Reliability evaluation of the mining flowsheet of seam 21 in “Olzherasskaya-Novaya” mine LLC “UC Yuzhny Kuzbass”

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Abstract. The paper assesses the flowsheet of mining seam 21 at “Olzherasskaya-Novaya” mine; based on the experience gained while testing the technology and calculating the reliability parameters the mechanisms, which break down most frequently, are specified.

1. Introduction
Reliability of flowsheet is the result of its functional capacity that is determined by different methodologies. To evaluate the reliability of the mining flowsheet of seam 21 in longwall face 21-1-5 we used the following indicators: Run to Fail $T_{RF}$; failure recovery time $T_r$; availability factor $K_a$; failure factor $K_{ff}$; the failure rate $K_{fr}$; downtime rate $K_{dr}$ [1].

Evaluation indicators were defined for the process flowsheet and subsystems: the face, conveyor transport, power supply, water supply, ventilation; and for the main face equipment: shearer, powered support, face and goaf conveyors. Run to Fail and failure recovery time were calculated according to the formulas presented in [2].

2. Observation results and their analysis
The results of observations and processing of statistical material helped to identify the number of failures of organizational, technological and technical reasons, causing the longwall face stoppage.

During the test period of 13 months there were 776 failures, most of which can be attributed to the slope belt conveyor, gas protection equipment, shearer, face and goaf conveyors. Failure rate for the slope conveyor is 0.215, gas protection equipment – 0.137, shearer – 0.126, face conveyor – 0.088, the goaf conveyor – 0.067.

Frequent stops of the longwall face occur due to high concentrations of methane and the gas protection activation, that was observed during roof settlings, the joint extraction and release of coal during the periods of working with high face advance rates.

Total downtime is 134515 min. (about 2242 hours, or 93.4 days). The largest proportion of the downtime accounts for the goaf conveyor, the downtime ratio is 0.3. A significant part of downtime is registered for the slope belt conveyor, downtime ratio is 0.104. The share of downtime for gas protection equipment is small, the ratio is 0.034.

On the ground of statistical data, we determined the mean Run to Fail of the complex – $T_{RT}$, the mean failure recovery time – $T_r$ and the average availability factor of the flowsheet: Run to Fail is $T_{RT}$ = 196 min; failure recovery time $T_r$ = 111 min; availability factor $K_a$ = 0.638; failure ratio $K_{fr}$ = 0.567.
Availability and failure factors were determined by the elements of the flowsheet taking into account long periods of inactivity (more than one day) and excluding them. The availability factor, with regard to long downtime has the least value for the goaf conveyor – 0.839 and for the shearer – 0.866. The greatest failure rate is for the goaf conveyor – 0.192 and the shearer – 0.155.

In general, in the group of the main machinery in equipment complex the indices of operational reliability taking into account long periods of downtime are $K_a = 0.65$, $K_f = 0.46$.

The use of working time of a shift is considered for a 6-hour and 8-hour shift. The downtime and failure rates were calculated and the time distribution in a shift for performance of coal mining operations, for emergencies and technological regulated downtimes.

Figure 1 shows a diagram of the time distribution in a shift according to the main processes (Figure 1a), and the longwall face downtime rates due to equipment failures and other reasons (Figure 1b) for an 8-hour work shift.

**Figure 1.** Time distribution of 8-hour work shift with long periods of downtime: a – the shift time distribution between main processes; b – downtimes distribution ($K_d$) by the main factors.
Working time of a shift is distributed in the following way: coal extraction and release make 54.6% of the shift time; downtime accounted 32.9%, technological downtime – 12.5%. The most downtime periods were due to failures of the goaf conveyor and the shearer.

It should be noted that some elements of the equipment require design improvements: insufficient jacks effort in advancing the roof support and the face conveyor, the jack pulling the goaf conveyor, jacks lifting rotary shearer gears; electric control circuit of the goaf and the face conveyors requires modification; the shearer weak points are its cutting drums.

The powered support often fails due to hoses, replacement of which is a time consuming operation.

Figure 2 shows the shift time distribution between the efficient use of the time and the downtimes in a 6-hour work shift.

**Figure 2.** Time distribution of a 6-hour working shift with long periods of downtimes: a – shift time distribution between coal extraction and downtimes; b – distribution of downtime rates by factors.
3. Conclusions
The working time of a 6-hour shift is distributed as follows: coal extracting and coal release 54.7% of
the shift time; overall downtimes 28.7%; technological downtimes 16.6% that characterizes the
technological flowsheet as a comprehensive one with regard to the modern technology.

References
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