction, the signal of "preemergency situation" is generated on the panel of automation work place of the operator.

Conclusions

1. To enhance the reliability of information – control systems operation of hardware – software complex of automatic control systems of thermal power plant , the improved structural – functional scheme of microprocessor system ACS TP of power plant unit is suggested.

2. Characteristic features of microprocessor systems operation with the introduction of the module of emergency features determination for the control of technological process parameters on energy units of thermal power plants in real time mode are considered.

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