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Availability analysis of the main conveyor in the Svea Coal Mine in Norway

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ABSTRACT

Reliability and maintainability of mining industry is more in focus than ever, and the mining systems are becoming more complex and the equipment more expensive to repair or modify. Unplanned failures can result in significant costs, especially when the machinery is hard to repair or spare parts are far away. This paper presents a case study describing a reliability and maintainability analysis of the main conveyor system of the Svea Coal Mine located in Svalbard, Norway. The conveyor system includes several separate conveyors. In this study, the main six conveyors of the whole system were selected for the analysis. The failure and repair data of the conveyors were collected for the whole year of 2010 using maintenance and daily reports. The date was analyzed and the result shows that the availability of six conveyers is 96.44% for one year of operation. However, reliability of these conveyers needs to be improved in order to reduce the number of failures.

1. Introduction

The history of mining can be traced back several thousands of years. The methods and equipment used were inefficient, required many workers and the gain was small amounts of goods. In modern times there are millions of employees, and the turnover of the mining industry is in the billions. The amount of money spent on equipment is also very high, and the demand for high quality and production has increased. The mining equipment are increasing in size and complexity, and this demands a higher level of performance and reliability of the mining equipment. Therefore, the optimizing of a mine production line is more demanding and complex than ever [1–3]. Furthermore, there is an expectation that mining equipment and technology are supposed to be available at all times, ready for use and have a high level of reliability and availability performance. A mine production line consists of several subsystems and components. Each subsystem and each component affect the total availability, and reliability performance of the total production line [4]. Therefore, the performance of each subsystem and component should be analyzed in order to determine how each subsystem and component affects the availability and reliability performance of the whole production line [5]. The result of such an analysis will help to identify the weakest areas of the mine production line and also increase the knowledge about the system. With this knowledge, one is more capable of making decisions when changing the system or operating circumstances. Therefore, a focus on a reliability, maintainability and availability analysis is critical for the improvement of the mining equipment performance ensuring that it is available for production as per production schedule. Hence, several studies have been performed to determine the reliability of mining machines such as load haul-dump (LHD) machines, longwall face equipment, and crushing plants in an underground mine [6–9]. Reliability and maintainability assessments of repairable mining machines have been reported in some papers [10–14]. The results of these studies show that reliability and maintainability analyses are very useful for planning and deciding maintenance intervals as well as improving mining equipment. The aim of this paper is to perform a reliability and availability analysis of the six main conveyors of the Svea Coal Mine in Svalbard in order to: (1) increase the understanding of failure and repair patterns in the main conveyor system, (2) estimate the reliability and maintainability characteristics of the main conveyor system, and (3) identify the critical subsystem which will require improvements or modifications of its operating environment or maintenance routines.

The paper is organized as follows: Chapter two contains an explanation of the system, information about the system and practical information relevant to the analysis. Chapter three deals with the methodology used in order to define the reliability and

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availability of the system. The data collection, evaluation and processing are all included. Chapter four presents the data and results from the analysis. Finally, Chapter five concludes the paper.

2. Case description

The mine in focus is located in Svalbard and is operated by Store Norske Spitsbergen Kullkompani (SNSK) AS. Therefore, there is a significant time span from the order of spare parts until they are received. The company extracts coal from a mine called Svea. The mine was first opened in 1917, later closed and reopened in 1999 for modern mining. The method of mining is the mechanized longwall method, which includes several subsystems such as a drum shearer, armored face conveyors, mine bolters, etc. The throughput capacity of the mine is related to the reliability and maintainability of different operating subsystems of the mechanized longwall method that shows the reliability block diagram of the mine.

The mine has three different production lines. The first line of the production is the mechanized longwall mining method, and the longwall shearer has a face of 250 m. The second line is a mine bolter (MB), which prepares new fields for the shearer. The third line of production is continuous mining, which utilizes a continuous miner machine (CMM) with a large rotating steel drum. In this mine, the MB cutting machine is making a tunnel towards a possible new mining field. The names and codes of the different subsystems and equipment of the mine are presented in Table 1.

The preliminary analysis of the failure data of the mine shows that the number of failures of the conveyor subsystem is higher than the failures of other subsystems of the mine. Therefore, in the first step, it was decided to apply the concept of reliability analysis for the conveyor. The conveyor subsystem of the mine can be divided into several conveyors, which may be changed, moved and serve different purposes. For this study, it was decided to narrow the reliability analysis of the conveyor subsystem of the mine to the part that will be operated for the longest period of time, namely the Stacker, T1, T2, H3, H4 and H5. The selected conveyors will also be the most static ones, not moving in the mine to follow other equipment. These conveyors will also be used for mining in another section of the mine in the future.

The mine is worked in two shifts, and during non-production periods of the mine, maintenance crews take oil samples, do vibration tests and use infrared cameras to make decisions about whether or not they should do preventive maintenance. The system, as shown in Fig. 1, is operated from a control room outside of the mine. The conveyors are operated by an operator that controls all the units inside the mine. On the MB, CMM and shearer there are operators that control the operations, but the control room has data fed from these machines to know the status. In order to calculate the reliability and maintainability characteristics of the main conveyors, it is assumed that: (1) the system is repairable; (2) the system is subjected to repair and maintenance; (3) the time to repair includes all waiting and logistic time; and (4) the repaired components are as good as new.

3. Methodology and data collection

3.1. Methodology

The formal definition of reliability is the ability of an item to perform required functions under given conditions for a given time interval [10]. The reliability and maintainability characteristics of the mining equipment can be determined by the analysis of time between failures (TBF) and time to repair (TTR) data sets. In this

Table 1
Subsystems of the mechanized longwall method used in the SNSK mine.

Name	Code	Function	Studied	Length (m)
Shearer	SH	Cutting coal	No	
Mine bolter	MB	Development work	No	
Continuous miner machine	CMM	Development work	No	
Conveyor	DT-8	Transport of coal	No	
	H5	Transport of coal	No	1400
	H4	Transport of coal	Yes	2700
	H3	Transport of coal	Yes	1650
	T2	Transport of coal	Yes	2700
	T1	Transport of coal	Yes	3100
	Stacker	Transport of coal	Yes	160
	H2	Transport of coal	Yes	
	H7	Transport of coal	No	
	H8	Transport of coal	No	

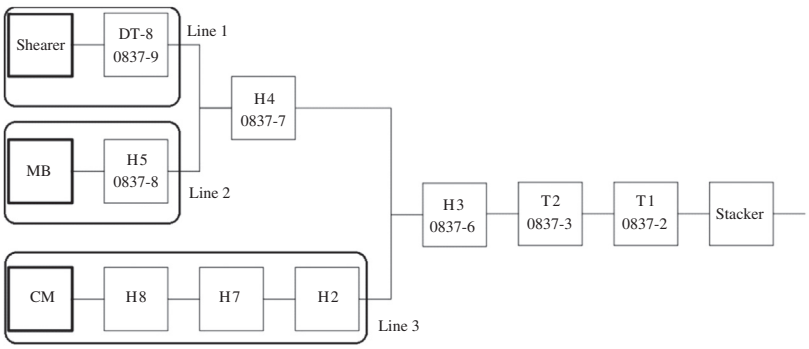

Fig. 1. Reliability block diagram of the Svea coal mine.