BALANCE OF INTERESTS IN A CAR FLEET SERVICE CONTRACT

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ABSTRACT

The way of achievement of balance of interests of a customer and of a contractor during service of cars which became possible on the basis of differentiation of a contractual value of technical availability rate is grounded. It is suggested within techniques of calculating technical availability rate to take into account the increase in the total number and total labor intensity of repair actions for a calendar period as the car fleet ages. Advantages of the proposed recommendations are shown at the example of service maintenance of open-pit dump trucks of a large metallurgical enterprise.

Keywords: car fleet, service maintenance, technical availability rate, contractual value, balance of interests.

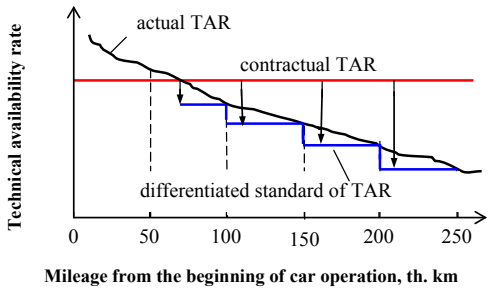
Background. *One of the main ideas for servicing the car fleet is the transfer of functions for its maintenance, current and overhaul to an outside contractor under outsourcing conditions. The advantages of this approach are obvious: there is no need for a carrier to keep its own resource-intensive repair facilities; the technical readiness of the car fleet is increasing because of the increased responsibility of the contractor for the quality of works. As a result, the contractor receives a profit from provision of repair services, and customer achieves the increase in efficiency of road transportation due to increased inter-repair mileage and reduction of the cost of maintaining the car fleet in good condition.*

Objective. *The objective of the authors is to consider provision of balance of interests of parties involved in a car fleet service contracts.*

Methods. *The authors use general scientific and engineering methods, mathematical calculations, evaluation approach, graph construction, analytical method.*

Results. *The interaction between the customer and the service provider of the car fleet is regulated by the contract for provision of related services. The main indicator of the quality of the work performed is technical availability rate (TAR). The choice in favor of this indicator is justified by the fact that it not only characterizes the current carrying capacity of the car fleet, but is also used to plan its operation, characterizing the reserves of productivity.*

Currently, in terms of service contracts, TAR value is a constant, regardless of the changing operating conditions of the vehicle fleet. Failure to comply with contractual amounts of TAR is formally a violation of contractual obligations and is punished with fines, which are expressed in reducing the cost of the work done.



Pic. 1. Graphical model of formation of a differentiated standard of TAR.

The value of TAR of the vehicle fleet depends on the age of its average unit, because as vehicles age, the overall need for maintenance and repair increases, that is, the amount and total labor intensity of repair actions increases over the period under consideration. Maintenance of TAR at a contractual level is naturally ensured by joint or disjoint observance of two conditions [1]:

– systematic updating of the vehicle fleet by the customer;

– extension of the repair works by the contractor, the number and qualification of the repair personnel as the serviced fleet ages.

These conditions cause the imbalance of interests of the customer and the contractor. This is due to some reasons. Systematic updating of the vehicle fleet by the customer in the interests of the executor of the works is unlikely, since it is very expensive. Continuous satisfaction of the growing needs for maintenance and repair of an aging fleet is limited by technological and personnel capabilities of the contractor [2–5].

Therefore, in case when the fleet being serviced is not updated, the contractor must have a tool to protect him from penalties for non-fulfillment of the terms of the contract for reasons beyond the control of the parties. It is proposed to consider as such a tool the differentiated standard of TAR, the value of which is calculated taking into account the dynamics of the age structure of the vehicle fleet (Pic. 1). Its presence will ensure a balance of interests in the contract for service.

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Turning to an explanation of the essence of the proposed recommendations for calculation of TAR, it is necessary to dwell on the analysis of the existing scientific and methodological basis for quantitative assessment of the technical readiness of the car fleet. A comprehensive analysis of scientific and methodological works on the problem under study was carried out in [6]. The level of technical readiness of a vehicle fleet is determined by a number of factors, including the maintenance system used, the observance of standards and rules for the technical operation of cars, the quality of the performance of preventive and repair measures, the supplied spare parts, the qualifications of drivers and maintenance personnel, and the fleet operation intensity [7, 8, 6, 9–13]. The key factor determining the technical readiness is the age of the car, quantified by the mileage from the beginning of operation, the service life and the degree of wear [12].

The results of the analysis of topical scientific papers indicate a uniformity of methodological

approaches to the quantitative assessment of the technical readiness of the car fleet. Existing approaches are essentially the same, because they are based on the ratio of the actual (or planned) and potential capabilities of the vehicle fleet to be ready for operation [14–17].

In scientific works [18–21], at the example of open-pit dump trucks, it is asserted that the ratio of the number of equipment units that are in service at the given time to their payroll structure does not enable us to determine a real potential of the car fleet technical readiness. The authors understand the technical readiness of the car fleet as the ratio of the total hours in operation to the failure of open-pit dump trucks to the fund of calendar time.

In [9, 22], when calculating the value of TAR, it is suggested to take into account the normative costs of time for performing maintenance and repair operations for rolling stock. The normalization of the time spent on performing these operations is based on optimizing the frequency of scheduled maintenance. Observance of the optimal periodicity makes it possible to reduce the operating time for the failure of the rolling stock, and, consequently, the costs of its restoration. The use of standardized parameters in the calculation of TAR provides greater reliability of traffic planning.

When calculating TAR, it is recommended to take into account the intensity of operation of the rolling stock. Thus, in [8, 12, 23, 24], the dependencies of TAR value on the average daily mileage of the car and on the duration of its idle time in maintenance and repair were established. In other works [25–27], it is proved expedient to take into account organizational idle times when calculating TAR of the car fleet, since, in the opinion of the authors, this increases the objectivity of the assessment. The technical readiness of the car fleet is proposed to be estimated by such indicators as the non-working days coefficient and the car use factor.

The difference between the output ratio and TAR characterizes the full use of the technical capabilities of the fleet. In [24], the coefficient of vehicle use is determined taking into account the operating mode of the carrier. This proves that, despite the interdependence of the coefficients, they characterize the different states of the car fleet.

In the scientific literature, the issues of increasing TAR are considered by reducing the length of idle time for vehicles in maintenance and repair. Thus, in [8, 28, 10] it is stated that the main share of vehicle downtime (85–95%) falls on current repairs. It is proposed to reduce these idle times by increasing mechanization and improving the technology of the repair process, improving the quality of technological operations, timely updating of the car fleet.

It should be noted that the implementation of the listed measures to improve the technical readiness of the road transport vehicles requires a large investment. In practice, of particular interest are the ways to increase TAR, which do not require large capital investments in improving the production and technical base and upgrading the skills of operating personnel. The development of such methods is considered in research works [29–31].

The essence of the proposed recommendations for the calculation of TAR is as follows. A scale of the categories of mileage is constructed from the beginning of operation of the average fleet unit. For each category of mileage, the value of TAR is calculated, which the contractor of maintenance with the existing repair facilities and staff will be able to provide. The obtained values of TAR are fixed in the contract for provision of services as differentiated standards.

The proposed calculation of the value of TAR of the vehicle fleet is based on the data on the number of maintenance and repairs that fall on the average vehicle for each category of mileage from the beginning of operation. This information is contained in work orders and acts of work performed. The proposed changes in the methodology for calculating TAR are represented by formulas (1–3).

Calculation of technical availability rate for the car fleet for a shift:

$$T \quad \frac{A_l \quad A_r}{A} \qquad (1)$$

where A_l – list car fleet, units; A_r – number of vehicles under maintenance or repair, units.

Ways of calculation of A_r:

existing

$$A_r = \frac{A_{TM}^{beg.} + A_{CR}^{beg.} + A_{TM}^{end} + A_{CR}^{end}}{2}, \qquad (2)$$

where $A_{TM}^{beg.}$, A_{TM}^{end} – number of cars under technical maintenance, respectively, at the beginning and end of the shift, units; $A_{CR}^{beg.}$, A_{CR}^{end} – number of cars, which are in current repairs, respectively, at the beginning and end of the shift, units;

<u>the proposed method</u>

$$A_r = \frac{\sum_{i=1}^{n} (N_{TM_i} + N_{CR_i}) \cdot A_{l.i_i}}{D_r}, \qquad (3)$$

where (N_{TMi} +N_{CRi}) – number of technical maintenance and repairs that fall on the vehicle of the i-th category of mileage from the beginning of operation for the period under review; $A_{l.i_i}$ – number of cars in the i-th category of mileage from the beginning of operation, units; D_r – number of shifts of the car repair enterprise in the period under review; n – number of categories of mileage of vehicles from the beginning of operation within the selected scale.

The need for statistical processing of the initial data will not complicate the calculations, since at present the accounting of information on the repair of rolling stock in almost all service companies is automated, and processing will not require much labor costs. The use of differentiated standards will give the contractor independence from the policy of the customer in relation to the acquisition and cancellation of the fleet in operation and will help achieve a balance of interests in the contract for maintenance of the car fleet.

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Advantages of the proposed recommendations are shown at the example of service maintenance of open-pit dump trucks of ore dressing enterprise (ODE) of a large metallurgical enterprise of Chelyabinsk region. The company's fleet includes more than 100 units of BelAZ-7547 open-pit dump trucks. Service maintenance of the open-pit car fleet is provided by the service department of Motor Transport Department (MTD), a subsidiary of a metallurgical enterprise.

In the contract for maintenance of open-pit dump trucks of ODE technical availability rate is fixed at the

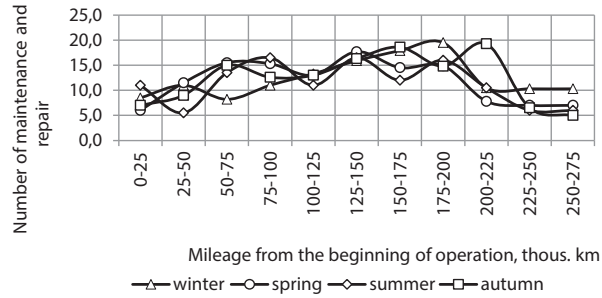
Table 1

Dependence of the average monthly mileage of the BelAZ-7547 dump truck on the season and the mileage from the beginning of operation

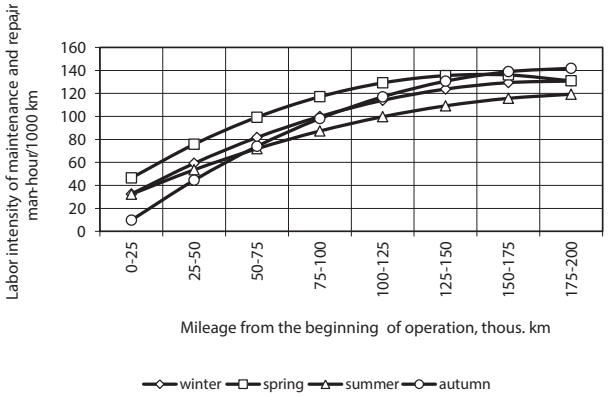
Operating season	Category of mileage from the beginning of operation, thous. km										
	0–25	25–50	50–75	75–100	100–125	125–150	150–175	175–200	200–225	225–250	250–275
Winter	4,5	4,2	4,0	3,7	3,5	3,2	2,9	2,7	2,4	2,1	1,9
Spring	4,8	4,5	4,2	4,0	3,7	3,5	3,2	3,0	2,7	2,4	2,2
Summer	4,4	4,1	3,9	3,6	3,4	3,1	2,9	2,6	2,4	2,1	1,9
Autumn	4,4	4,1	3,8	3,5	3,3	3,0	2,7	2,4	2,1	1,9	1,6

Note: value of average monthly mileage is given in thousand km.

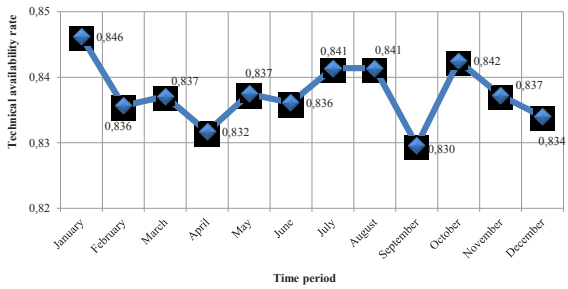
Pic. 2. Dependence of the number of maintenance and repair of a dump truck BelAZ-7547 for a season from the beginning of operation.



Pic. 3. Dependence of labor intensity of maintenance and repair of a dump truck BelAZ-7547 on the mileage on the beginning of operation.



Pic. 4. Forecast of dynamics of TAR for the car fleet of dump trucks BelAZ-7547 for 2016.



level of 0,85. However, the subdivisions of ODE do not aspire to update their own vehicle fleet in the interests of the service company, therefore, in the conditions of a limited budget, MTD does not actually fulfill the terms of the contract, maintaining the value of TAR with the available repair facilities at the level of 0,83–0,84.

To calculate the differentiated standards of TAR, it is required to establish how the average monthly mileage of BelAZ-7547 dump truck will change, its need for maintenance and repairs, and the laboriousness of these impacts as it ages and depending on the operating season. The establishment of these dependencies was based on an analysis of more than 15000 acts of completed work. The required dependencies are given in Table 1 and in Pic. 2 and 3.

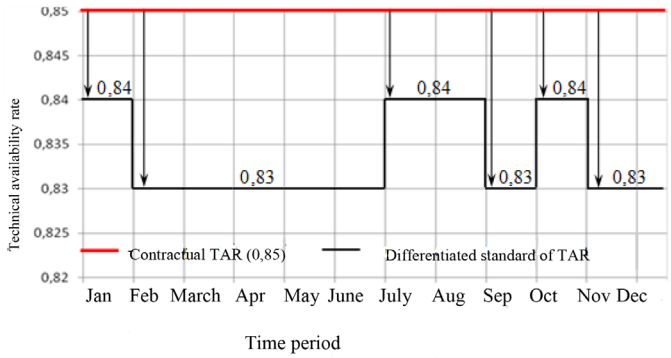
Based on the data in Table 1, a forecast was made for a change in the mileage in 2016 from the beginning of operation of average dump truck the BelAZ-7547. According to the results of the forecast it is established that the considered open-pit car fleet will grow old in the current year. The mileage from the beginning of operation of the average dump truck will be

Table 2

The amount of fines for non-fulfillment of contractual obligations for maintenance of an open-pit car fleet in 2016

Month	Total labor intensity, man-hours	Penalty percentage,%	Cost of labor hour of work, rubles	The amount of the fine, rubles
January	8321,15	2	506,24	84250,0
February	8376,04	4		169612,0
March	10128,12	4		205090,0
April	10264,36	4		207849,0
May	10344,22	4		209466,0
June	6959,80	4		140933,0
July	6976,16	2		70632,0
August	6984,42	2		70716,0
September	7564,77	4		153184,0
October	7633,75	2		77290,0
November	7820,58	4		158364,0
December	8005,45	4		162107,0
TOTAL:				1 709 493,0

Note: the total labor intensity of the maintenance work was established taking into account the dependence shown in Pic. 3.



Pic. 5. Proposed differentiated standards of TAR for the car fleet for 2016.

140 thousand km. This is due to the fact that in 2016 the renewal of ODE fleet is not planned.

Using the dependence (Pic. 2), by the formulas (1, 3) the dynamics of the value of TAR of open-pit dump trucks was determined, which in 2016 can be provided by the motor transport department with the available repair facilities (Pic. 4).

From Pic. 4 it can be seen that during the year TAR for the vehicle fleet will not reach 0,85, which will lead to non-fulfillment of contractual obligations for servicing the MTD open-pit dump trucks before ODE. To prevent penalties for MTD it is necessary to fix the value of the differentiated standard of TAR at a level of 0,83–0,84 in the contract for service maintenance of the fleet (Pic. 5).

The instability of TAR during the forecast period is explained by the change in the total car fleet needs for maintenance and repairs when changing the operating season.

The balance of interests of the customer and contractor in the service contract is ensured by the absence of MTD penalties for non-fulfillment of contractual obligations for reasons beyond its control. The amount of the fine in accordance with the contract is 2% of the cost of works performed for non-fulfillment of 0,01 contractual amounts of TAR. The results of calculating the possible losses of MTD from the application of penalties are given in Table 2.

The data in the tables with accrued total are shown in Pic. 6.

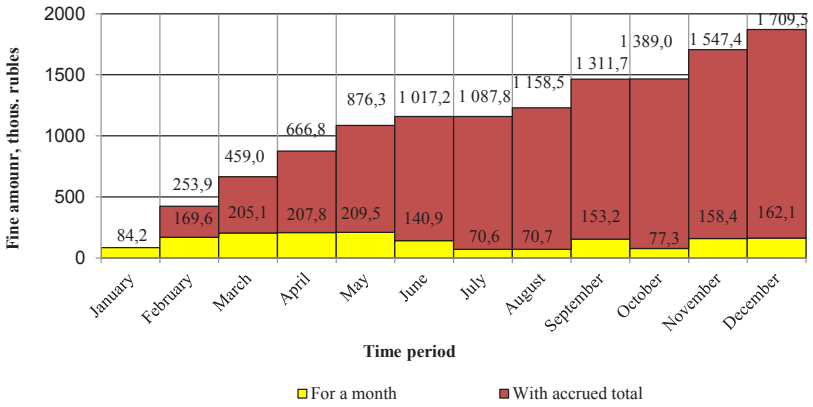
From the diagram it follows that the possible losses of MTD from the application of penalties for non-compliance with the contractual value of TAR in the forthcoming planning period may reach 1,7 million rubles.

Conclusions.

1. One of the main ideas for servicing the vehicle fleet is the transfer of functions for its maintenance and repairs to an outsourced contractor under the conditions of outsourcing. Advantages of this approach: no need for the carrier to maintain its own resource-intensive repair facilities; increase of technical readiness of a car fleet owing to strengthening of the responsibility of the executor for quality of works.

2. The main indicator of the quality of service is technical availability rate (TAR). In service contracts, the TAR value is a constant regardless of the change in the operating conditions of the vehicle fleet. Failure to comply with the contractual value of TAR formally violates contractual obligations and is punished with fines, which are expressed in reducing the cost of work done.

3. Keeping TAR at the contractual level is naturally ensured by joint or disjoint observance of two conditions:



Pic. 6. Dynamics of fines for non-compliance with a contractual value of TAR.

– systematic updating of the vehicle fleet by the customer;

– securing by the contractor of enhanced repair capacities, number and qualification of repair personnel as the car fleet ages.

4. The reasons for the imbalance of the interests of the customer and the contractor for servicing the car fleet are:

– large customer's costs for the systematic renewal of the fleet in the interests of the contractor;

– limitedness in the technological and personnel capabilities of the contractor to meet the increasing need for maintenance and repair of an aging car fleet.

5. A tool protecting the contractor from penalties for non-fulfillment of the terms of the contract for reasons beyond his control is the differentiated standard of TAR. The size of the standard is calculated taking into account the dynamics of the age structure of the vehicle fleet and corresponds to the technological and personnel capabilities of the performer.

6. Differentiation of the contractual value of TAR of the vehicle fleet is based on establishing the dependencies of the average monthly mileage, the number of maintenance and repairs, the labor intensity of preventive and repair influences on the average unit of the served vehicle fleet from the season and the mileage from the beginning of operation.

7. The use of TAR differentiated standards in the organization of maintenance of open-pit dump trucks of a large metallurgical enterprise in Chelyabinsk region ensured a balance of the interests of the customer and the contractor for service by eliminating penalties to the contractor for non-fulfillment of contractual obligations for reasons beyond his control.

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