DOI: 10.18372/2310-5461.61.18515
UDK 629.7 (043.3)

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PROBLEMS OF DETERMINING THE NEED FOR SPARE PARTS AND MATERIALS FOR THE MAINTENANCE OF AIRPORT SPECIAL EQUIPMENT

Introduction

Special equipment at a modern airport plays an important role in ensuring the safety, efficiency and regularity of flights. Currently, the number of special equipment units at international airports reaches several hundred vehicles and their number is constantly increasing as passenger traffic increases.

With the growing number of special vehicles at the airport, the problem of ensuring the efficiency and safety of their use is becoming increasingly important. One of the conditions for its successful solution is timely and quality maintenance of special equipment. Material resources, including spare parts, special liquids, oils, greases and other materials, are necessary for maintenance. Lack of resources leads to untimely or incomplete performance of preventive operations, downtime while waiting for maintenance, and excessive stocks – to an increase in the cost of turnover funds and, accordingly, the cost of operating special equipment [1].

As practice shows, even with a high culture of production organization at the airport, in some cases it is not possible to achieve high indicators of the technical availability factor. Analysis of the reasons for deviations of actual values of the technical availability factor from the planned ones showed the presence of significant downtime of special equipment waiting for maintenance. Thus, 13.6 % of excessive downtime is due to waiting for maintenance operations. One of the reasons for downtime is the lack of materials for maintenance.

Thus, there is a problem of improvement of technical operation in the part of the system of supplying materials for maintenance of special equipment at the airport, the solution of which will reduce the downtime while waiting for technical actions, as well as the cost of operation.

As a methodological basis of the research, it is necessary to use the system approach. In this regard, let us consider the tree of technical operation systems [2]. In this structure from the subsystems of the first level it is necessary to allocate the following "Supply and redundancy system" and "Operating conditions". Of the subsystems of the second level, the most significant in solving research problems are "Application of rational norms of fuel, oil and other materials consumption", as well as "Provision of optimal reserves and methods of their replenishment".

In addition to them it is necessary to consider the subsystems "Consideration of natural and climatic conditions", "Consideration of road conditions", "Consideration of transportation conditions and intensity of use of products". This is due to the influence of operating conditions on the frequency of maintenance and running time to the limit state of the elements to be replaced by condition. Accordingly, the number of maintenance operations and consumption of materials to be replaced according to the operating conditions, as well as the consumption of elements to be replaced according to the condition depends on the operating conditions.

Further, when solving the problem of improving technical operation in terms of the system of supplying materials for maintenance of special equipment, the research object studied in this paper will be defined as a subsystem within the considered structure.

The purpose of the article

Based on an analysis of modern systems for the maintenance of special equipment at a modern airport, to substantiate the directions of research in the field of providing resources and consumables for technological processes associated with the operation of aviation ground vehicles and airport equipment.

Factors determining the flow of requirements for maintenance of special equipment

As noted in [3], there are two different strategies for ensuring serviceability:

– preventive, providing for the prevention of failures and malfunctions by carrying out maintenance;

– restorative, which provides for the restoration of lost serviceability by carrying out repairs.

The first strategy is unrealizable to the full extent, because even with any small periodicity of maintenance it is impossible to provide a hundred percent probability of failure-free operation. The second strategy is irrational for special equipment, because failures are random, and it is impossible to predict at what moment of time how many failures will occur, and what will be the level of operability of the fleet of machines. Therefore, the third strategy of ensuring operability, which is a combination of the first and the second one, is widely spread in airports. This strategy is realized in the form of a special equipment maintenance system.

In the known systems of maintenance, the strategy of ensuring serviceability of special equipment is realized in various tactics, which can be reduced to three variants:

– hard time maintenance and repair – scheduled maintenance after reaching the standard operating time or time specified in service documents;

– on condition maintenance – in this case the maintenance operation includes control and performance parts. After fulfillment of the first part of the operation, depending on the condition of the service object, a decision is made on fulfillment or non-fulfillment of the second part of the operation;

– condition monitoring – periodic or continuous measurement of the controlled parameters is performed; in case of reaching the limit state, recovery is performed.

There are the following types of maintenance: maintenance during operation, maintenance while waiting, maintenance during storage, maintenance after transportation. Since the 2^{nd}–4^{th} of the mentioned types of maintenance are episodic and do not have a significant impact on resource consumption, let's consider in more detail maintenance during use.

Maintenance of special equipment at the airport includes periodic maintenance performed at certain intervals of operation or time, seasonal maintenance performed at the change of the season of operation, and maintenance in special conditions.

For many models of special equipment used in modern airports satisfying the environmental class Euro-3 the periodicity of Maintenance-1 and Maintenance-2 is 10 and 30 thousand kilometers, for Euro-4 – 25 and 50 thousand kilometers, and for Euro-5 – one stage of maintenance with a frequency of 40 to 80 thousand kilometers depending. Thus, there is a long-term stable tendency to increase the frequency of maintenance.

The existing structures of maintenance cycles can be divided into two groups: single-stage (all services are performed with the same periodicity) and multistage (services of each stage have their own periodicity, multiple of the periodicity of a higher stage).

Single-stage structures provide for maintenance at equal intervals of operation, with part of operations performed every service, and the other part – after one, two or more services. To characterize the frequency of operations performance the coefficient of operations repetition K_r is used, which is equal to the ratio of maintenance periodicity to the periodicity of operation performance. For example, if the frequency of maintenance is 10 thousand kilometers, and the frequency of operations is 20 thousand kilometers, then K_r = 0,5. Therefore, the lists of maintenance operations, performed at different operating hours of special equipment, are significantly different. But at the same time, after performing a number of maintenance operations during the operating time corresponding to the periodicity of the operation with the minimum value of the coefficient of repeatability, the following maintenance operations are performed in the same order, i.e., the maintenance cycle is repeated.

In the known methods of calculation of the production program, as a rule, two-stage maintenance systems are considered, including Maintenance-1 and Maintenance-2, as well as Maintenance and Service. But nowadays a greater number of stages is provided for special equipment used at airports. For example, for the TMX-450-TLD airfield tractor, Maintenance-1 includes two lists of operations performed during even and odd services. For Maintenance-2, five different lists are provided. At the same time, the lists of Maintenance-2 – 1 and Maintenance-2 – 5 coincide, and every 3rd, 4th, 5th and 6th differ from them both by the list of operations and labor intensity [4].

The structure of the TMX-450-TLD maintenance cycle includes:

– DM – daily maintenance;

– Maintenance-1000 – maintenance in the initial period of operation after the first 1000 hours of operation;

– Maintenance-1 – the first maintenance. Each second Maintenance-1 is different from the first, so we denote: Maintenance-1 – 1 and Maintenance-1 –2;

– Maintenance-2 – second maintenance; they are carried out according to the cycle of six services differing in content, in all cases operations Maintenance-1, Maintenance-2 –1 and additional operations included in each Maintenance-2, except for the 1st and 5th, are performed; after the first six Maintenance-2 the cycle is repeated;

– SM – seasonal maintenance. We consider seasonal maintenance performed in the fall (SM-W) and spring (SM-S);

– Maintenance-2 of the year – maintenance performed in two-year intervals.

In the considered case each of the five stages differs in labor intensity, in the list and volumes of consumables. The flow of requirements for maintenance has a complex structure. Therefore, when using known methods of calculation of the production program for maintenance, the need for materials cannot be predicted with sufficient accuracy.

Besides, for example, for TMX-450-TLD the maintenance program is carried out after 96 thousand kilometers, and for Neoplan buses the maintenance program is carried out after 200 thousand kilometers, i.e., not every year, but after 1–3 years. This makes it difficult to calculate the annual production program using traditional methods.

Most often for each type of maintenance the production program is calculated for one year. On the basis of this program the annual volumes of maintenance works are determined. In addition, these calculations make it possible to determine the need for resources for maintenance.

Calculation of the production program for maintenance is an integral part of the technological design of the special equipment service of an airport or a handling company. In this connection it is given much attention in practical activity.

There are several deterministic methods of determining the annual production program for maintenance and repair.

Most often the cycle method is used, which provides for calculation of the number of technical actions per cycle before overhaul of a particular model of special equipment, and then - the transition from cycle to year through the transition coefficient. But nowadays full-complete overhaul is practically not performed, and for a number of special equipment models the norm of resource before overhaul is not defined. In this regard, in the methodology described in [5], it is proposed to use the maintenance cycle in the calculation instead of the cycle before overhaul.

Similar results are obtained by a simpler method, which consists in calculating the total annual operating time of all special equipment and dividing it by the frequency of maintenance of the corresponding stages, and then subtracting from the number of maintenances with a lower frequency the number of maintenances with a higher frequency.

Deterministic methods are relatively simple, but they do not take into account the random nature of the arrival of special equipment for maintenance. This does not significantly affect the result of calculation of the production program in case of stationary flow of requirements for maintenance, when the established periodicity of maintenance is observed, and the intensity of special equipment operation is constant. But, as a rule, the actual periodicity differs significantly from the normative one, and the intensity of operation varies in time within wide limits. Therefore, in general case the flow of requirements for maintenance is characterized by non-stationarity, and its characteristics cannot be determined analytically. Therefore, the most acceptable method of solving this problem is to use a simulation model.

In [6], basic models of the flow of requirements for technical impacts were developed, including the model of the flow at a fixed operating time to the limit state. This model allows us to reproduce the flow of requirements for maintenance when changing the intensity of use of special equipment.

Typical regularities of changes in the intensity of operation over time are also developed, trend, periodic and random components are analyzed. Using the obtained data, as well as the above-mentioned basic model, typical regularities of change in the flow of maintenance by time were established. This allowed us to propose a simplified version of the methodology for calculating the production program for maintenance, which can be used in combination with known methods for calculating the number of maintenance stations.

The next step in the research of the production program for maintenance was the development of simulation models, which allow to simulate the flow of requirements for maintenance not only when the intensity of operation of specific models of special equipment changes, but also when the actual frequency of maintenance varies.

Thus, the results of earlier studies confirm the assumption of non-stationarity of the flow of requirements for maintenance, which allows us to conclude that the process of resource consumption for maintenance is stochastic. The experience of creating simulation models is supposed to be used by us to create a model of the flow of requirements for resources for maintenance.

The system of supplying spare parts and materials for maintenance of special equipment

When using special equipment at the airport, resources are consumed, which can be divided into two groups: resources for the use of special equipment for its intended purpose and resources for maintenance. The nomenclature of resources of the second group is quite wide, which creates certain difficulties with supply, and the level of organization of supply largely depends on the efficiency of the special equipment service. The logistics subsystem is designed for uninterrupted supply of resources. It should ensure the use of special equipment without downtime associated with the lack of resources, but at the same time the cost of acquisition, delivery, storage of material resources should be minimal.

The processes of utilization of special equipment at the airport are stochastic, respectively, the processes of consumption and supply of resources are also stochastic. In this regard, the logistics system can be conceptualized as a mass service system. Stochasticity of the system is caused not only by the properties of the ongoing processes, but also by the randomness of the factors influencing them. In this regard, to manage the system under consideration, it is necessary to know the list of factors that determine the intensity of resource consumption, as well as the regularities of their changes.

In the context of the problem under consideration, not only the average consumption of materials is important, but also its change over time. Therefore, to characterize the consumption it is necessary to select indicators that take into account, among other things, the variation of consumption. They include the following:

– average annual flow rate;

– coefficient of variation of consumption during the year;

– average monthly consumption;

– coefficients of variation of consumption by month during the year.

In accordance with maintenance tactics, resource utilization requirements are generated either as a result of reaching the regulated operating time before maintenance or a technical condition close to the limit. In this regard, it is necessary to consider separately the factors affecting the consumption of materials for replacement by operation or time, as well as the factors affecting the consumption of materials for replacement by condition.

Consumption of materials for replacement by operating time (materials of the 1st group) is determined by:

– the amount of material per service;

– frequency of replacement;

– intensity of special equipment operation;

– the number of special equipment in the fleet.

Material consumption per one service is determined by design factors, and the frequency of replacement is also determined by operating conditions.

There are two known methods of planning the staging of special equipment at the airport for maintenance: calendar planning and planning by operating time.

In calendar planning the date of the next maintenance is calculated by dividing the normative maintenance frequency by the average daily operating time of a particular unit of special equipment.

To determine the date of the next maintenance when planning by operating time, the actual operating time of a particular unit of special equipment for a day after the previous maintenance is added up. When the sum of operating hours is close to the normative frequency of maintenance, a specific date of maintenance for this unit of special equipment is determined.

Calendar planning is easy to apply in practice, but it is expedient to use it only at stable intensity of special equipment operation. Planning by operating time gives more accurate results, but it is also more labor-intensive.

The frequency of maintenance depends on the actual frequency of maintenance and the intensity of operation of special equipment of a particular model.

The intensity of operation is determined by many factors. Among them we can single out the type of special equipment and climatic conditions of operation. It is established that the change in the intensity of operation in time is determined by three components – constant (trend), periodic (seasonal) and random.

The constant component is determined by the operating time of a particular unit of special equipment from the beginning of operation. The greater the operating time, the greater the number of failures and downtime in repair. Most often the constant component is described by an exponential law.

The periodic (seasonal) component is caused by seasonal variation in the demand for the performance of certain works by a particular type of special equipment, as well as by changes in operating conditions. The best description of the seasonal component is provided by a harmonic series including from 2 to 5 harmonics.

The presence of a random component of the intensity of operation is associated with the stochasticity of the processes of using special equipment. The random component of operation intensity can be described by various laws: Weibull (65 % of cases), exponential (20 %), normal and lognormal (15 %).

The consumption of resources for replacement over the operating life depends on the number of maintenance operations, which, in turn, depends on the intensity of operation. It is obvious that the need in resources changes according to the regularities similar to the regularities of changes in the intensity of operation. It can be assumed that, depending on the ratio of the annual operating time and the normative periodicity of maintenance, the seasonal wave of resource demand will be expressed to a lesser or greater degree. In addition, the shift of the extrema of the first dependence relative to the extrema of the second dependence probably depends on these factors.

Consumption of materials for replacement by condition (materials of the 2nd group) depends on the same factors as the consumption of spare parts for current repair. Taking into account that the group under consideration includes materials of different properties (brake pads, air filters, oils and special fluids, drive belts, electric lamps, etc.), it should be noted that for each item of materials of the second group the list of influencing factors can be individual, differing from the set of factors for another item.

Thus, the need for resources for maintenance is influenced by a large number of factors, and, presumably, the lists of significant factors are different not only for materials of the first and second groups, but also for different materials of the second group. To determine the factors that significantly affect the consumption of resources of each item, it is necessary to conduct special studies.

Methodologies for determining resource requirements differ depending on the type of resource. The need for spare parts is determined by the following methods:

– by nomenclature norms;

– by actual demand;

– a mixed method, which is a combination of the two previous methods.

Nomenclature norms establish the consumption of spare parts for each part for 10 units of special equipment of a particular model per year and are established by normative documents. The rate of spare parts consumption for the period of operation of special equipment means the average expected number of replacements of component parts for this period due to failures and resource exhaustion. The rate of material consumption for the period of operation means the average expected for this period amount of wasted materials.

Based on the nomenclature norm, the need for spare parts is calculated according to the formula:

$$\Pi_z = \frac{HA}{10} K K_1 K_2 K_3 ,$$

where HA is the number of units of special equipment of a particular model in the fleet; K is a coefficient that takes into account the ratio of actual annual and standard operating time; K_1, K_2, K_3 are coefficients of demand adjustment, taking into account the category of operating conditions, product modification and climatic region.

The method of calculating the demand for spare parts based on actual consumption provides for collecting information on the flow of requirements and determining the supply plan by consumption for the previous analogous period.

The mixed method is based on a combination of the first two methods.

The need for motor, transmission, special oils and greases in accordance with the current regulatory documents is determined based on the planned fuel consumption. Engine oil consumption rate is increased by 20 % for special-purpose machinery that is more than five years old or capitally repaired.

It should be noted that in the existing normative documents, firstly, there are no standards for the consumption of spare parts used in maintenance, secondly, there are no recommendations for resource stocks and, thirdly, the variation of the flow of requirements for resources over time is not taken into account.

The need for resources of a given type N_i, for a period of time T_i can be calculated by the formula:

$$N_i = H T_i \sum_{j=1}^{A_c} l_{ji} K ,$$

where H is the rate of resource consumption per hour of operation; l_{ji} is the intensity of operation of the *j-th* model of special equipment for the time interval T_i; A_c is the size of the special equipment fleet; K is a coefficient that takes into account seasonal variation in resource requirements.

For resources, the consumption of which does not depend on the operating time of special equipment, the calculation of the monthly demand is performed according to the formula:

$$N_i = \frac{1}{12} N_g K ,$$

where N_g is the annual demand for a resource of this type.

Management of stocks of material resources is achieved by solving the following tasks:

– control of the current stock in the warehouse;

– determining the size of the safety stock;

– determining the size of the order;

– determination of the moment (periodicity) of delivery.

The current stock theoretically varies from the maximum stock formed after the next delivery to the minimum stock equal to the insurance stock. The indicator "average current stock" is used to characterize stocks. Its value determines the amount of working capital invested in inventories, as well as the cost of storage.

Insurance stock is a part of the stock designed to minimize the risks associated with fluctuations in demand and failure to meet delivery deadlines. Insurance stock is a stock of resources intended for uninterrupted supply of production and consumption in cases of reduction of supplies in comparison with the stipulated ones.

If the demand is relatively stable and the source of supply is close to the company, the Just-In-Time concept can be realized. Its use allows to reduce the level of stocks by 40 % and to reduce storage space by 15 %.

Inventory management tasks include determining the size and frequency of deliveries and the size of the safety stock. Deterministic or stochastic approaches are used to solve these problems. Deterministic methods allow to find simpler but less accurate solutions. Therefore, they can be used for planning the average consumption for a sufficiently large period. Stochastic methods are much more difficult to implement.

Determination of the parameters of the inventory management system is reduced to an optimization problem, which consists in the calculation of the volume and frequency of deliveries, corresponding to the minimum of the sum of the cost of acquisition, delivery and storage of materials.

To determine the delivery volume in inventory management, the optimal order size Q is calculated by the following models:

– economic order model

$$Q = \sqrt{\frac{2DS}{H}},$$

where D – is the annual demand for parts in value terms; S – is the cost of placing and receiving an order; H is the cost of storing a unit of inventory;

– production order model

$$Q = \sqrt{\frac{2DS}{H\left(1 - \frac{D}{M}\right)}},$$

where M – is the capacity of the producer;

– ordering model with reserve stock

$$Q = \sqrt{\frac{2DS}{H} \cdot \frac{H + B}{B}},$$

where B – reservation costs

– discounted ordering model

$$Q = \sqrt{\frac{2DS}{hC}},$$

where h – storage costs as a fraction of the price; C – purchase price.

In most of the known methods of calculating the need for resources are based on the stationarity of the flow of requirements for resources. In practice, this flow is non-stationary, i.e., its parameters change in time. This is caused by the seasonal changes in the intensity and operating conditions of special equipment at a modern airport. Consequently, the known analytical models used to calculate the parameters of the supply and inventory management system do not allow to obtain sufficiently accurate results. This once again shows the expediency of using simulation modeling.

In a number of scientific studies, the reasons of unevenness of demand in spare parts during the year are established. One of the main reasons is seasonal change of climatic conditions.

The regularities of influence of seasonal conditions on the intensity of resource consumption by types in the operation of special equipment have been established. For example, the relative intensity of spare parts consumption increases with decreasing air temperature.

It has been established that the air temperature affects the parameter of the failure flow of different units and systems of special equipment in different ways: for internal combustion engines, gearboxes, transfer boxes, drive axles, the number of failures is characterized by an increase in the number of failures when the temperature decreases, and for control systems – by a decrease. In addition, based on the concept of object quality formation in the process of operation, three components of the failure flow were identified: trend, periodic and random.

All spare parts are most often divided into three groups:

– group T (thermal) – spare parts with significant variation in flow rate and are consumed more intensively at high air temperature;

– group U (uniform) – spare parts with stable flow rate and insignificant influence on air temperature;

– group C (cold) – spare parts with significant variation of flow rate and are consumed more intensively at low air temperature.

Most of the previously performed studies are devoted to determining the need for spare parts for overhaul and current repair of special equipment. The issues of planning the need for spare parts for maintenance of special equipment are not sufficiently investigated.

Conclusions

The following conclusions can be formulated on the basis of the analysis of previously performed studies:

– in accordance with the tactics of maintenance, the requirements for the use of resources are generated either as a result of achieving the regulated operating time before maintenance, or the technical state close to the limit. In this regard, it is necessary to consider separately the factors affecting the consumption of materials for replacement by operating hours or time, as well as the factors affecting the consumption of materials for replacement by condition;

– the need for resources for maintenance is influenced by a large number of factors, and, presumably, the lists of significant factors are different not only for materials of the first and second groups, but also for different materials of the second group. In order to determine the factors that significantly affect the consumption of resources of each item, it is necessary to conduct special studies;

– the results of earlier studies confirm the assumption of non-stationarity of the flow of requirements for maintenance of special equipment at the airport, which allows us to conclude that the process of resource consumption for maintenance is stochastic. The experience of creating simulation models can be used to create a model of the flow of requirements for maintenance resources.

REFERENCES

[1] Thomas, R. (1997) Quantitative Methods for Business Studies. New Jersey. Published by Prentice Hall, 517 p.

[2] Industry (MPIG based on AHM WG proposal) (2018). "Aircraft Health Monitoring (AHM) integration in MSG-3", International Maintenance Review Board Policy Board (IMRBPB).

[3] Guzhva, V., Raghavan, S., D'Agostino, D.J. (2018). Principles of maintenance reserve development and management. Aircraft Leasing and Financing. Elsevier, pp. 263-298.

[4] Maintenance manual TMX-450-TLD, (2019). 1487 p.

[5] Asabere, N.Y., & Kusi-Sarpong, S. (2012). mVES: A Mobile Vehicle Expert System for the Automobile Industry. International Journal of Engineering Research and Applications, 2(6), 1108-1123.

[6] Ji, J., Bie, Y., Zeng, Z. & Wang L. (2022). Trip energy consumption estimation for electric buses. Communications in Transportation Research, 2. http://dx.doi.org/10.1016/j.commtr.2022.100069.

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ПРОБЛЕМИ ВИЗНАЧЕННЯ ПОТРЕБИ У ЗАПАСНИХ ЧАСТЯХ І МАТЕРІАЛАХ ДЛЯ ТЕХНІЧНОГО ОБСЛУГОВУВАННЯ АЕРОПОРТОВОЇ СПЕЦТЕХНІКИ

Розглянуто сучасні умови роботи аеропорту з погляду зниження тарифів на послуги шляхом зниження витрат на експлуатацію спецтехніки. При цьому основну увагу приділено аналізу впливу на собівартість використання спецтехніки витрат на запасні частини та матеріали, що використовуються під час її технічного обслуговування. Процеси використання спецтехніки в аеропорту розглядаються як стохастичні, а система матеріально-технічного постачання в аеропорту розглядається як система масового обслуговування. При цьому враховується, що стохастичність системи обумовлена не тільки властивостями процесів, що протікають, а й випадковістю факторів, що на них впливають. У зв'язку з цим для управління даною системою проаналізовано перелік факторів, що визначають інтенсивність витрачання ресурсів, а також закономірності їх зміни. Основну увагу приділено необхідності знаходити компроміс між безперебійним постачанням, що потребує збільшення розмірів замовлень, та зниженням обсягів запасів, що збільшують вартість оборотних фондів авіаційного підприємства. Також проаналізовано вплив на витрати ресурсів для технічного обслуговування спецтехніки в аеропорту кліматичних умов експлуатації. Аналіз показав, що визначення потреби в ресурсах для технічного обслуговування спецтехніки в аеропортах в даний час планується виходячи з фактичної витрати за попередній рік і при цьому практично не враховується, що витрата змінюється за сезонами. У цьому відзначено проведення актуальності досліджень, спрямованих на розробку методик планування потреб служб спецтранспорту у сучасних аеропортах у запасних частинах та витратних матеріалах для технічного обслуговування з урахуванням варіації інтенсивності та умов експлуатації спецтехніки. У проаналізованих підходах до розробки таких методик показано необхідність розглядати процес визначення потреби у запасних частинах та витратних матеріалах для технічного обслуговування спецтехніки як нестаціонарний, зумовлений сезонними змінами інтенсивності та умов експлуатації. Виходячи з цього запропоновано базові принципи розробки теоретичних положень та практичних рекомендацій щодо визначення розмірів запасів запасних частин та витратних матеріалів для технічного обслуговування аеропортової спецтехніки.

Ключові слова: аеропорт; спецтехніка; обслуговування; ресурси; стохастичність.

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PROBLEMS OF DETERMINING THE NEED FOR SPARE PARTS AND MATERIALS FOR THE MAINTENANCE OF AIRPORT SPECIAL EQUIPMENT

The modern conditions of airport operation are considered from the point of view of reducing tariffs for services by reducing the costs of special equipment operation. The main attention is paid to the analysis of the influence of the costs of spare parts and materials used in its maintenance on the cost of special equipment use. The processes of special equipment utilization at the airport are considered as stochastic, and the logistics system at the airport is considered as a mass service system. It is taken into account that the stochasticity of the system is conditioned not only by the *properties of the processes, but also by the randomness of the factors influencing them. In this regard, to manage the system under consideration, the list of factors that determine the intensity of resource consumption, as well as the regularities of their changes is analyzed. The main attention is paid to the necessity to find a compromise between uninterrupted supply, which requires an increase in the size of orders, and the reduction in the volume of stocks, which increases the cost of working capital of the aviation enterprise. The influence of climatic conditions of operation on the consumption of resources for the maintenance of special equipment at the airport is also analyzed. The analysis has shown that the determination of the need for resources for the maintenance of special equipment at airports is currently planned on the basis of the actual consumption for the previous year and it is not practically taken into account that the consumption varies seasonally. In this regard, it is noted that the relevance of research aimed at developing methods for planning the need of special transport services of modern airports in spare parts and consumables for maintenance, taking into account the variation in the intensity and operating conditions of special equipment. The analyzed approaches to the development of such methods show the need to consider the process of determining the need for spare parts and consumables for maintenance of special equipment as non-stationary, due to seasonal changes in the intensity and operating conditions. On this basis the basic principles of development of theoretical provisions and practical recommendations for determining the size of stocks of spare parts and consumables for maintenance of special equipment are proposed.*

Keywords: airport; special equipment; service; resource; stochasticity.

Стаття надійшла до редакції 28.02.2024 р.
Прийнято до друку 10.04.2024 р.