SCIENTIFIC AND ANALYTICAL SOLUTIONS FOR RESCUE OPERATIONS IN THE EVENT OF EMERGENCY SITUATIONS TO ENSURE THE SUSTAINABILITY OF ECONOMIC OBJECTS

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Abstract: *The article presents the scientific basis of preparation for operational action at economic facilities in the event of an emergency. In addition, mechanisms for using the necessary means of protection against natural and man-made emergencies at territorial sites during training exercises are given.*
Key words: *training exercises, emergency, sacrifice, material resources, continuous interaction.*

We will consider the issues of carrying out measures to prepare the population for action in emergency situations during a strong earthquake, i.e., conducting command post exercises, the methodology for forming groups to control forces and means in the process of eliminating the consequences of destruction among managers and specialists of subsystems, stages of carrying out measures to protect the population and territories from natural and man-made emergencies.

Conducting training exercises will allow us to determine the reliability of planned documentation for carrying out measures to protect the population and territories from natural and man-made emergencies, as well as determine the possibility of practical development of entire complexes of these measures, the territorial location of economic facilities, taking into account their specifics, production and other features. The analysis carried out in this system, the level of security of the population and the country's economy from the possible consequences of natural and man-made situations is one of the most important factors ensuring the stability of the state. One of the most effective and important forms of training for the leadership and forces of this system is command post exercises.

It has been established that maintaining continuous interaction is one of the most important tasks of the head and the operational headquarters in the process of eliminating emergency situations (Fig. 1).

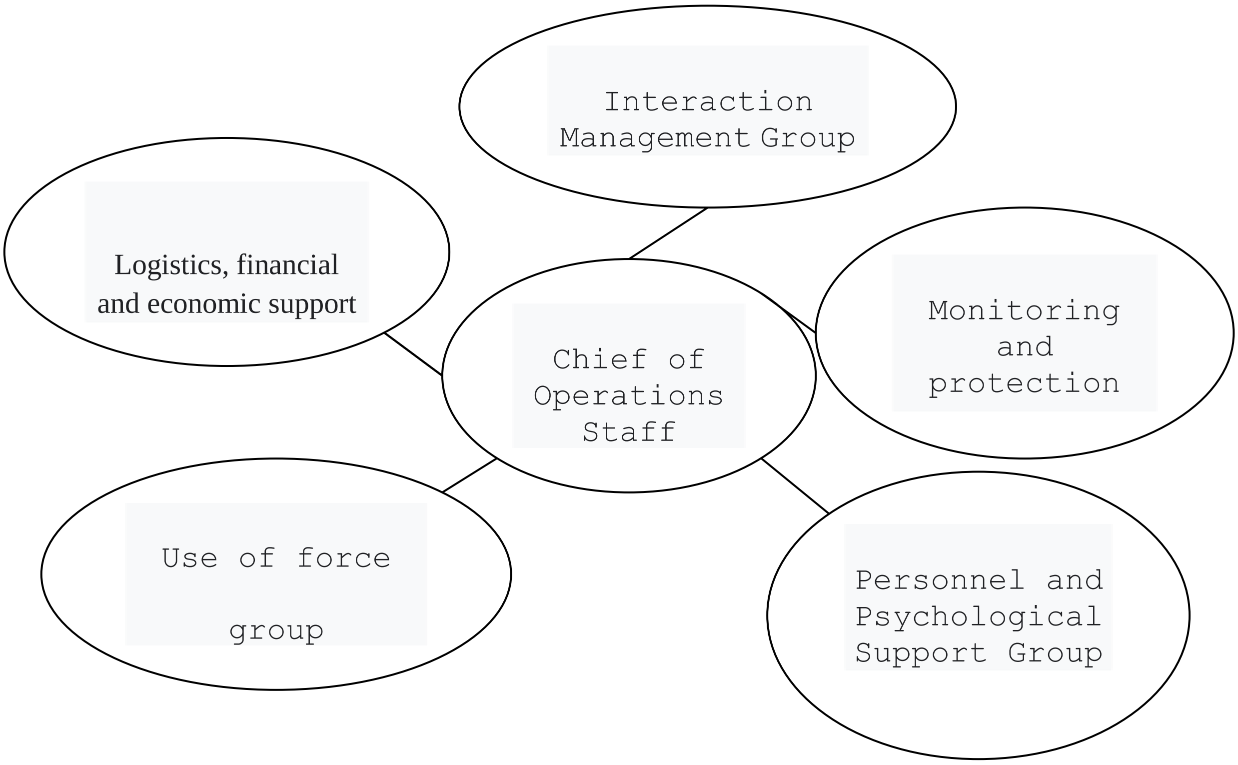

Figure 1. Scheme of organizing the interaction of the operational headquarters during the liquidation of an emergency.

The tasks of the head and the operational headquarters for the implementation of these measures include: firstly, the implementation with sufficient completeness and accuracy of the prescribed procedure for mutual actions of units when performing a combat mission; secondly, timely identification, introduction of additions and development of this procedure taking into account changing situations; thirdly, its restoration in case of violation of joint actions or re-organization is discovered.

The randomness of the occurrence of an emergency, the scale of coverage of the territory, requiring prompt decision-making and increased readiness of the civil defense forces have been established. The main tasks of planning and management in emergency situations are to find a way to rationally distribute forces and resources, determine the required number of operational services and personnel.

To this end, to increase the efficiency of the activities of operational services during emergency response, a methodology for attracting forces and resources can be used, which allows rational distribution of organizational resources.

The effectiveness of eliminating natural and man-made emergencies is largely determined by the availability of material resources. Stocks of material resources for emergency response are an important component of the state system of warning and response to emergency situations. Their creation is an integral part of a set of measures to prevent and prevent emergency situations, reduce the risk of their occurrence and possible negative consequences.

The dependence of the effectiveness of work to ensure the life safety of the affected population and the implementation of civil protection measures on timely material and technical support for the provision of services is presented. Successful implementation of logistical support for civil defense activities, clear planning and proper organization are achieved. To increase the efficiency of operational services, queuing high-priority requirements and changing the number of units over a certain period of time can be used.

At the same time, methods for assessing the effectiveness of rescue services are carried out according to the following indicators:

- time frames for responding to emergency situations;
- number of rescued victims (as a percentage of the total number of victims);
- the amount of damage caused (as a percentage of the probable damage if rescue units are not involved);
- resources spent on emergency response;
- services operating in cooperation (forces and means of responding to emergency situations)

In turn, reserves of material resources for liquidation of emergency situations are the most important and integral component at all levels of this system and are included in a set of measures to prevent the occurrence of emergency situations, reduce the risk of their occurrence, as well as minimize possible negative consequences. To forecast and determine, on the basis of an economic model, inventories of material assets of territorial subsystems, to implement a system of mathematical modeling of the process of creation and placement of inventories, we provide the following information:

- A - duration of the planned period;
- N - need in the planning period;
- K - overhead;
- S - cost (cost) of storing a unit of material resources per unit of time;
- P - fine for lack of material resources per unit of time;
- λ - intensity of supply, i.e. the amount of requested material resources per unit of time;
- μ - intensity of need, i.e. e. requested material per unit of time; number of tools;

X is the highest level of redundancy (storage capacity);

T - delivery time;

L is the amount of expenses attributable to the planned period;

Lv. - average costs per unit of time;

L - sum corresponding to the delivery period costs. The following inequalities are satisfied a priori:

$\mu < \lambda$ (1)

$S < P$ (2)

Otherwise, there is no point in the existence of a material support system. If we assume that condition (1) is false, then the accumulation of reserves by the system is impossible, and (2) when the inequality is false, it makes more sense to pay a fine than to store something, in which case there will be no need to create a system. When modeling the process of material supply and (2), we accept the inequalities as correct.

If the need is continuous, then the intensity of work is constant, that is, it does not change throughout the entire period of work. Fast delivery in the mathematical model indicates that this delivery far exceeds the intensity of demand (1). That is, this means that, based on inequality (1), at the beginning of operation the system will be in state X and almost immediately will fill its level to state X, and T will be busy providing material resources during the period of operation.

Upon completion of activities in period T, the value of inventories tends to zero. This system repeats the cycle. During the entire period of operation, the system spends its funds on storing inventories.

We will calculate the total cost attributable to the delivery period lt. It is formed from the sum of total costs, storage costs and overhead costs for the delivery period. The amount of inventory in activity period t decreases linearly from maximum (peak) to zero, so that an average of 50% of X is assumed to be stored during time t, in this case:

$$L_t = \frac{XST}{2} + K \qquad (3)$$

To find the average cost, it is necessary to determine the ratio of cost and cost t corresponding to the delivery period:

$$Л_е = \frac{\frac{ХСТ}{2} + К}{Т}$$

Here

$Л_е = \frac{XS}{2} + \frac{К}{Т}(4)$

If we take into account that during the T-period the system identifies the highest level of supply, then the intensity of demand is determined by the following ratio:

$\mu = \frac{X}{T}(5)$

Here we find;

$Т=\frac{X}{\mu}$ (6)

Let us reformulate formula (4) by introducing expression (5), and it will look like this:

$L_e = \frac{XS}{2} + \frac{K\mu}{X}$ (7)

It is necessary to find the optimal X, where the average cost per unit of time should tend to a minimum. Another factor to consider is that X cannot be a negative value.

X>0 (8)

Taking into account the stationarity of the process when solving this issue

It is necessary that allows us to make the derivative from l_(E) to X equal to zero, resulting in the following expression:

$$\frac{S}{2} - \frac{K\mu}{X^2} = 0$$

Reformulating it based on expression (7), we obtain the following expression:

$X=\sqrt{\frac{2K\mu}{S}}$

Substituting expression (8) into expression (5), we obtain the following expression:

$T=\frac{\sqrt{\frac{2K\mu}{S}}}{\mu}$ (10)

From expression (8) we pour (6) and find that:

$L_e = \sqrt{2K\mu S}$ (11)

Expressions (8) - (10) give the optimal values of the parameters of the model under consideration that are of interest to us.

Conclusion: the given recommendations for improving the organization and conduct of training exercises make it possible to increase the efficiency of management decision-making and prompt response in the event of emergency and crisis situations, allowing for the effective and timely organization of actions of practice units.

Development of recommendations for organizing the interaction of territorial units participating in command post exercises on the ground, allowing to increase the efficiency of management decision-making and prompt response in the event of emergency and crisis situations. The result of the study was a search for ways to improve the stages of command post exercises, and also a set of proposals and recommendations was developed based on the use of international experience of foreign countries to improve and solve existing problematic issues in this area.

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