KAPITEL 9 / *CHAPTER 9* [9]
THE DEVELOPMENT OF INFORMATION MANAGEMENT MODEL OF PROGRAM TECHNICAL COMPLEXITY OF AUTOMATIC SYSTEM MANAGEMENT OF TECHNOLOGICAL PROCESS FOR THE EMERGENCY REGIME OF FUNCTION THE POWER ENERGY EQUIPMENT THE POWER STATION

Introduction

Nowadays, the modernization of the information and management systems of software and technical complexes of automatic system the management of technological process of power blocks of power stations is carried out as part of the program of the increasing the safety and extension of the life of power blocks of nuclear and thermal power stations. The development and modernization of information and management systems of program technic of complexes of automatic system the management of technical process of the technological process the power blocks the nuclear and thermal power stations are conducted according to the legal and law actions and also the standards of the International agency of the nuclear energy (IAEA SSG-37 (Rev. 1) (2023), which are significantly tightened requirements for this systems and its components in the part of the extended service life, reliability, safety and reliability with the more quantity of the controlling points and technological parameters. As the analyses of the mathematic methods and models showed [1, 2] of informational management of the system of automatic system the management of technical process of the technological process the power blocks the nuclear and thermal power stations the process of the processing of deviation information of the technological process of the power stations doesn't allow to determine the reliability and unreliability of information of the technological parameters with the ample probability. Therefore, the quantity of the false detections and the rejection of the power electrical technological equipment increases.

Also need to pay attention to the changing of the technological parameters in time: change from normalized of pre-variation parameters, for example, the heat transfer rate

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from the first contour reaches an enormous value – contour of reactor PWR (pressurized water reactor) is depleted in about time *t = 1…10 sec.* in the first moment of accident, but the temperature of the shells of the most tense FR (fuel rod) a few seconds after the beginning of the accident reaches values above the temperature *T = 700…800 °C.* So, the necessity of the controlling the process deviations of the technological parameters occurs in the real time in the same time which in the dynamic model of the modern informational management system of the program technical complex of the automatic system of management of the technological process of power block the power station is not possible.

The process of processing of information includes on the functional connecting the initial values only the one of technological of the area the equipment which is the initial informational signal for another. This prevents the evaluation of information in the whole informational area the informational management system of the program technical complex of the automatic system of management of the technological process of power block the power station and doesn't allow to control the parameters in the pre-emergency situation in the irregular operating modes. For example, the initial values of the steam generator parameters are the input values of the main circulation pipeline. The different informational management systems are included in the program technical complex of the automatic system of management of the technological process of power block for the realizing of the control function and processing the information of the deviation of the parameters of the technological process the power energy equipment the nuclear and thermal power station.

These systems perform measurement, recording and initial processing of current values of the characteristics of the technological parameters as a current, voltage, position of contact relay protection. However, the dynamic of the characteristics of the parameters the technological process in the pre-emergency situations in the real time doesn't be controlled in the fact of the information unreliability and false alarms.

It is important to note that in the dynamic models of the existing information management systems of the automatic system of management of the technological process of power block as an information carriers are used the average (standard mean)

value of the electrophysical characteristics of the technological parameters (volume, current) which are as a base of the forming of the informational signal about the changing of deviations of the technological parameters. These parameters are fixed-delay time values and with particular coolant. For example, according to the requirements of the sub-systems for emergency and warning protection – the period of the questions – the every *0,5 sec.* and the delay time *2 sec.* And another example, the normal temperature the coolant of the first counter the reactor PWR at the entrance of the steam generator *T = 320 °C*, deviations are in the limited of the setpoints *±5%.* Therefore, one of the main problem of the identity of the deviation the charactiristics of the technological parameters, which could lead to accidents in the irregular operating modes, is the encuring to controll and ensure the dynamic the process of deviation the characteristics of the technological parameters from of the normal on the one hand. And on the another hand, it is possibility the function of the information management system of the automatic system of the technological process of power block of power stations with the sufficient reliability, which are specified of requirements to the operation controlls on the purpose of the timely detection the emergency signs iv the pre-emergencu situations in real time.

It is proposed to develop the cluster model of structure the informational area the technological process of using the fractal cluster theory for the solving these problem. In addition, based on this theory is proposed the development of the dynamic fractal cluster model the information management system of the information management system of the automatic system of the technological process of power block of power stations in the irregular operating modes of the power equipment in real time in the power station.

9.1. The researching of the volume the information area of the technological process of the information management system of the automatic system of the technological process of power block of power stations on base of the fractal cluster theory

It is suggested to use the concept of volume the informational area about the informational signs, which have the information of the emergency signs of the deviations the parameters the technological process the power stations, which is the set of informational signals, the for the researching the deviations of the parameters the technological process on the nuclear and thermal power stations blocks.

Therefore, it was proposed to use the cluster model of the structure the volume of informational area which is based on the using the apparatus of the fractal cluster theory [3]. Are known [3], the apparatus of the fractal cluster theory allows imagining the volume of the informational area as a cluster clusters aggregation, i.e. as a cluster with different features. So, it was suggested to consider the information area of the technological process the power equipment the power stations $Q_{V\Sigma is}$, which are processed by the information management system of the automatic system of the technological process of power block of power stations as a combination of clusters.

In this case, the clusters on normal fixed values of signals of parameters creates the volume of cluster-cluster aggregations with volume – $Q_{V\kappa\kappa N}$, and the clusters with emergency signs creates the cluster-cluster aggregations with the volume – $Q_{V\kappa\kappa rd}$, which is shown on the figure 1.

As the figure 1 shows, the clusters of the separate informational signal of the technological parameters create the particular volume of the cluster-cluster aggregations with parameter values normalized $Q_{V\kappa\kappa N}$, and the other with the emergency signs (parameters random values $Q_{V\kappa\kappa rd}$). Therefore, the full volume of the informational area $Q_{V\Sigma is}$ could show as a summa the volume of the cluster-cluster aggregations with the parameter values normalized $Q_{V\kappa\kappa N}$ and the volume of the
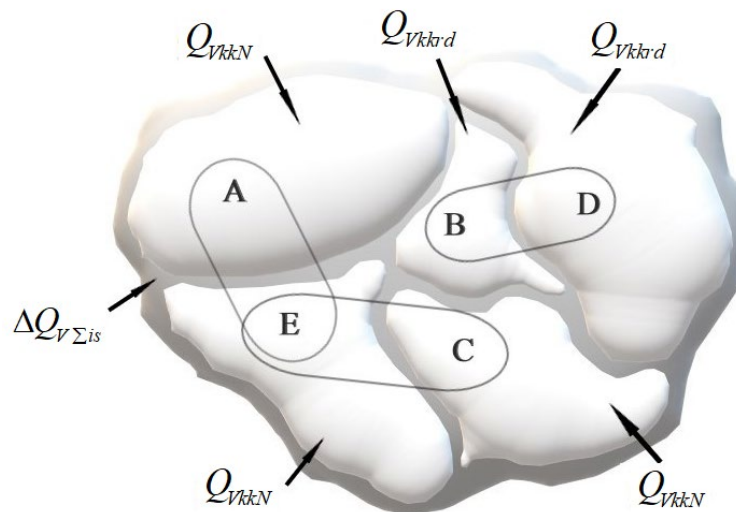
Figure 1 – Graphical representation of the formation of cluster-cluster aggregates in the information space

cluster-cluster aggregations with the emergency signs (parameters random chaotic values $Q_{V\kappa\kappa rd}$) according to the formula (1):

$$Q_{V\Sigma is} = Q_{V\kappa\kappa N} + Q_{V\kappa\kappa rd} \qquad (1)$$

From which it follows, the emergency parameters signals (random chaotic signals) account for part of the blank amount of the informational area $\Delta Q_{V\Sigma is}$, as shown in the formula (2):

$$\Delta Q_{V\Sigma is} = Q_{V\kappa\kappa rd} = Q_{V\Sigma is} - Q_{V\kappa\kappa N} \qquad (2)$$

According to the fractal cluster theory [3], as a quality of the physical value, which is characterized the level of the full filling the informational area $Q_{V\Sigma is}$ of the relevant information signals about the technological parameters, is the informational fractal dimension d_{fi}. It is accepted the assumption that the every cluster is limited by its volume, because of the volume $Q_{V\Sigma is}$ of the informational area the management system of the program technical complexity of the automatic system of management of the technological process of power block of a power station with the information of quality $Q_{V\Sigma is}$ could be shown as a formula (3):

$$Q_{V\Sigma is} = (Q_{VA} + Q_{VB} + Q_{VC} + Q_{VD} + Q_{VE})^{d_{fi}}, \qquad (3)$$

where Q_{VA}, Q_{VE}, Q_{VC} -cluster's volume with the informational signals about the parameter values normalized, Q_{VB}, Q_{VD} - cluster's volume with the emergency signs (parameters random chaotic values). Therefore, from the formula (3) follows that the volume $Q_{V\Sigma is}$ of the informational area of the informational management depending on the level of the informational fractal dimension d_{fi}. So, the structure of the volume $Q_{V\Sigma is}$ of the informational area has a fractal property. In addition, the limitation of the informational quantity $Q_{f\Sigma is}$ in this volume $V_{\Sigma is}$ is introduced. For example, the quantity of the information $Q_{f\Sigma is}$, which is in the volume of data memory in the microprocessor system of the information management system of the automatic system of management of the technological process of power block of a power station.

9.2. Developing the structure of the cluster model of the informational area the technological process

According to the theory of the signal transmission [4], the quantity of information $Q_{\Sigma is}$ in the volume three-dimensional phase information space $Q_{V\Sigma is}$ with the fractal properties is the same of the changing energy and signal power, which are pass through the structure this volume, i.e. $\Delta Q_{V\Sigma is} \sim \Delta E \sim \Delta P \sim \Delta Q$

Hence, the changing of the energy and power $\Delta E, \Delta P$ of the informational signals depends on the changing the quantity of the information $\Delta Q_{V\Sigma is}$ in the volume of three-dimensional phase information space $V_{\Sigma is}$ of the information management systems of the automatic system of management of the technological process of power block of a power station. So, the conclusion can make that the changing of the energy and power the random signal $\Delta E, \Delta P$, which is provided through the structure of the volume of the informational space $Q_{V\Sigma is}$, which has a fractal properties, and according to the formula (3), also are related to the changing the quantity – the informational fractal

dimension d_{fi}.

Based on this information, in the process of researching the volume of the three-dimensional phase information space $V_{\Sigma is}$ according to the fractal cluster theory and the theory of the dynamic system [4], the direct task was solved and was shown that the informational fractal dimension d_{fi} of the informational space depends on the rising of the quantity of information $\Delta Q_{\Sigma is}$ in the information signal, the return time of the characteristics of parameters of the technological process to the normalized values τ_f and to the cycle time increment, as shown in the formula (4):

$$d_{fi} \cong d_{0fi} \cdot 2^{(\ln 2)\left|\Delta \overline{Q_{\Sigma is}}\right|\left(\tau_f - \Delta t_c\right)},$$

(4)

where d_{0fi} – initial value of information fractal dimension at normalized parameter values; Δt_c – parameter life cycle increment; τ_f – parameter return time to normalized parameter values; $\Delta Q_{\Sigma is}$ – increasing the amount of information in the volume of the information space when passing a random information signal.

The formula (4) shows that the changing the informational fractal dimension d_{fi} is related to the changing of the information quantity $\Delta Q_{\Sigma is}$ in the volume of the information space $Q_{V\Sigma is}$. It must be noted that of the no changing of the quantity of the information $\left(Q_{V\Sigma is} = 0\right)$ the changing of the informational fractal dimension does not occur, i.e. $d_{fi} = d_{0fi}$ and $\tau_f = t_c$. It is demonstrated the no signals with the parameters emergency signs in the technological process. Where the opposite problem was solved of the founding the changing of the quantity of information $\Delta Q_{\Sigma is}$ in the volume of the information space $V_{\Sigma is}$, as shown the formula (5):

$$\left|\Delta \overline{Q_{\Sigma is}}\right| \cong \frac{\ln \dfrac{d_{fi}}{d_{0fi}}}{\left(\ln^2 2\right)\left(\tau_f - \Delta t_c\right)}$$

(5)

The formula (5) is shown that the passing through the volume of the information

space $Q_{V\Sigma is}$ of the random informational signal the increase of the quantity of the information $\Delta Q_{V\Sigma is}$ is appearing. And the local informational inhomogeneity in the form of a strange attractor with an area S [2] is created. It is shown signs in case of detection the fractal informational signal, which pass through the volume of informational space and the informational dimension d_{fi} is different from the initial value by a value Δd_{fi}.

9.3. Dynamic fractal cluster model of the informational space the technological process in the irregular operating modes

Analyses shown that the existing and used information dynamic models of the informational space of the informational management system of the technological process of the information management system of the automatic system of the technological process of power block of power stations are the system of the mathematic concentrated equations, which are characterized the state of the informational space [1].

Furthermore, the shortcomings of the informational dynamic models were identified. The main of these are the information signal change accounting only in the strict particular time moment, which doesn't allow to change the control to the dimension of the technological parameters in the dynamic in the coordinates of the space. Also, the deficiencies of informational dynamic models were identified. The main deficiencies are the accounting for changes in the information signal only in the particular time moment, which doesn't allow to control of the dimension of the technological parameters in the spatial coordinates. Therefore, the detecting of the emergency signs in the random signals about the deviations of technological parameters in real time is not possible. Also, the average summary quantity of information is used in the formulas of existing models of information signal processing and only in the defined discrete intervals accounting the standard deviations. Its

introduces significant errors to calculate and doesn't allow to follow the dynamic of changing signals in time and space. Therefore, it was suggested to research of informational random signals of informational space of the technological process uses the apparatus of the fractal cluster theory [3]. The informational random signal according to the fractal cluster theory has been reviewed as a signal, which has the fractal properties. The process of the passing the informational signal through the volume of informational space $V_{\Sigma is}$, shown on the figure 2.
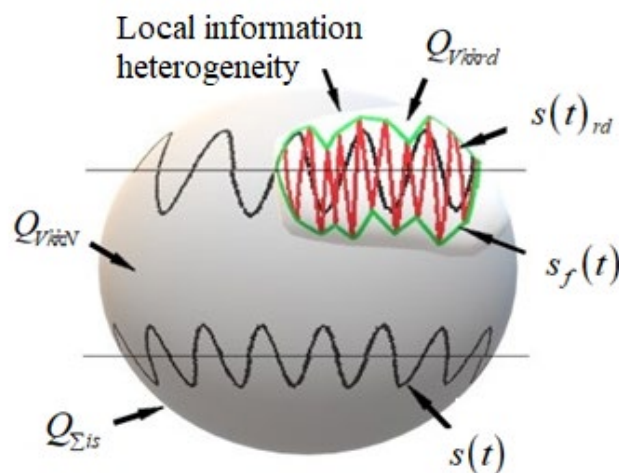

Figure 2 – The process of passing the informational random signal obstacles through the volume of informational space

As you know, according to the theory of signal processing [4], for the separating of informational flows the useful signal describes by the mathematic formula (6):

$$s(t) = U_0 \cos(\omega_0 t + \varphi_0),$$
(6)

and the random signal as which in the work it is proposed to consider the random signal of obstacles is defined by the formula (7):

$$s(t)_{rd} = U_{rd} \cos(\omega_{rd} t + \varphi_{rd}),$$
(7)

i.e. the summary informational signal according to the theory of signal transmission [4] could define as summa the useful and random informational signals as are shown by the formula (8):

$$s(t)_{\Sigma} = s(t) + s(t)_{rd},$$
(8)

Therefore, the work proposed the availability of signal with the emergency signs is determined by the difference between the summary and useful informational signal, which shows by the formula (9):

$$\Delta s(t) = s(t)_{\Sigma} + s(t)_{0}$$

(9)

Conclusions

In this work, the solving task was the development of cluster and dynamic fractal cluster model of informational space for the increasing of function the informational management system of the information and control systems of software technical complexes of automated process control systems of power stations block.

Shown that the passing random informational signals through the informational space the level of the filling the three-dimensional phase volume of the informational space depending on the changing the energy and power of the fractal informational signal is changed. Found that between the dimensions, which characterize the level of filling the volume of the informational space, the most appropriate to use the informational fractal dimensions, which is the fractional value, and shows how the form and the time series fills the space. Also, shown that these dimension connect with the changing of quantity the information in the memory of the informational control system of information and control systems of software technical complexes of automated process control systems of the power plant blocks of the nuclear and thermal power station. Researched that the increasing the quantity of the information appears when signal passes through the volume of the informational space informational control system of information and control systems of software technical complexes of automated process control systems of power block of power station the random informational signal. Also, the local informational nonperiodicity in the strange atractor is formed. This fact may indicate the presence of the emergency signs in the random informational signal, which passes through the volume of the information space. Also, the informational fractal dimension has the differences from the initial value.