A. P. Poliakov, Dc. Sc. (Eng.), Prof.; D. O. Galuschak; O. O. Galuschak; O. P. Antoniuk

METHOD FOR FORMING THE REQUIRED QUANTITY OF SPARE PARTS FOR TRANSPORT MEANS REPAIR

An algorithm is presented for realization of the method for forming the required quantity of spare parts for transport means repair. The analysis of factors influencing the demand of a motor transport enterprise for spare parts in the process of hauling stock operation has been conducted.

Key words: *spare parts, hauling stock, motor transport enterprise, running time, automobile service life, replacement flow parameter.*

At present high-quality transportation service could be granted by a motor transport enterprise only with a reliable hauling stock, the serviceable condition of which requires improvement not only of the services engaged in maintenance and repair, but also of the hauling stock material-and-technical provision system.

Material-and-technical provision system of automotive transport has strong influence on the hauling stock technical readiness. Improvement of the process of organizing the hauling stock provision with spare parts is one of the ways to increase the efficiency of its maintenance.

An important component of the material-and-technical provision system at a motor transport enterprise is a subsystem for managing the reserves of spare parts.

The spare part is a component of the product designed to replace the same component in order to ensure proper operation or serviceability of this product.

Management of the reserves of spare parts (provided that their supply is stable) under current market economy conditions involves control, standardization and regulation of the nomenclature and quantity of spare parts at a motor transport enterprise. Estimation of the optimal nomenclature and quantity of spare parts at a motor transport enterprise is one of the priority directions of raising the hauling stock technical readiness and saving material resources [1].

As the existing methods of predicting the necessary quantity of spare parts do not fully meet current requirements (increased automobile park diversity, availability of the information base), improved organization of provision with spare parts is possible by developing new and perfecting the existing methods, which will make it possible to improve the material-and-technical provision system of a motor transport enterprise.

Analysis of the factors affecting the quantity of parts, assemblies and units used during the hauling stock maintenance process has determined that a motor transport enterprise demand for spare parts is influenced by a large number of factors (constructive, operational, technological and organizational) [2, 3].

However, the following factors were found to have the greatest influence on the dynamics of the use of spare parts during the hauling stock operation process: intensity of service, reliability of the vehicles (units, assemblies, parts), quantity and age structure of the hauling stock as well as the automobile running time from the beginning of its service [4, 5].

Therefore, an improved method for predicting the needs for spare parts of transport means should be based on taking into account complex influence of the above factors that determine an automobile demand for spare parts in the conditions of a definite motor transport enterprise as well as a number of requirements to the procedure of forming the necessary quantity of spare parts for transport means repair.

In order to ensure a motor transport enterprise effective provision with the corresponding quantity of spare parts, given method should meet the following requirements:

– to take into account running time and service life of vehicles as key factors affecting the quantity of spare parts used during their operation;

- to provide technical readiness coefficient of the hauling stock in the range from 0,9 to 0,95;
- to provide shorter duration of the hauling stock downtime during repairs;
- to reduce a motor transport enterprise material expenditures connected with the hauling stock provision with corresponding spare parts and their storage;
- to have a relatively simple practical implementation.

Hence, the above-mentioned improved method should be based on the task of creating such a procedure for forming the necessary quantity of automotive spare parts for transport means repair that ensures timely and rhythmic motor transport enterprise provision with spare parts with minimal expenditures for purchase and storage of the unused spare parts by timely prediction of the limit state of parts, assemblies and units and determination of the quantity of spare parts required for operational repair of the vehicles.

The parameter of the flow of failures or replacements, used for predicting a motor transport enterprise need of spare parts, enables more reliable estimation and operational forecasting of their quantity to be used during a definite interval of the automobile running period, which is very important for short-time prediction of the demand for spare parts. Therefore, the improved method of forming the required quantity of spare parts for transport means repair is based on the failure flow parameter, service intensity and age structure of the vehicles. The failure flow parameter for parts, assemblies, units and the automobile on the whole is the main criterion that combines the methods for automobile reliability estimation and the demand for spare parts and units. Besides, the replacement flow parameter can be determined simply by using a statistical sampling of the component life before it fails. Operation intensity of a part (a unit or assembly) is characterized by the automobile running time during the forecasted period. Age structure of the hauling stock of the automobile park is determined by the running time of automobiles from the beginning of their service. The existing methods for forming the required quantity of spare parts for transport means repair do not take these parameters into account.

The improved method for forming the required quantity of spare parts for transport means repair is implemented by performing the sequence of operations presented in fig. 1.

Taking into account that a motor company need for spare parts is affected by the number of cars of the same type, the number of identical parts, the automobile running time from the beginning of its service, duration of its service, for performing calculations it is necessary to have data on failures and replacements of components, assemblies and units, their range of service and age at the time of failure, the number of cars of the same brand at the enterprise and the number of similar parts installed on the car. Therefore, the following data were taken as initial ones for calculations:
N – the number of cars of the j-th age group; R – the number of the automobile identical parts; L_{0JJ} – running time of the n-th automobile of the j-th age group from the beginning of its service; ΔL_{JJ} – the predicted running time of the n-th automobile of the j-th age group at the end of the period to be investigated; T_0 – service life of the n-th automobile; T_r – period for which the required number of spare parts for the n-th automobile is determined.

In the improved method of forecasting thequantity of spare parts required for transport means repair the automobile running time for each group and subgroup of vehicles is calculated by the formula:

$$L_i = L_{0i} + \Delta L_i , \tag{1}$$

where L_{0i} is running time of the i-th automobile from the beginning of its service; ΔL_i – running time of the i-th automobile at the end of the forecasted period.

After that the replacement flow parameter for parts, assemblies and units is formed for each group and subgroup of automobiles at the beginning and at the end of the period for which the required quantity of spare parts is determined:

$$\omega(l) = \frac{\sum_{j=1}^{N} R_j}{N \cdot l}, \qquad (2)$$

where R_j is the number of replacements of the parts, assemblies and units during the investigated interval of the running period *l*; N – number of cars of the given group.

Division of the automobiles of the same type into groups according to the running time from the beginning of their service

Division of the automobiles of the same type into groups according to their service life

Analyzing the number of replacements of parts, assemblies and units within the previous service period of automobiles

Distribution of replacements of parts, assemblies and units both according to the running time and to the service life of automobiles

Calculation of the running time of automobiles belonging to each group and subgroup, for which the required quantity of the automotive spare parts is forecasted.

Forming the replacement flow parameter for parts, assemblies and units for each group, and subgroup of automobiles at the beginning and at the end of the period for which the required quantity of spare parts is determined

Approximation of the obtained dependencies of the replacement flow parameters for the automotive parts, assemblies and units on their running time and service life at the beginning and at the end of the period for which the required quantity of spare parts is determined.

Calculation of the quantity of automotive spare parts required for the maintenance of automobiles during the forecasted period of their service for each group and subgroup of the vehicles.

Taking a decision about the motor transport enterprise provision with the total quantity of spare parts necessary for maintenance of the car park during the forecasted period of its service.

Fig. 1. Algorithm of implementing the method for forming the quantity of spare parts required for transport means repair

The obtained dependencies of the replacement flow parameters for parts, assemblies and units on the running time and service life of the cars are approximated in three steps. In order to obtain the analytical two-factor equation of the dependencies of the replacement flow parameter for parts, assemblies and units on the running period L and service life T we approximate the dependencies of the said replacement flow parameter $\omega(l,)$, derived on the basis of statistical data about replacements of parts, assemblies and units.

The two-factor equation $\omega(l)= f(L,T)$ is composed by means of sequential approximation. At the first stage, to obtain numerical values of coefficients for the approximation equation of the dependence of the replacement flow parameter for automotive parts, assemblies and units on their service life, graphical dependencies of the replacement flow parameter on the running time are approximated $\omega(l)= f(L)$.

At the second stage, according to the numerical values of the approximation equation coefficients $\alpha_к$ their graphical dependencies on the automobile service life T are built.

At the third stage general analytical dependence of the replacement flow parameters ω for parts, assemblies and units of the automobiles on their running time L and service life T is composed:

$$\omega = \alpha_0(f(T)) + \alpha_1(f(T)) \cdot L + ... + \alpha_k(f(T)) \cdot L^k, \quad (3)$$

where $\alpha_k = f(T)$ are analytical dependencies of the approximation equation coefficients on the automobile service life; κ – degree of the approximation equation.

Using the obtained values of the replacement flow parameters for the j-th part at the beginning $\omega_{0J} = f(L_{0J}, T_{0J})$and at the end $\omega_J = f(L_J, T_J)$ of the period for which the required quantity of automotive spare parts is determined, the necessary quantity of automotive spare parts is calculated by the formula:

$$m(\Delta L_i) = C \cdot \sum_{J=1}^{N}[\omega_J(L_J, T_J) - \omega_{0J}(L_{0J}, T_{0J})] \cdot A, \quad (4)$$

where C is the number of identical parts installed on the car; A – the number of cars of the same type in the group.

On the basis of calculations of the necessary quantity of automotive spare parts a decision is taken about the motor transport enterprise provision with the total quantity of spare parts required for maintenance of the automobile fleet of the motor transport enterprise during the forecasted period of its service.

Conclusions

The improved method enables more accurate prediction of the necessary quantity of spare parts, which makes it possible to reduce expenses for purchasing and storing the unused spare parts as well as to reduce idle time of the hauling stock of a motor transport enterprise during its repair.

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Poliakov Andriy – Dc. Sc. (Eng.), Prof., Dean of the Faculty of Automobiles, their Repair and Restoration.

Galuschak Dmitro – Student.

Galuschak Oleksandr – Student.

Antoniuk Oleg – Post-graduate student of the Department of Automobiles and Transport Management.