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## **Innovative Approaches in the Labor Organization of the Auxiliary Production at Mining and Smelting Enterprises**

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*Application of work standardizing in the optimization of the number of personnel to improve production efficiency is now an example of the innovative approach to the organization of labour of auxiliary workers. In this article we propose an algorithm for calculating the planned number of repair workers based on the application of the time and labour content standards.*

*Keywords: maintenance and repair, methods for calculating the number of personnel, regulations and standards.*

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Difficult operating conditions and, consequently, rapid deterioration of mining equipment attach special importance to the maintenance of continuous operation of the equipment through the timely and qualitative execution of maintenance, repair and operations (MRO).

In addition to the rational organization of work on MRO of technological equipment, great importance is also given to providing repair and mechanical services with necessary resources, including labour ones.

Currently, this issue is given much attention. This is primarily due to the need for more efficient use of labour potential of employees, optimization of their numeric and occupational structure and timely correction of requirements to the personnel based on the market conditions. The problems of

justifying the number of maintenance personnel have objectively come to the fore in recent years, since available techniques have outdated long ago and do not meet the existing requirements in facilities.

Relevance of the chosen topic is obvious, as substantiated methods for calculating the number of maintenance workers will solve the problem of rational use of labour resources to improve production efficiency.

Features of maintenance work of equipment and workplaces in comparison with the work of primary production mainly involve a wide variety, unsteadiness, complexity in measuring the quantity and quality of work.

As we know, the basic functions of repair personnel include carrying out the full, medium and small repairs of equipment, its inspection and

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interrepair maintenance. Additional functions of repairmen are observation of the equipment operation, correct operation control, equipment repair journalizing, spare parts provision, etc. In addition, fitters and electricians do a significant amount of work that is not specific for repair services: assembly / disassembly of equipment, some construction works, cleaning, etc. Due to the nature of the subsidiary units the assessment of the effectiveness of functioning is more problematic and requires detailed observation during the entire shift. All this complicates the approaches to the calculation of the planned number of maintenance workers.

In the study of theoretical experience in the field of organization and regulation of labour we have analyzed the main methods for calculating the number of personnel in order to determine the acceptable approach:

- based on the established specific weight of individual groups of personnel;
- based on the analysis of time consumption;
- based on the placement of workers in the workplace;
- based on the standards of time;
- based on the number of employees or service standards.

Each method has its advantages and disadvantages.

*The method based on the established specific weight of individual groups of personnel* requires the artificial maintenance of the number of workers at a certain previously achieved level. This method is not widely used because it does not response to changes in technology, labour organization and the range of commodities. Also, a significant drawback is that if once the number of employees is determined incorrectly, then when normalizing the number according to this method it can remain in a long-term imbalance with a true need.

*The method based on the analysis of time consumption* is to examine the categories of workers with the help of pictures of the working day or moment observations. On their basis the percentage of losses of working hours is determined, following which the calculation of the number of workers reduces by this value. The big advantage of this method is that the observations are carried out under certain conditions, and thus all the specific sides of work of the observed workers are taken into account. However, this method is uncommon, since it requires a considerable amount of time on observation and highly skilled observers.

When using *the method based on placing workers in the workplaces*, the possible options to reduce costs, the possibilities of appointing some of the workplaces to serve the main workers, the combination of other functions and activities, and combination of several workplaces into one are considered. This method is not suitable for repair works, as they are not tied to the specific equipment. Basically, this method is used to normalize the number of crane operators, drivers and some of the other professions.

*The method of determining the number of employees according to the time and labour content standards* is to determine a list of works and their quantity on the basis of the time standards. Next, labour content of the entire scope of work is specified. Then, the calculation of the number reduces to the division of the labour content of the planned work by an effective amount of time of one worker. This method is applicable in cases when the workload of employees is constant, rhythmic, and there are no objective causes of the unsteadiness in the work. In this regard, it has not received widespread recognition for determining the number of auxiliary employees.

*The method of calculating the number of personnel according to the number of previously developed standards* is to ensure that depending

on specific factors the number of workers of the given profession is determined in accordance with the tables or standard formulas. Feasibility of this method is a mandatory provision of the necessary accuracy of standards.

In our opinion, the most acceptable methods for determining the number of repair personnel are *the method based on the existing time and labour content standards* and *the method based on the analysis of time consumption*.

As mentioned above, the method based on the application of the time and labour content standards is difficult to use for calculating the number of auxiliary workers because of their irregular employment when during the working day there is a need to fix a different number of failures of the equipment. However, if you use a system of preventive maintenance (PM) that includes occasionally repetitive work on the maintenance and repair of equipment, the amount of work performed by repair workers can be planned and organized. *Thus*, we can see an advantage of this method, which is the possibility to calculate the number of workers engaged in all types of repairs.

When studying the existing normative base, the absence of time regulations and standards of the labour content for repair and maintenance of mining and metallurgical equipment meeting current requirements and conditions in the factories was revealed. This is primarily due to the fact that at the present time research institutions developing labour standards are not functioning, large-scale research in this area is not being carried out, the existing regulations are outdated (Tverdokhlebova, 2011).

However, in our opinion, because of the slow pace of introduction of the new equipment at the enterprises we can use the normative base of the Soviet period by adapting it to the modern conditions. To calculate and justify the number of repair personnel we suggest that we use the

time regulations and standards of labour content of maintenance and repair of equipment collected in the “Regulation on preventive maintenance of equipment and vehicles at enterprises of the Ministry of Metallurgy of the USSR” Moscow, “Nedra”, edition of 1984.

Thus, we have developed an algorithm for the calculation of the planned number of workers based on the application of the time and labour content standards in order to use this technique for the maintenance personnel (see Fig. 1).

Given the fact that the standards were developed nearly 30 years ago, the most crucial step of the calculation of the number of workers is the correction of the labour content standards under the existing conditions in the enterprise.

The first step of the correction is amendment to the labour content standards taking into the account the change in *mass of the equipment*. In accordance with the Regulations on the PM, if there are no standards for implementing repair of the equipment installed at the facility, it is allowed to select equipment similar in design parameters, determine the rate of mass changes and the corresponding correction factor of labour content changes resulting in the corrected labour content standards.

A high *degree of wear and tear of the equipment*, of course, affects the amount of repair works and, consequently, the duration of their performance. Therefore, the next step of the correction of the labour content standards involves the compulsory accounting of this factor.

In accordance with the “Guide to the MRO of the general industrial equipment” if the real operating life of the equipment exceeds the normative period by 10%, then the appropriate correction factors of the change in labour content is applied (Yashchura, 2006).

Next, on the basis of the annual graphic of PM *the number of all types of maintenance and repair works* of equipment is determined. Then,

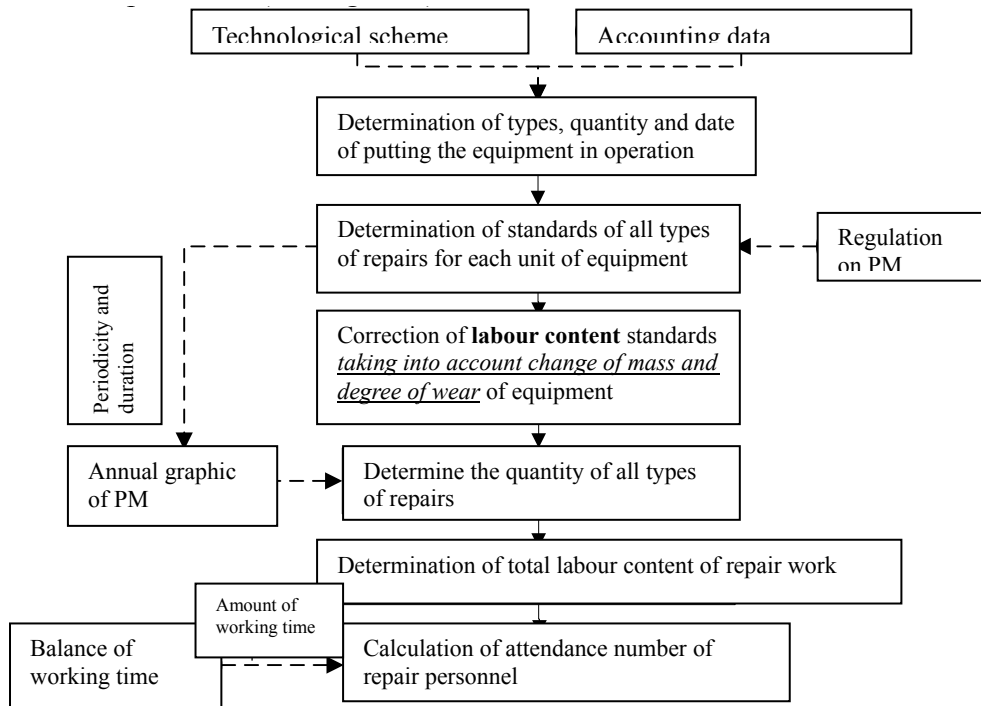


Fig. 1. Algorithm for calculating the number of maintenance personnel on the basis of the time and labour content standards

taking into account the corrected standards the *total value of labour content* of MRO is determined by the following formula:

$$\sum Rlc = \sum (N_{CMi} \times Rlc_{CMi} + N_{Ci} \times Rlc_{Ci} + N_{Fi} \times Rlc_{Fi}) \quad (1)$$

where  $\sum Rlc$  is the total annual labour content of the repair works for equipment, person-hour;

$N_{CMi}$ ,  $N_{Ci}$ ,  $N_{Fi}$  is the annual amount of the current maintenance work, current and full repair respectively for the  $i$ -th unit of equipment, unit;

$Rlc_{CMi}$ ,  $Rlc_{Ci}$ ,  $Rlc_{Fi}$  is the labour content of works of the current maintenance, current and full repair, respectively, for the  $i$ -th unit of equipment, person-hour.

The planned *attendance number* of the maintenance personnel is determined by the ratio of the annual amount of maintenance work expressed in terms of total labour content to

the value of the effective amount of time of one worker per year.

$$N_{at} = \frac{\sum Rlc}{A_{ef}} \quad (2)$$

$$Np = N_{at} \times Fp \quad (3)$$

where  $\sum Rlc$  is the total annual labour content of the repair works for equipment, person-hour;

$A_{ef}$  is the effective amount of time of one worker per year, hour.

where  $N_{at}$  is the planned attendance number of maintenance personnel, pers.;

$Fp$  is the factor of payroll (Pavlenko, 2008).

The total number of personnel required to perform the annual maintenance work is determined by the factor of payroll taking into account the discrepancy between the operating regime of the enterprise and the operating regime of one worker (3).

Another available method, the use of which allows to calculate the number of maintenance personnel, is a technique based on *the analysis of costs of working time* (Shepelenko, 2000). The big advantage of this approach is the possibility to take into account all specific aspects of work performed by maintenance workers. But since it requires considerable labour and time costs for observation and processing of the obtained results, it is applied extremely rarely.

The implementation of the method for calculating the planned number of maintenance personnel on the basis of the analysis of the actual costs of labour involves the sequential execution of the following steps:

1. The preparatory step (the study of business processes, development of observation sheets for the assigned tasks, observers' orientation, etc.).

2. The experimental determination of the actual costs of labour to perform maintenance work (time study, picture of the working day, moment observations).

3. The analytical processing of observation results (formation of the actual structure of the working day, identification of work time losses, determination of causes of violation of manufacturing processes, etc.).

4. The design of the normal balance of the working day (determination of removable unproductive costs of working time, the normative values of time for rest and personal needs by the agreement with the department of economics, maintenance of the workplace and implementation of the preparation and finishing-up operations).

5. The identification of reserves of the working time in the structure of the day and calculation of the substantiated number of repair workers. (Bychin et al, 2002).

The maximum qualitative performance of objectives of all these steps contributes to a fairly accurate determination of the planned number of

maintenance workers in the existing organization of labour at the enterprise. The method allows to accurately and objectively determine how much time the personnel spend on the execution of certain duties, how optimal the working process is organized.

Given the large labour content of the application of the method based on the analysis of working time costs, we decided to use this method as a confirmation of the correctness of the calculations of the number of workers based on the determination of the labour content of repairs. In addition, it allows us to identify the hidden reserves of the improvement of productivity.

In this regard, one of the important results of our research work on improving the organizational structure and mechanical repair services of one of the leading companies in the gold mining industry in Russia was the development and justification of methods for calculating the number of maintenance personnel in accordance with the following algorithm (Fig. 2).

In the study the calculation of the number of maintenance staff was carried out according to the proposed techniques for workers repairing both the main and auxiliary equipment installed in the target object.

It should be noted that the planned number of the maintenance personnel defined on the basis of the time and labour content standard is *maximal* since it is meant for the implementation of all types of repairs for each unit of equipment while, in turn, the number determined on the basis of the picture of the working day is *minimal* as it takes into account all possible losses of working time.

The application of the above methods for calculating the number of maintenance personnel at the target object and comparison of the obtained results with the actual value revealed a significant number of reserves within 20.8% – 35.4%, which allows the enterprise to conduct a rational allocation of the available labour resources.

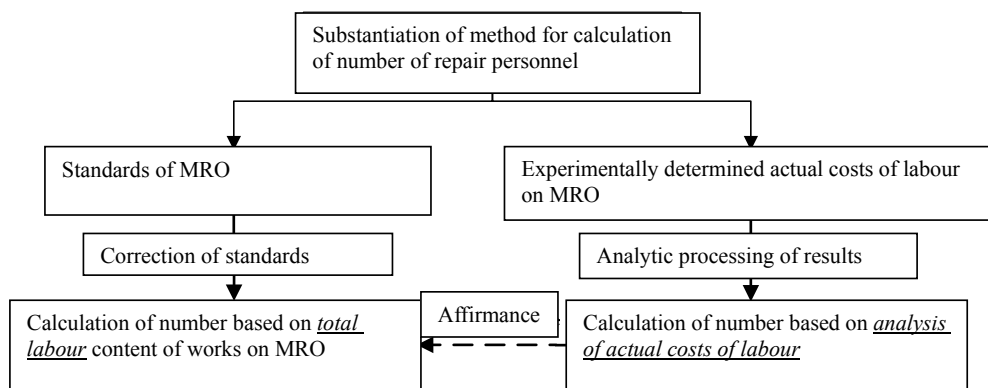


Fig. 2. Algorithm of feasibility of methods for calculating the number of maintenance personnel

The use of the substantiated approach to the calculation of the number of repair workers can solve the problem of improvement of the efficient use of labour resources at the enterprise. In addition, measures developed on the basis

of experimental observations to improve work organization contribute to further growth in labour productivity of workers of repair services and, in particular, to the improvement of the production efficiency of the enterprise as a whole.

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**Инновационные подходы в организации труда  
вспомогательного производства  
на предприятиях  
горно-металлургического комплекса**

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*Применение нормирования труда в рамках оптимизации численности персонала для повышения эффективности производства является в настоящее время примером инновационного подхода в организации труда вспомогательных рабочих. В статье предлагается алгоритм расчета плановой численности ремонтных рабочих, основанный на применении норм времени и нормативов трудоемкости.*

*Ключевые слова: техническое обслуживание и ремонт, методика расчета численности, нормы и нормативы.*

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