ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 9 , September 2019

Method for modeling factors determining the characteristic of multifunctional special equipment in ensuring the required level of fire safety of a complex object

Mavlyankariev B.A., Khatamov B.B.

Doctor of Technical Sciences, Professor, The Branch of the Gubkin Russian State University of Oil and Gas in Tashkent
Master teacher, The Military Technical Institute of the National Guard of the Republic of Uzbekistan

ABSTRACT: The article reveals the relevance of the transformation of the fire safety system of complex objects. The article substantiates the dependence of the development of scientific and technical support and the fire safety management of complex facilities on the creation of multifunctional special equipment and an adapted methodological base for their systemically effective application. An analysis of the losses of ensuring fire safety of complex objects formed by a phased orientation during the development and implementation of new equipment (without taking into account the interdependence of all stages) and the corresponding methodological support for individual stages substantiates the methodological concept of system integration of the life cycle stages of multifunctional special equipment, with the potential for implementing their systemically effective application. The latter determine the strategic platform for the creation, systematization of the methodological base, its adaptation to the conditions of use, for the oriented formation of the “Knowledge Base” – the basis for accelerated achievement of the required fire safety level of complex and operating facilities under construction, and use in systematic research of system integration of all stages of the life cycle (including stage of practical application) of new technical systems.

KEY WORDS: Transformation, fire safety, scientific and technical support, system integration, life cycle stages, concept, “Knowledge Base”, methodological support, system efficiency.

I. INTRODUCTION

Taking into account the global trend of increasing social consequences of industrial accidents, natural disasters, usually resulting in fires, and the need to search for scientifically sound directions for forecasting and preventing such crisis situations, actualizes the problem of developing scientific and technical fire safety for complex objects (CO). The term “complex object” is understood as a set of economic objects with a pronounced fire and explosion hazardous production cycle, complex structural and planning, technological solutions, infrastructure, which are susceptible to functional failures, significant material and human losses in crisis situations.

The development of a new economic structure, the transformation of the labor market, the strategy of innovative development of industries, the change in social status and economic conditions of life of citizens cannot occur without a transformation of the fire safety system. Under these conditions, taking into account the functioning of fire departments in market conditions, the tasks of expanding the variety of operational-tactical and engineering measures in managing firefighting, ensuring the parameters of a normative response, creating conditions for the effective use of all types of available forces and means, and creating it new, promising modifications - collectively regulated scientific and technical support for fire safety. Since the technical segment is quite extensive in the indicated problem, the program-targeted management of the development of scientific and technical support for fire safety is becoming particularly relevant, with justification for the increasing role and importance of multifunctional special equipment (MSE).

The crisis of certain types of firefighting equipment and traditional approaches to dealing with crisis situations is explained by the depletion of their capabilities, against the background of increased requirements for already obsolete

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 9 , September 2019

equipment and its use. There is an urgent need for innovation in science, technology and fire safety technologies. Material losses of the current state of scientific and technical fire safety of COs are formed, including from the currently dominant, not meeting modern requirements, phased orientation when introducing new equipment (without taking into account the interconnection of all stages), and corresponding to individual stages of methodological support. This is apparently due to the multidimensional nature of the tasks and the impressive number of possible combinations of activities, as well as a significant number of parameters that affect the final results of using technical systems. These shortcomings make it possible to justify the general methodological concept of building the necessary MSE, with the potential to implement the principles of systemic efficiency at all stages of their creation and practical application [1]. Thus, the development of scientific and technical support and the fire safety management of COs depends on the creation of MSE and an adapted methodological base for their systemically effective application.

The development of the concept of creating MSE includes a number of stages and requires compliance with and implementation of its entirety. The creation of MSE, and this is a technically complex product, requires compliance with the indicated rules [2]. The exclusion of individual phases or the insufficient study of individual stages is fraught with unpredictable risks and losses. Concept development is most important, as the MSE being created should be in demand and competitive. Usually adhere to the following sequence of elaboration of a similar question. Competitive prototypes are evaluated (if similar), a technical-level comparative table is compiled, an optimal combination of functional and technical characteristics, advantages and features of MSE is selected. At this stage, work is underway to clarify additional conditions, taking into account the specifics of MSE (mobile transportation, conditions and practice of its use), as well as a number of activities with the designated purpose – to get a comprehensive, as close to reality picture of the life cycle of MSE. The concept of MSE includes information on the functional description, tasks to be solved, technical description, operational issues, objects and application scenarios. At the end of the stage, proposals are issued for the development of a new device –MSE.

To create a promising MSE is not enough, it is necessary to study and analyze all stages of its life cycle in order to guarantee the success of the application [1]. The methodological concept of the system integration of the stages of the life cycle of MSE, with the potential for the implementation of systemically effective application, is justified by the analysis of the fire safety losses of COs formed by a phased orientation during the development and implementation of new equipment (without taking into account the interdependence of all stages) and the corresponding methodological providing.The latter determine the strategic platform for the creation, systematization of the methodological base, its adaptation to the conditions of use, for the oriented formation of the “Knowledge Base” – the basis for accelerated achievement of the required fire safety level of complex and operating facilities under construction, and use in systematic research of system integration of all stages of the life cycle (including stage of practical application) of new technical systems. The set of oriented methods developed, their systematization at the level of adaptation to the conditions of use, with the formation of oriented "Knowledge Bases", within the framework of the indicated concept, is an urgent task [2]. The lack of an ideology for creating such “Knowledge Bases” is a vulnerable methodological flaw in the task of accelerating the achievement of the required level of fire safety of complex facilities under operation and construction, as well as in analytical studies of the system integration of the creation, adaptation and practical use of new technical systems.

The technical study of MSEis the most critical issue. It is distinguished by the presence and influence on the process itself of many complex interrelated factors. The posed question of systemic efficiency when using MSE involves the creation of appropriate adapted techniques. Moreover, the latter should be directional (with strict binding of their recommendations to specific types of COs) – “rough” study, and also taking into account the features of the stages of the life cycle for a particular type of MSE – “thin” study.
This revealed pattern allows you to use the capabilities of the methods to solve the following research tasks:

- Optimization of indicators of MSE in the format of a separate stage of its life cycle.
- Achievement of systemic efficiency of paired stages united by targets – “development-equipment” or “implementation-operation”.

The results of technical studies on the creation of MSE once again confirm the importance of analyzing the “factor-characteristic” relationship, determining the degree of their significance and priority for decision-making. The following section is devoted to a calculated, objective method for determining these factors.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 9 , September 2019

II. RELATED WORK

The following studies should be considered close in essence to the issues being solved and the approaches used. In the work of Alchinov V.I. and Volchikhin V.I. "Information and methodological support for managing the operation of complex systems"[3], as well as in the work of Maltsev G.N. and Sklemin D.V. "Analysis of the readiness of complex technical systems when using information technologies for supporting the life cycle"[4], it is argued that the main direction of solving the problem of information and methodological support for the preparation of operational and technical decisions (OTD) is the development and implementation of a set of interrelated methods, models and algorithms that improve quality accepted OTD.

A similar question is studied in more detail, with adaptation to specific oil production facilities, in the work of Plesnyaev V.A., Zhuchkov K.N., Bogdanov D.A., Myskin R.A. and Soloviev M.A. "Development of logistical integrated support complexes in offshore oil gas production facilities"[5].

III. METHODOLOGY

The experience of the technical development of the creation of MSE and the analysis of the "factor-characteristic" relationship shows that the significance and order of factors are usually determined by an expert method, through their consistent discussion. The method proposed below is a calculated one that excludes subjective errors of the expert method.

In all cases, changes in factors affect the level of the studied characteristics. Thus, a universal problem arises to ensure the required level of a specific, studied characteristic. The semantic and logical nature of the latter is diverse, and in accordance with the objectives, it can be represented:

- generalized technical indicators for the modification of MSE;
- oriented to the requirements of a specific CO, "optimized" characteristics and capabilities of the recommended MSE;
- promising (innovative) characteristics and properties of new, designed schemes of MSE.

In each of these cases, the research process should begin with a thorough study of a separate, influencing factor in the following areas:
1) the stability of the factor, the probability and nature of its change;
2) a method for assessing (measuring) factors;
3) the sensitivity of the factor to regulation, and how it is carried out;
4) the relationship between the magnitude of the factor and the characteristic (linear, nonlinear, etc.);
5) the effect of factor instability on the dispersion of characteristics;
6) whether the norms of the factor are standardized, the possibility of their standardization.

Must be specified, methods, ranges, directions of change of factors. In view of the many varieties of tasks with the characteristic being studied, let us dwell on its classical variety when maintaining the fire safety level for a CO is determined by its technical support. For our case, correlated with the fire safety level of a CO, the readiness indicator of MSE may be the evaluated characteristic of technical support. The forecast for its decline adequately reflects on ensuring the required level of fire safety for the CO under consideration, and at the same time depends on the MSE used. The problem statement is as follows, Y– output estimated characteristic – forecast of decrease in the availability of MSE, related to the level of fire safety for a CO, achieved by using MSE. The state of readiness of MSE is described by a set of $X = [X_1, X_2, ..., X_m]^\tau$parameters, X_j, Y_o, X_{jo}, β_j are the coefficients determined from the history by processing the experimental data.
In general, a static problem is considered in the sense that the dependence of Y and X_j on time is not taken into account [6]. As the initial data, the recorded results of systematic observations of operation are used. Each *i-th* line of this systematization corresponds to one *i-th* fixation, in which the values Y_i of the quantity Y and the values X_i, ..., X_{im} of the variables $X1$, $X2$, ..., X_m are obtained. The role of such fixations may be the *i-th* threat of MSE, the risk of a decrease in its readiness.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 9 , September 2019

Following the goal, we write the initial equation *n* times (where *n* is the number of fixations) for each of the lines of systematization. At the same time, the possibility of occurrence of deviations of calculated values from actual, experimental values is taken into account.
Now let us assume, by averaging over the systematization columns (tables), and we will assume that ε_i– are random, independent for $i = 1, n$ with the same mathematical expectation but unknown dispersion σ^2 [6].
By appropriately labeling and presenting the above equations in matrix form, we find for the desired vector β the estimate β'' by the least-squares method, which consists in finding the value β - β'' such that β minimizes the following expression

$$\left\| A_\beta - b \right\| = \sum \varepsilon_i^2 . \qquad (1)$$

So, if the rank *r* of matrix *A* is equal to *m*, then, as is known [7], it is possible to determine the numerical values for β'', for its total value, as well as $\delta^2{}''$.
The following notation is introduced here: β'' – unbiased estimate for β; $\Sigma\beta''$–covariance matrix of the vector β'' of estimates β''_i, for β_i; σ^2 – is an unbiased estimate of the variance of ε_i.
The goal of forecasting a decrease in the readiness indicator for MSE, provided that the presented estimates are determined from analytical expressions, can be

$$\beta'' = [\beta_1'' \, \beta_2'' \beta_m'']^T . \qquad (2)$$

An estimate of β'' for the coefficients $\beta i''$ can be carried out using the following dependence

$$Y = Y'' + \sum_{j=1}^{m} \beta_i'' \left(X_j - X_{0j} \right) \qquad (3)$$

where, Y'', X_{0j}'', β_i'' are found from the prehistory, and X_j– are the values of the variables that affect the output characteristic of the studied decrease in the parameter of readiness for MSE.
The forecast accuracy is characterized by the covariance matrix $\Sigma\beta''$ and the variance estimate σ^2.
The disadvantages of the considered evaluation method are:
1) postulate a linear dependence of *Y* on *X*;
2) the lack of dynamic construction, allowing to take into account the dependence of *Y* on time $t > 0$.
In [7], an approach is proposed that allows the construction of an evolutionary estimation model, in which relations of the form (2) are also used.
Based on the principles of dialectics, it is postulated that the rate $Y'' = dY/dt$of change in the output characteristic $Y = Y(t)$ is determined as the result of the interaction of two trends expressed by the functions *U* (development factor) and *V* (inhibition factor). Hereat, *U* and *V* act on Y'' in opposite directions, which is expressed in the form of the differential equation $Y'' = U - V, Y(0) = Y_0$, which determines the law of development of the output characteristic $Y = Y(t)$.
In each specific task, a special study should be carried out in order to establish the form of the functions *U* and *V*, reflecting the mentioned tendencies of growth and inhibition.
If the dependence $Y = Y_p(t)$ is found by solving the evolution equation $Y'' = U - V$, $Y(o) = Y_0$, and it is known that in this case the factors $X_1, X_2, ..., X_m$ affecting *Y* remained unaccounted for, then it is proposed to find the final solution of the problem by the formula

$$Y(t) = Y_p(t) + \sum_{j=1}^{m} \beta_j \left(X_j - X_{0j}'' \right), \qquad (4)$$

where, the coefficients β_j'' are found by the least-squares method for any moment in time *t*, and the factors X_j are considered to be time-independent.
It follows from the evolutionary equation that for $U = V$

$$Y'' = 0 \text{or} Y(t) = const = c . \qquad (5)$$

The controversial point is that Y'' is the product of the interaction of two trends (expressed by the functions *U* and *V*), but is the difference U – V = Y'' the only form of representation of this interaction?

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 6, Issue 9 , September 2019

It is also obvious that the principle of compiling the evolutionary equation will be preserved in any other case, in which

$$Y'' = f(U,V)\ , \qquad (6)$$

where f increases in U and decreases in V.
Hereat, the case $U = V$ must be specified separately. If, with the equality of "development forces U" and "braking forces V", the system behaves so that its output characteristic Y is stabilized, i.e. for $U = V$: $Y''(t) = 0$, $Y(t) = const = c$, then an equation of the form $Y'' = U - V$ describes this system.
If for $U = V$ the system follows the law of uniform motion with constant speed c in the sense that for $U = V$, $Y'' = c$, $Y = Y_0 + ct$, then in the scalar case we can use the other relation proposed here

$$Y'' = c * U/V + U - V\ ,\ Y(0) = Y_0\ . \qquad (7)$$

Here it is assumed that $V \neq 0$, and the functions U, V are considered scalar (this allows us to consider the fraction U/V, $V \neq 0$).
If $U = V$, then $Y'' = c$, $Y = Y_0 + ct$.
It turned out that in the problems of the class under consideration, equation (7) used to estimate the characteristics of such processes is more convenient compared to the previously proposed relation $Y'' = U - V$, which follows from (7) with $c = 0$.
Omitting the possible expressions for evaluating the characteristics of MSE, determined by the coefficients of the development and braking rates, it can be stated that managing the decrease in the availability rate of MSE due to the improvement of the operation process can be implemented as follows:
1) the features of the operation and maintenance of MSE or its specific variety are studied (it is possible to consider a specific node of a separate type of MSE);
2) On the basis of this study, semantic values and the form of the functions $U = U(t)$and $V = V(t)$are established, the first of which develops, and the second inhibits the development of the output characteristic $Y = Y(t)$of the process, which determines the decrease in the availability indicator of MSE (for example, it may turn out that $U = at$, $V = bt$);
3) determined by a set of factors $X_1, X_2, \ldots, X_m$, affecting $Y(t)$, but not taken into account using U and V;
4) by considering the evolutionary equation, its solution $Y = Y_p(t)$is found and the experimental values are used to establish the coefficient values in the expression for $Y(t)$;
5) for one of the instants of time $t = t_1$, the difference is calculated using the following formula

$$Y'''' = Y_{cp}(t_1) - Y_p(t_1), \qquad (8)$$

where, $Y_{cp}(t)$is the actual time dependence of the output characteristic.
For Y, the analytic expressions calculate the regression function according to the following formula

$$Y'''' = Y'' + \beta_j (X_j - X''_{0j}), \qquad (9)$$

after that the relation (2) is used;
6) having determined from (3) the estimated values of the output characteristic Y (t) for the upcoming moments of time, compare them with acceptable boundaries (according to technical documentation or experimental recommendation);
7) in the case of an unfavourable assessment – a "forecast" of a decrease in the readiness indicator for the operation of MSE, the task is to consistently analyse all component units for their operational behaviour in specific tactical conditions. Based on this analysis, the issue of changing the operating mode of MSE is considered, by varying factors X_j or by implementing other organizational and technical measures.
As a result, a system can be created to prevent a decrease in the readiness indicator for MSE and eliminate trends (analysis of the impact on the indicator of the previous stages of the life cycle of MSE) that contribute to the emergence of threats of sudden failure of individual components or the multifunctional equipment in question.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 9 , September 2019

IV. CONCLUSION AND FUTURE WORK

The proposed approach, which has a methodological basis, can be recommended for optimizing the output characteristics of MSE, which in our case determines the fire safety level of a particular CO.

The effectiveness of using MSE, in general, is determined by its maximum adaptation to the conditions of use. Therefore, the proposed method can be used to create an adapted methodological basis, with the potential to implement the principles of systemic efficiency of using MSE based on software, algorithmic and structural unification and modular organization of its components. This basis can be represented by methods and complexes of various practical orientations, which as a whole is focused on improving the fire safety of a particular CO. This, in turn, helps to solve urgent problems of the development of scientific and technical support for fire safety, based on the corresponding development of conceptual principles for creating MSE with a specific orientation and a systematic approach to the principles of their construction on a resource-saving platform.

REFERENCES

[1] Mavlyankariev B.A., Khatamov B.B., Pen A.Yu., Talibjanov I.R. "System integration of the life cycle stages of a technical system as an innovative resource for its effective application", 26th International Conference "Problems of Security Management of Complex Systems", Moscow, December 2018, pg no: 211-217.
[2] Khatamov B.B. "Formation of the nomenclature of functional tasks in modeling forecast strategies and models for the development of scientific and technical support for fire safety of complex objects", 8th International Scientific and Technical Conference "Actual problems of fire safety, prevention and emergency response", Kokshetau, October 2017, pg no: 107-110.
[3] Alchinov V.I., Volchikhin V.I. Information and methodological support for the management of complex systems [Electronic resource]. News of higher educational institutions. Volga region. Technical science. - 2007 No. 4, pg no: 107-121. – https://rucont.ru/efd/269317
[4] Maltsev G.N., Sklemin D.V. Analysis of Complex Technical System Availability using Information Technologies of Lifecycle Support. Scientific journal. "Information and Control Systems", 2016 No. 3(82), pg no: 38-45.
[5] Plesnyaev V.A., Zhuchkov K.N., Bogdanov D.A., Myskin R.A., Solov'ev M.A. Development of logistical integrated support complexes in offshore oil gas production facilities. Scientific Electronic Library. Journal "Exposition Oil Gas", 2014 No. 7(39), pg no: 39-42.
[6] Mavlyankariev B.A., KuldashevA.Kh., Khatamov B.B., Pen A.Yu. Methodology for reducing the risk of developing a fire based on a dialectical analysis of situations. // Fires and emergency situations: prevention, elimination. – Moscow. – № 3. – 2016, pg no: 56-60.
[7] Mavlyankariev B.A. "Facility Security: Management Strategy, Model", 16th International Scientific and Technical Conference "Security Systems - 2005", Moscow: Academy of the State Fire Service of the Ministry of Emergency Situations of Russia, 2005, pg no: 67-70.

AUTHOR'S BIOGRPAHY

Mavlyankariev Bakhtiyor Abdugafurovich

Doctor of Technical Sciences, Professor, The Branch of the Gubkin Russian State University of Oil and Gas in Tashkent

Bakhtiyor Mavlyankariev was born on October 15, 1947 on Tashkent.
In 1965 he entered and in 1970 graduated from the Tashkent Polytechnic Institute, Faculty of Chemical Technology. From 1970 to 1972 junior lecturer of the Tashkent Polytechnic Institute. From 1972 to 1975 graduated student of the Tashkent Polytechnic Institute. He successfully defended his thesis in 1975. From 1980 to 1991 Associate Professor of the Tashkent Polytechnic Institute. From 1991 to 1992 he was senior researcher of the Tashkent Polytechnic Institute. From 1992 to 1993 he was Associate Professor of the Tashkent Institute of Chemical Technology. From 1993 to 2018 he was Associate Professor, Head of Department, Professor of the Higher Technical School of Fire Safety (the Institute of Fire Safetynow) of the Ministry of Internal Affairs of the Republic of Uzbekistan. In 1998 he defended his doctoral thesis at the Moscow Institute of Fire Safety (now the Academy of the State Fire Service) of the Ministry of Emergency Situations of the Russian Federation. Since 2001, Professor. In 2003 he was elected a full member of the World Academy of Sciences of Integrated Safety. Since 2018, Head of the Scientific Department of the Institute of Civil Protection of the Republic of Uzbekistan.Since 2019,Professor The Branch of the Gubkin Russian State University of Oil and Gas in Tashkent.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 6, Issue 9 , September 2019

KhatamovBakhodirBakhromovich

Master teacher, Military Technical Institute of the National Guard of the Republic of Uzbekistan

BakhodirKhatamov was born on Tashkent on December 24, 1974.
In 1996 he graduated from the Tashkent Higher Military Technical Training Establishment of Ministry of Internal Affairs of the Republic of Uzbekistan (the MilitaryTechnical Institute of the National Guard of the Republic of Uzbekistannow).
He has been working at this Institute in teaching positions from 1997 to this day. Currently he is a senior lecturer in the department of “Information and Communication Technologies”.He is working over a doctoral dissertation (PhD) on the theme: “Creation of multifunctional special equipment and adapted methodological basis of improving the fire safety of complex objects”.