ENSURING RELIABILITY IN UPGRADING AND MAINTAINING SPECIAL-PURPOSE RADIO-ELECTRONIC EQUIPMENT

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Summary: *In the article, the issues of ensuring the reliability of the special-purpose radio-electronic means during the preventive and major repair of the carrier structural parts were considered. The principles of increasing the selection efficiency of the products entered into the military warehouses and its fundamental repair were proposed.*

Keywords*: special-purpose radio-electronic means, overhaul, carrier structure, reliability, efficiency evaluation, operational readiness coefficient, probability of non-failure operation*

INTRODUCTION

Solving the issues of updating military weapons and radio-electronic means (REM) remains one of the main issues in protecting the national security of the Republic of Azerbaijan. In military units, as well as in their management command, various types of special-purpose REMs form a single system. Therefore, it is required to solve the issues of complete restoration of the integrity of the REM included in this system, replacement of its individual parts and renewal of its resources (Binnetov et al., 2023).

During the stages of major repair of the samples of military-purpose REM, some of its devices are updated, while the remaining parts are undergoing major repair stages. Therefore, the issue of ensuring the reliability of those tools is raised (Hasanov et al., 2023).

Ensuring the reliability of REM is based on the evaluation of its effectiveness with scientifically based measures. If we look at REM as a subsystem within the product, then the reliability of all products for military purposes is understood as the level of the ability to perform the assigned function under the specified conditions (Agamirov et al., 2016).

EVALUATION OF THE EFFICIENCY OF RADIOELECTRONIC MEANS.

As we know, special purpose REMs used in military battles consist of mechanical and carrier parts. In accordance with the technical work performed on the mechanical and carrier parts of REM with specific characteristics, their renewal and major repair are performed at various enterprises. In this regard, in the given article, the issues of ensuring the reliability of the special-purpose REM used in military fields, but only the hardware parts placed in the carrier structure, were considered.

Scientifically based measures to ensure the reliability of REM used in military fields include the issues of evaluating its effectiveness (Rustamov et al., 2020; Chekanov, 2016). Taking into account the main factors, its ET(t) technical and EI (t) economic efficiency are used to evaluate the REM's efficiency E(t)

$$E(t) = ET(t)EI(t)$$

The assessment of the quality of technical efficiency is determined from the interrelationships of the required and real efficiencies of special-purpose REM.

$$E_T(t) = \frac{W(t)}{W_{to}(t)} \quad (1)$$

where W(t) is the real value of the technical efficiency indicator of special purpose REM; $W_{to}(t)$ - the required value of the technical efficiency indicator of special purpose REM; t- is the relative time period of starting the product in operation.

As a criterion of economic efficiency, the real efficiency of REM is determined by comparative methods from the basic model (new or created in the future) and the costs of operation, renewal, and repair.

$$E_I\ (t) = \frac{W(t)}{C(t)} \quad (2)$$

where C(t)- is the cost spent on the improvement and repair of the newly acquired REM - in the product.

In order to solve the issues of ensuring reliability in the quantitative assessment of the effectiveness of special purpose REV, it is enough to consider four possible cases:

1. Option A. Here, the following condition of the service period in the major repair and renewal of a certain part of the REM included in the complete composition of the product is satisfied

$$W_{(A)}(t) \geq W_{to}(t)\ \cdot$$

The technical efficiency of REM in the specified version,

$$E_{(A)T}(t) = \frac{W_{(A)}(t)}{W_{to}(t)};$$

economic efficiency

$$E_{(A)I}(t) = \frac{W_{(A)}(t)}{C_{(A)}(t)}.$$

The value of the overall effectiveness of REM for option A

$$E_{(A)}(t) = \frac{W_{(A)}^{2}(t)}{W_{to}(t)C_{(A)}(t)}\cdot$$

2. Option B. Here, the renewal of the REM, which is included in the complete composition of the product, is fully replaced based on the new element base and meets the specified condition during the specified service period.

$$W_{(B)}(t) = W_{to}(t)\cdot$$

The technical efficiency of REM in the specified version,

$$E_{(B)T}(t) = \frac{W_{(B)}(t)}{W_{to}(t)},$$

economic efficiency

$$E_{(B)I}(t) = \frac{W_{(B)}(t)}{C_{(B)}(t)}\cdot$$

Overall effectiveness of REM for option B

$$E_{(B)}(t) = \frac{W_{(B)}^{2}(t)}{W_{to}(t)C_{(B)}(t)}\cdot$$

3. Option C. Here is a new sample of REM, which is the opposite of the main sample. In this version, the technical efficiency of REM,

$$E_{(C)T}(t) = \frac{W(c)(t)}{W_{to}(t)},$$

economic efficiency

$$E_{(C)I}(t) = \frac{W_{(c)}(t)}{C_{(c)}(t)} \cdot$$

Overall effectiveness of REV for option C

$$E_{(C)I}(t) = \frac{W_{(c)}^2(t)}{W_{to}(t)C_{(c)}(t)} \cdot$$

4. Option D. The main example is to buy a newer upgraded REM. The technical efficiency of REM in the specified version,

$$E_{(D)T}(t) = \frac{W_{(D)}(t)}{W_{to}(t)},$$

economic efficiency

$$E_{(D)I}(t) = \frac{W_{(D)}(t)}{C_{(D)}(t)} \cdot$$

Overall effectiveness of REV for option D

$$E_{(D)}(t) = \frac{W_{(c)}^2(t)}{W_{to}(t)C_{(D)}(t)} \cdot$$

If we show the indicators of the total effectiveness of REV for the above four options based on W_to (t) and during the specified service life of the product

$$W_{(A)}(t) \approx W_{(B)}(t) \approx W_{(C)}(t) \approx W_{(A)}(t)$$

assuming then

$$E_{(A)}(t)C_{(A)}(t) \approx E_{(B)}(t)C_{(B)}(t) \approx E_{(C)}(t)C_{(C)}(t) \approx E_{(D)}(t)C_{(D)}(t) \cdot. \quad (3)$$

$C_{(A)}(t) \ll C_{(B)}(t) < C_{(C)}(t) \ll C_{(D)}(t)$ when the condition is paid,

$E_{(A)}(t) \gg E_{(B)}(t) > E_{(C)}(t) > E_{(D)}(t)$ olar.

The real value of the technical efficiency of military products depends on its strategic operational and technical characteristics. The main strategic operational characteristics of the products include indicators of the degree of performance of combat tasks. The probability of hitting the target P(Ω) given in the environmental conditions Ω given to the characteristic of such an indicator is assumed. In the general case, P(Ω) will be a vector quantity. Taking into account the reliability of special purpose REM in products, the analytical expression for indicators of technical efficiency is as follows

$$W(t) = K_{oh}(t)\,P(\Omega), \tag{4}$$

where K_{oh}- coefficient of operational readiness; $P(\Omega)$- $\Omega = \{\xi_1, \xi_2, \dots \xi_i, \dots\}$ probability of hitting the target within given environmental conditions; ξ_i-i-th condition of environment; t- is the duration of the combat mission.

K_{oh} operational readiness factor is accepted based on the condition of REV in the product. It should be noted that the probability of the non-failure operation period of the special purpose REV should be taken according to the events up to the moment of its connection, and not from the previous situation. The situation we have shown is possible at a relative value of P> 0.95 at the time of connection of the special purpose REM.

The operational readiness coefficient of the REM is denoted as the probability of the intersection of two events. It is assumed that event A will occur at an arbitrary point in time (if its destination is not expected to be used) and from that moment the REM operates flawlessly until event B at a given point in time Δ. The probability of event B at time Δ does not depend on the previous state. Thus, the probability of events A and B is determined from the readiness coefficient (K_{hi}) and the probability of failure-free operation P(t) REM.

It is possible to calculate the preparation coefficient of the i-th product of the special purpose REV, characterized by non-rejection and recovery properties, by the following formula

$$K_{hi} = 1 - \frac{1}{t_{ti}}\left(nT_{bi} + \varepsilon\tau_n + \nu\frac{T_{pi}}{2}\right), \tag{5}$$

where t_{ti} – the calendar period (hours) of operation of product *i* in REM; according to n and $T_{(bi\,)}$- the number of rejections of *i*-th products in REM during t_{ti} period and the average time of their recovery (hours); ε and τ_n - the number of training control and the duration of training control (hours) during t_{ti}, respectively; ν and $T_{(pi\,)}$- is the time (hours) between the number of hidden rejections and the planned readiness control, respectively.

The probability of non-failure operation of special purpose REM product i in the time interval Δt can be calculated by the following formula

$$P_i(t) = \exp\left(-\Delta t \sum_{j=1}^{N} \omega j\right), \quad (6)$$

where ωj - is the parameter of the rejection current at position j in the scheme; N - is the number of positions of REM in the scheme.

By changing the expression (1), we get the following formula

$$E(t) = \frac{K_{oh_r}(t)}{K_{oh_t}(t)}, \quad (7)$$

Where $K_{oh_r}(t)$ - the real value of the operational readiness coefficient of the products in REM at time t (this value is calculated from formulas (3) and (4)); $K_{oh_r}(t)$- is the required value (this value is indicated in the operating documents) of the operational readiness coefficient in the REM in the time interval t.

The REVs used in the military units of the Armed Forces of the Republic of Azerbaijan are complex and expensive products. Therefore, the REVs included in these examples are performed on the basis of the principle of functional node constructions based on the 3-rd, partially 2-nd level element base, and the following characteristic features can be indicated (Binnetov et al., 2015; Gasanov et al., 2022):

1. Elements (radio parts, electrotechnical products, electronic equipment, quantum electronics, optical electronic products, etc.).

2. Object of REV - which is not independently applicable, non-restored and non-removable. The combination of radio details (elements) applied in special-purpose REM is called the element base and is classified according to the stage of development.

3. Modules, micromodules and integrated circuits – is a simple complete structure that performs the functions specified in the REM. The structure consists of radio details (elements) and is called a functional node.

4. Junction (cassette) - a complete structure consisting of a functional junction and elements (radio details), mounting plates and electrical assemblies. This type of construction is called a typical replacement element (TRE). In military conditions, its maintenance is not considered in the operational documents. The TRE is connected to the subpanel and then to the panel.

5. Stand, remote control, etc. - a complete structure consisting of a sub-panel and a cassette in a panel.

6. Blocks – consisting of nodes, functional nodes, assembly elements, is a construction completed by mounting on a board, frame, general chassis.

CONCLUSION

According to the mentioned features, it can be concluded that the supports, nodes (cassettes) and functional nodes used in special purpose

REV are not unified with each other. As a result of the analysis of the element base of REV, it was determined that most of the groups belonging to the nomenclature of electroradiodata (ERD) are of the same type. This case allows to assess the reliability according to the condition of the element base, taking into account the architectural characteristics of all special-purpose REV.

Thus, in the modern era, in the issues of ensuring the reliability of the special-purpose REM, increasing the selection efficiency of the products included in the military warehouses and, accordingly, plans for their improvement or major repair should be established. In the case of carrying out scientific-methodical and technical-organizational measures in the adopted plan, it should be taken into account that the coefficient of operational readiness is not less than the value of the tactical-technical task under the condition of maintaining the special-purpose REM.

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