CASE STUDIES

Assessment of the Vocational Risk of Natural Mining Environment

1. Case metadata

▪ *Country of origin:*

Poland

▪ *Year of publication by the Agency:*

2009

▪ *Sector:*

B5.1.0 - Mining of hard coal

B5.2 - Mining of lignite

▪ *Keywords:*

08801A Risk analysis and management

19641D Risk assessment

18081D Accident prevention

12561D Measurement and assessment

24401C Case studies

24361C Good practice

20641 D Worker participation

2. Organisations involved

The Katowice Coal Holding, Co. Hard Coal Mine "Wujek"

3. Description of the case

3.1. Introduction

The core business of the Katowice Coal Holding, Co. mines is exploitation of coal deposits, cleaning of coal and trading of coal in compliance with the requirements of the customers and mining waste management. The Holding consists of six hard coal mines. The Hard Coal Mine "Wujek" is one of them. It is a modern, efficient and profit-making unit. Last investments in machinery made the Coal Mine safer and more efficient.

Carrying out the underground operations bring about an everyday exposure to risks generated by technological, organisational and environmental hazards, as well as natural hazards, such as:

- ignition or explosion of methane
- explosion of unprotected coal dust
- rock formation crump
- burst of water
- fire
- radiation
- high temperature.

Natural hazards are of extremely complex nature and often appear as associated hazards. The occurrence of any of them may trigger the occurrence of the next one. Examples of associated hazards are the risk rock formations crumps, explosion of coal dust or ignition or explosion of methane. For an effective safety management and decision making it is necessary to assess the risks associated with occurrence of natural hazards, using analytical methods, which take into account the specific character of the risks.

3.2. Aims

The main aim of the project was to elaborate an analytical method which takes natural hazards into account in the risk assessment process. Before that none of existed risk assessment methods was an analytical one taking into account the specific natural hazards and their co-occurrence.

The improvement of other aspects of the risk assessment was also an important aim. The risk assessment method used in the past met the proper regulations formally. Accordingly with the regulations, the recommended cards were prepared and filled in for each workplace in each mine team. Because coal mine teams change their place of doing work very often, existing risk assessment cards were copied by the OSH service for the same work in every new place. It met obligations and saved time but did not improve the risk assessment process. Additionally, no new achievements in risk assessment were created. The process was also very bureaucratic. For each small change in the dates, a change in many documents was needed. This is inconsistent with the idea of an effective and non bureaucratic risk assessment process, as is recommended in the EU directives. Using their experiences in supervising risk assessment the project managers developed a more simple and user-friendly method.

3.3. What was done, and how?

A major achievement was the development of an analytical risk assessment method for natural hazards, which combined the contents of the Polish standard PN-N-18002, containing guidelines for risk assessment, with the requirements of secondary legislation to the Geological and Mining Law. The method comprises nine risk assessment modules, and these refer to the assessment of risk associated with the following hazards:

- rock formation crumps
- methane risk in general
- methane risk for mining longwalls
- methane risk for driven dog headings
- explosion of coal dust
- water
- fire
- radiation
- climatic.

Three mutually dependent risk processes were distinguished: technological, natural and environmental. Teams of experts were established for assessing the risk in a given group.

Natural hazards risk assessment methodology was elaborated, named the Risk of Natural Mining Environment**,** further referred to as RNME**.** It is based on an analytical approach to the respective hazards and to the issue of their co-occurrence. The generally accessible IT tool, Microsoft Excel was used.

In all modules, the probability of hazard activation and the scope of damages to human health, which may be caused by such activation, were assumed as the major parameters describing the volume of risk. To determine the figures relating to the probability of hazard activation, measurable quantities were used, defined in the secondary legislation to the Geological and Mining Law, which are measured or determined by scientific entities with competencies of experts in natural hazards, or specialised services for monitoring and control of natural hazards. The figures, on the basis of which the probability parameter was determined, represent the values contained below in the Table 1.

Table 1. Parameters for determination of probability in the assessment of crump hazard risk

Sparking aptitude of the rock causing methane ignition,	Assessment of methane risk for long walls and headings
Conditions for mechanical rock mining,	
Conditions for headings ventilation (air flow rate),	Assessment of general methane risk
Ventilation systems in use (air cycle, ventilation pipes),	
Classification of coal deposits to the respective methane hazard categories,	Assessment of general methane risk Assessment of coal dust explosion risk
Classification of coal deposits to cramping or non-cramping,	Assessment of coal dust explosion risk
Classification of coal deposits to the respective classes of coal dust explosion hazard,	
Determination of values against the background: gamma radiation, short-period products of radon disintegration (alpha radiation), radon contents in mine waters and sediments,	Assessment of radiation risk
Air temperatures expressed in Co degrees, measured by dry-bulb thermometer and cooling intensity K expressed in wet Kata degrees, measured by wet-bulb Kata thermometer,	Assessment of climatic risk
Carbon oxide indicator and carbon oxide increments indicator,	Assessment of fire risk
G (Graham) indicator calculated on the basis of the results of analyses of air samples taken on localised measurement stations,	
Classification of coal deposits to the respective water hazard degrees,	Assessment of water risk
The twenty figures characterising crump hazard in the mining reconnaissance methodology.	Assessment of crump risk

Because of the complexity of evaluation of certain natural hazards and technical possibilities of their presentation, descriptions of three selected risk assessments are presented below:

- the hazard of crumps
- methane hazard
- fire hazard.

Assessment of risk relating to the hazard of crumps

In assessing the risk relating to the hazard of crumps, one of the methods of a complex evaluation of crumps' danger was applied during the design stage – i.e. the mining reconnaissance method. This method allows to calculate probability of events' occurrence on the basis of the granted scores, which depend on the replies to questions describing twenty factors affecting the situation of exposure to a danger. The amount of collected scores describes the probability of occurrence of the hazard subject to an assessment. The evaluated mining long wall or dog heading is divided into a number of zones. Their number and length will depend on the geological and mining structure of the long wall or heading. For each zone a separate risk assessment is carried out. The second parameter is the possible losses, which may occur due to hazard activation. These two parameters determine the risk matrix. Risk categories and the rules for determining its permissibility are presented in the Table 2:

Table 2. Risk categories determination table – the crump hazard risk

Table for risk category determination and its acceptability RT = S * P					
Degree resulting from the mining reconnaissance method	Hazard status	P Probability of occurrence of an event	H - HARMFULNESS low harmfulness	medium harmfulness	high harmfulness
a	NO HAZARD HEADINGS	LP low probability	A	A	B
b	LOW HAZARD HEADINGS		acceptable	acceptable	acceptable
c	MEDIUM HAZARD HEADINGS	MP medium probability	A	B	C
d	HIGH HAZARD HEADINGS		acceptable	acceptable	unacceptable
nb	DANGEROUS CONDITIONS	WP highly probable	B	C	C
			acceptable	unacceptable	unacceptable

Assessment of the methane risk

Methane risk assessment comprises three modules. This is caused by the various legal provisions of the Geological and Mining Law regarding monitoring and the prophylactics used in the course of mining work on long walls, working faces and other dog headings where no mining works are conducted. All these factors are translated in real terms into the adopted method for determining the volume of risk of natural hazard activation.

The RNME methodology relating to methane hazard risk assessment for mining long walls is convergent with the method used for evaluation of methane risk for driven dog headings. In both methods, to determine the probability figure, the following parameters established by a mining expert were used: sparking aptitude of the rock causing methane ignition and the condition for mechanical rock mining. In these methods, besides the determination of harmfulness of hazard activation, an additional parameter in the risk matrix is the parameter resulting from the maximum value of crump hazard risk assessment, obtained in the evaluated zones, as presented below in the Table 3.

Table 3. Risk category determination – methane risk

Table for determining risk categories and its admissibility RM = P*H* RT				
	P - PROBABILTY			
H HARMFULNES S (GRAVITY OF EFEFCTS)	LP low probability (1)	MP medium probability (5)	HP high probability (20)	RT Crump hazard risk categories (max. volume resulting from zones)
L low harmfulness (1)	A acceptable	B acceptable only when conducting rescue operation	C unacceptable	A, B acceptable (1,0)
M medium harmfulness (2)	A acceptable	B acceptable only when conducting rescue operation	C unacceptable	
H high harmfulness (3)	A acceptable	B acceptable only when conducting rescue operation	C unacceptable	
L low harmfulness (1)	A acceptable	B acceptable only when conducting rescue operation	C unacceptable	C unacceptable (2,0)
M medium harmfulness (2)	A acceptable	C unacceptable	C unacceptable	
H high harmfulness (3)	B acceptable only when conducting rescue operation	C unacceptable	C unacceptable	

Assessment of the fire risk

Due to the complexity of fire hazard, two algorithms of risk assessment were established, based on an exceeding of the values of measured factors describing a fire. The first algorithm is based on the criterion of assessment of the fire risk on the basis of carbon dioxide indicator and incremental increase of carbon dioxide calculated from the results of analysis of air samples taken on the detailed measurement stations for mining long walls and driven dog headings (see Table 4).

Table 4. The algorithm based on the criterion of assessment of the fire risk on the basis of carbon dioxide indicator and incremental increase of carbon dioxide

Fire risk category	Indicator Vco [l/min] i ΔCO [%]	Action
A acceptable	0 < Vco =< 10 when ΔCO < 0,0010	No additional preventive action is required, the work on the working post can be conducted.
B acceptable	0 < Vco =< 10 when 0,0010 < ΔCO =< 0,0026	Increased observation in the controlled region, increased frequency of air sampling.
C acceptable	10 < Vco =< 20 when ΔCO =< 0,0026	It is necessary to undertake prophylactic works, while retaining normal operations in the hazardous area, whereas the prophylactic works plan shall be elaborated by the head of the ventilation section and approved by the head of running of a mining establishment.
D unacceptable	ΔCO > 0,0026	Fire fighting action, conducting work on work posts inadmissible, except for employees taking part in the fire fighting action.

The second algorithm (see Table 5) is based on the fire hazard criteria according to the G (Graham) indicator calculated from the results of analysis of air samples taken on the detailed measurement stations.

Table 5. Algorithm based on the fire hazard criteria according to the G (Graham) indicator

Fire risk category	Indicator Vco [l/min] i ΔCO [%]	Action
A acceptable	0 < G =< 0,0025	Normal situation – no fire hazard occurrence in abandoned workings.
B acceptable	0,0025 < G =< 0,0070	Increased observation in the controlled region, increased frequency of air sampling.
C acceptable	0,0070 < G =< 0,0300	It is necessary to undertake prophylactic works, while retaining normal operations in the hazardous area, whereas the prophylactic works plan shall be elaborated by the head of the ventilation section and approved by the head of running of a mining establishment.
D unacceptable	0G > 0,0300	Fire fighting action, conducting work on work posts inadmissible, except for employees taking part in the fire fighting action.

The results of the risk assessment process along with the applied prevention are collected in Excel spreadsheets and published in the Integrated Management System Intranet service. The service is accessible from the level of a division. The Head of a division, having made print outs of the risk assessment charts for the supervised work posts, notifies the results to the employees who confirm that by their signature on standardised forms. During employee trainings the issues relating to legal basis and rules for risk assessment are presented. Such a system for carrying out risk assessment and giving information about it to employees leads to a decrease of the burden of bureaucracy on the risk assessment process and as a result the system becomes simpler and more intelligible. The assessment itself is made by qualified hazard control experts.

The elaborated natural hazards risk assessment methods were consulted with representatives of the employees as regards usefulness and effectiveness of implementation and gained a positive opinion.

3.4. What was achieved?

An analytical method was developed, whose novelty consists in obtaining parameters describing natural hazards of high degree of reliability. The method is based on Polish Standard 18002, which contains guidelines for risk assessment, as well as on secondary legislation to the Geological and Mining Law, which allows for its alignment with the changing legal regulations. It is closely connected with the results of working conditions measurements, the level of hazard and is carried out by professionals dealing with natural hazards identification. The method allows obtaining a very transparent and legible risk assessment result.

The method is an effective tool for fulfilling the obligation of risk assessment within the work safety management system, whereas the results and the method of carrying out the assessment have an impact on planning of measures and identification of hazards, which may cause serious damages.

The method constitutes and “instruction” for safe work performance and contributes to raising awareness of the probability of activation of a given natural hazard and the problems of labour safety among the employees.

The great benefit is raising employees’ awareness relating to the existing hazards, encouraging safety-oriented behaviour and contributing to reduction of the number and seriousness of accidents.

With reference to the costs it is a tool for reducing losses in a coal mine. It reduces losses as a result of preventing accidents, which would cause harmful effects for the injured and their environment. It essentially influences the reduction of losses through statutory reduction of the basis for determination of the accident contribution as its percentage. In 2005-2008 the mine has paid a significantly lower contribution.

3.5. Success factors

The success factors of the project were:

- An active attitude of OSH services towards risk assessment process, willingness to improve methods used until now and search for more comprehensive ones.
- Education, as a factor deciding about authors’ ability to create new solutions. The case shows that at a workplaces as difficult as a coal mine, risk assessment has to be based on a solid expert knowledge and an extensive experience.
- Providing employees with training including information on how to take part in the improved risk assessment process.
- A positive attitude of the management and considering OSH issues as a very important element of the general management system in the mine, taking precedence over productivity.

3.6. Further information

TOMASZ WIELGO

The Katowice Coal Holding, Co., Hard Coal Mine „Wujek", Poland

Wincentego Pola 65 St.

40 596 KATOWICE

Tel: (032) 208 50 00

Fax: (032) 2515 507, 2517 570

Email: tomasz.wielgo@neostrada.pl

Web: http://www.khw.pl/

Web: http://www.wujek.pl/

3.7. Transferability

It is possible to transfer the project, or at least the idea showed in the project to other similar enterprises, mainly mines. It requires the strong involvement of both management and OSH services'.

4. References, resources

Information provided by the company/organisation in the framework of the Good Practice Award Competition 2008/2009.