ANALYSIS OF EFFICIENCY OF RECOVERING AND RE-INSTALLATION OF LONGWALL EQUIPMENT IN THE CONDITIONS OF THE KUZNETSK COAL BASIN

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ABSTRACT
The main objective of the executed researches was assessment of efficiency of recovering and equipment re-installation of longwalls at the applied technological schemes of mining of flat coal seams of the Kuznetsk coal basin. The analysis of the actual duration of performance of dismantling and installation works in mines of the SUEK Kuzbass company is made. It is shown that very poor state of a roof of recovery rooms is a basic reason for increase in duration of equipment downtimes. Recommendations about increase in roof stability of recovery rooms, a longwall erection are made. Economic disbenefit assessment from outages of the high-performance equipment of longwalls is executed.

Key words: underground mining, coal mine, longwall, recovery room, longwall equipment, downtime

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1. INTRODUCTION
At underground coal mining in Russia the main method is longwall mining. With use of the reliable high-performance equipment in Russia record productivity of a longwall is reached –
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60 thousand tons per day (more than 1.6 million tons per a month) are mined in the mine "of V.D. Yalevsky" in Kuzbass when mining a thick flat gassy seam. In other mines when mining thick seams the production rates of a longwall reach 30 thousand tons per day, and when mining seams of average production rates can reach 20 thousand tons per day. At the same time the low stability of indicators of work of a longwall connected with equipment downtimes for various reasons is observed. The largest duration of downtimes of the high-performance equipment is observed at work on removal and reinstallation of the equipment. Now there are two main options of forming of recovery rooms for moving of the equipment on the new longwall panel. At the first option the recovery room is carried out in advance that provides reduction of terms of removal. However, at such way very often there is a failure of a coal pillar between a longwall face and the recovery room when approaching a longwall that leads to emergency [1-4]. The second option assumes forming of the recovery room a longwall face. Such option provides use of a polymeric grid and bolting of a roof. The second option of forming of the recovery room is the basic for mines of the SUEK Kuzbass company. Issues of increase in efficiency of dismantling works are relevant for mines of the Kuznetsk coal basin and for the solution of these questions it is required to deal with basic reasons for downtimes of the high-performance equipment of a longwall.

2. METHODS
When performing researches the analysis of duration of installation and dismantling works in 9 mines of the SUEK Kuzbass company (during the period from 2014 to 2016) which carries out underground mining by longwalls of flat coal seams in the Kuznetsk coal basin is made. In total 22 cases of removal and equipment installation of a longwall are considered. Comparison of duration of the following technological processes is executed: forming of the recovery room, additional works, duration of moving of the equipment. Comparison of planned and actual duration, and in case of excess of planned terms is executed, the analysis of the reasons of equipment downtimes is made. At implementation of the analysis the thickness and seam inclination, a mining depth are considered.

3. RESULTS AND DISCUSSION
As a result of the executed researches durations of the actual duration of performance of removal of equipment in mines have been established. Results of researches are presented on figure 1. The planned duration of installation and removal of equipment averages two months: at the same time 15 days are provided on forming of the recovery room by a longwall and 45 days on moving of the equipment on the new longwall panel and installation. From figure 1 it is possible to see what in 17 of 22 considered cases is observed excesses of planned due dates of works on moving of the equipment of longwall faces. At the same time in 17 of 22 cases excess of planned terms of forming of the recovery room was observed.

The analysis of the reasons of excess of terms has shown that very much state of disrepair of a roof of recovery rooms is basic reasons for increase in duration of works on moving of the equipment. The similar conclusion is drawn also by other researchers [5-8]. The lack of taking note of a main roof and also influence of multiple seams is basic reasons for state of disrepair of a roof of recovery rooms [9-20].
Thus, for increase in roof stability of recovery rooms it is necessary to define the place of forming of the recovery room taking into account a step of collapse of a main roof [8, 21, 22].

The complexity of forecasting of a step of roof caving is connected with lack of the modern techniques considering influence of all geological and mining factors [8, 21, 22, 23]. At the same time application of a modern monitoring equipment allows to determine a step of collapse of a main roof by actual pressure in hydraulic props of the powered support [8]. Other important factor is influence of the high rock pressure zones resulting from leaving of the pillars and regional parts of the rock massif created when mining contiguous seams [9-17].

**Figure 1** Results of the analysis of duration of recovering and re-installation works

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**4. CONCLUSIONS**

As a result of the executed researches it is established that in the majority of the analyzed cases excess of planned terms of carrying out removal and equipment installation of a longwall is observed. From 22 cases in 15 excess of planned terms of moving for a week and more was observed. The average duration of equipment downtimes was 33 days. Thus with an average output of a longwall of 10 thousand tons per day, losses of mining because of equipment downtimes have averaged 330 thousand tons. Taking into account cost of mining and coal price in the region the damage from equipment downtimes averages 50 thousand US dollars on one longwall.

Basic reason for high duration of remounting and equipment downtimes is the unsatisfactory state of a roof of recovery rooms that also the labor input of works leads to increase in danger. For ensuring stability of the recovery room location of the room outside a high rock pressure zone when mining of the pulled together coal seams is recommended and forming of the mounting chamber taking into account a step of collapse of a main roof.

As a result of increase in width of longwall panels and extraction height of seam the mass of the dismantled and transported equipment has increased, and with growth of length of a longwall panel path length at transportation has increased that has increased duration of...
equipment downtimes in moving time. Besides, when mining seams thickness less than 1.8 m dismantling works are more difficult because of the small height of the recovery room, however the equipment has smaller weight. When mining thick seams working conditions in the recovery room are more favorable, but the big weight of the equipment can create problems at its transportation.

The problem of outages of the high-performance equipment of a longwall is relevant for many mines in the world [26-40]. Decrease in equipment downtimes is one of effective ways of increase in efficiency of underground coal mining.

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