Management of maintenance service and repair of heavy-duty mining equipment during its adaptation to the working conditions by the company Minetech Machinery LLC, official dealer of HITACHI

E N Bulakina, O N Nedzelskaya, A N Bikineeva, V V Moiseev, D O Pochufarov and A V Ketov
Siberian Federal University, 82A Svobodniy ave., Krasnoyarsk, 660041, Russia
E-mail: elenagb09@mail.ru

Abstract. Mining industry is one of the main industries that determine the country’s energy sovereignty. This paper presents the study of the effectiveness of organizational and managerial decision making by a separate subdivision of Minetech Machinery LLC which is an official dealer of mining equipment Hitachi in the Russian Federation. The main indicator of the operational efficiency of heavy mining machines is the technical-preparedness factor of the equipment. The manufacturer recommends to carry out preventive maintenance and repairs on time for a trouble-free service of Hitachi mining equipment.

1. Introduction
This paper examines the organizational and management activities of Minetech Machinery LLC, an official dealer of Hitachi mining equipment in the Russian Federation, in order to increase the efficiency of deposits development in the open pits where integrated mechanization is being introduced, characterized by the continuity of communications from the point of the face to excavation and loading, in dumps and auxiliary programs. Another prerequisite is that the machines involved in drilling, excavating the mined rock, performing its further loading into transport devices and other types of work must match each other in terms of productivity and power.

Dump trucks are still the main transport unit in quarries. The predominant number of such machines has a carrying capacity up to 155 tonnes, to a lesser extent giants (200-300 tonnes) are involved in open-pit mining. In addition, 360-tonne railway units with a carrying capacity of about 180 tonnes are actively used. Powerful excavators, which provide clearing of the territory, excavation of the mined mass, its further loading into transport devices and other work, are no less in demand.

Two types of equipment are used – diesel and electric modifications of excavator-type machines, but the latter of them cause a lot of difficulties in operation, therefore, diesel-powered machines are considered the most common types.

Hydraulic excavators provide high efficiency of selective development of complex-structured deposits, the possibility to service several faces for production averaging, efficient development of flooded deposits, and blast-free mining of semi-rocky rocks.

Currently, about 50 models of hydraulic mining excavators are produced in the world.
It is important to understand that in different countries and regions the situation develops in different ways. For example, in Russia and the CIS countries, the following trend has been maintained for a long time: the leading role at most of the operating enterprises for the extraction of ferrous and non-ferrous metals, mining, chemical and construction raw materials is given to mining electric excavators with a bucket capacity 8–15 m³, while in the far-abroad countries in this standard size the basic purchases volume accrues to hydraulic excavators [1-3].

2. Organizational and managerial activity of the company Minetech Machinery LLC

The constant increase in the volume of resources extraction, in particular ore and coal, entails an increase in demand for special machinery and equipment, and the labor intensity of the deposits, difficult climatic conditions and the specifics of work, in turn, dictate special requirements for means of mechanization. Minetech Machinery LLC (Moscow) was opened at the end of 2016 and since January 1, 2017 it is the only official distributor of Hitachi Construction Machinery in Russia, authorized to sell mining-class equipment, spare parts for it, as well as provide technical and service maintenance.

The main task of the separate division of Minetech Machinery LLC is direct interaction with customers on all issues related to the acquisition and further operation of Hitachi mining equipment. The main part of questions with customers related to the purchase of equipment and the supply of spare parts is solved by the Head of the MD (main division), he also deals with problems concerning the functioning of separate division. The head of the section for maintenance and repair of mining equipment is in charge of issues related to the maintenance of customer equipment.

1C-Administrator reports directly to the head of the section for maintenance and repair of quarry equipment, draws up the repairs carried out in the 1C program, forms documents for customers, but since in most departments this person is assigned the duties of an office manager, he carries out the instructions of the MD Head of the for collecting documents, maintaining the register of documents to be sent, posting, etc.

3. Monitoring the state and operating conditions of Hitachi equipment

At most sites where Hitachi mining equipment is used, a daily presence of specialists from Minetech Machinery LLC is organized. They are engaged in daily monitoring of the state and operating conditions of equipment, as well as take readings from machines. Based on the monitoring results, “Daily reports” are drawn up, which reflect the state of the machine units (assemblies), the conditions of its operation, identified malfunctions, if any, recommendations for their elimination.

Shift mechanics draw up reports on the technical readiness ratio of equipment and note the technical and technological downtimes of equipment in them. According to these reports, it is clearly visible for what reasons the equipment was idle and which machine system should be given special attention. If equipment malfunctions are identified, the shift mechanics enter it into the “Backlog” report. It reflects the date when the malfunction was detected, its description, photograph and recommendations for its elimination with catalog numbers. After the elimination of this malfunction, the status of this malfunction is changed to “Completed” and the date of its elimination is recorded.

4. Analysis of data obtained during equipment maintenance

The data obtained during the maintenance of the equipment is viewed using the official Hitachi program called Maintenance PRO Viewer. It allows the following to be viewed: arising malfunctions of the equipment, the main indicators of the machine operation, the engine load factor, etc. Let us consider the most important data.

Alarms and malfunctions. This information can be viewed in the form of developed tables, which reflect lists of faults and the number of their occurrence, on a certain day (figure 1). In case of malfunctions, within a day more than ten times, the cell turns red, thereby drawing attention to itself.

When clicking on the error code in the first column, its description and the necessary actions for its elimination appear (figure 2).
Figure 1. Alarms of equipment malfunctions.

Figure 2. Malfunction analysis.

Alarms can be viewed in the form of a list, which displays the date and time of the malfunction, its code and name, the status – “on” or “off”. There is also a button “Details” for viewing the description
of the malfunction (figure 3). In the “Monthly operational information” section, the intensity of the machine’s work on engine load and the downtime of the equipment can be seen (figure 4).

![Figure 3. Alarms from equipment (machine).](image)

![Figure 4. The operation intensity of Hitachi equipment.](image)

5. **Recommendations for scheduled preventive maintenance by Hitachi**

The main indicator of the work of heavy mining machines is the technical-preparedness factor. The manufacturer recommends scheduled preventive repairs for trouble-free operation of Hitachi mining equipment.

The service department in all regions carries out maintenance and repair work of any complexity of Hitachi mining equipment, with the exception of repair work for CUMMINS engines installed on mining excavators and rigid dump trucks. Specialists from an official CUMMINS dealer are involved for their repair.
Applications for the performance of work from customers are sent to the head of the section for maintenance and repair of quarry equipment, he instructs the 1C-administrator to issue the planned work according to the 1C program and form a preliminary calculation or specification (depending on the terms of the service contract), after that the head of the maintenance section and repair of quarry equipment agrees with the customer this calculation and the timing of the work. Within the specified timeframe, the head of the section sends service mechanics to the client’s site to perform the necessary work. Upon completion of the necessary work, the mechanics draw up a technical act for the work performed and sign them with the authorized representatives of the customer. After returning, the mechanics hand over the technical acts to the 1C-administrator for the carried out works according to the 1C program and for the formation of closing accounting documents.

In case of need for heavy overhaul of a units or assemblies, this unit is sent to a subdivision in Novokuznetsk, where there is a workshop for overhaul of units and assemblies for this service region. There they carry out its washing, disassembly and defect identification, after which a defective statement and a commercial offer for its repair are drawn up. In cases where the cost of repairing an assembly exceeds 75% of the cost of a new one, the client is offered to exchange the old assembly for a new one under the REMAN program at a cost equal to 75% of a new assembly.

At the enterprise, in Abakan, for maintenance and repair of the customer’s machinery (equipment), there is the necessary equipment and tooling for maximum mechanization of all processes. The main technological equipment is a mobile workshop based on the KAMAZ 65115 vehicle, equipped with all the necessary equipment for maximum mechanization of the process of maintenance and repair of heavy excavators and dump trucks from Hitachi [4-5].

Calculation of the required number of service mechanics at a separate subdivision of Minetech Machinery LLC, research and monitoring of the effectiveness of organizational and managerial decision-making was carried out for the city of Abakan.

To calculate the required number of service mechanics at a separate subdivision of Minetech Machinery LLC, in Abakan (2018), the calculated labor inputs for all customers and the total labor input of technical servicing and repair are summarized (table 1).

Table 1. Summary table of labor inputs by clients.

| Name of an open-pit | Open-pit Stepnoy | Open-pit Chernogorsky | Open-pit Borodinsky |
|---------------------|------------------|----------------------|---------------------|
| Labor intensity of technical servicing | 2058 | 392.7 | 1217.3 |
| Total labor intensity of running repairs | 3066 | 382.2 | 1211 |
| Total labor intensity of technical servicing and running repairs | 5124 | 774.9 | 2428.3 |
| Total: labor intensity of technical servicing and repair | | | 8327.2 |

The shift duration of service mechanics is 8 hours. Their work schedule is five working days with two days off.

The technologically necessary (attendance) number of workers $W_T$ and staff $W_S$ are determined by the expressions:

$$W_T = \frac{T_{A}}{F_T},$$  

$$W_S = \frac{T_{A}}{F_S},$$

where $T_{A}$ is the annual volume of work on maintenance and repair, person h;
6. ConSite automated reports
All heavy-duty trucks shipped from Hitachi factories since 2018 have data terminals. This modification of the equipment allows the dealer’s employees to partially view the readings of the devices remotely using the Globale-Service system. The main advantage of this system is the generation of automated ConSite reports on the equipment operation for each month.

The reports show how efficiently the equipment is being used. For example, Hitachi EX 1200-6 excavator in March performed 450 hours of 608 hours of total engine operation, the operating efficiency is about 75%, which means that it did not perform any operations for 25% of the engine operation time. The total downtime of equipment for the entire period of operation of the machine was 4045 hours out of 11003 hours, which is approximately 36% of the total engine operation time of the equipment.

7. Conclusion
Based on the studies and calculations, for the owners of Hitachi machinery (equipment) which is subject to the appropriate preventive maintenance developed by the manufacturer, summary tables of labor intensity for consumers are presented. When implementing organizational and management solutions for the maintenance and repair of heavy-duty mining equipment from Hitachi and the effective selection of equipment for the appropriate performance and capacity, it is economically justified for both the dealer and the client.

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