

## ANALYSIS OF SAFETY AT WORK RATE IN CHOSEN MINES OF UPPER SILESIAN COAL BASIN

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### Abstract:

The article presents an experimental comparison of safety at work in hard coal mines located in Upper Silesia Coal Basin. The aim was to show the best practices and activities in Poland and Czech Republic which could be successfully implemented in other mines in order to improve safety of their workers.

**Key words:** mining, safety, accidents, Czech Republic, mines

### INTRODUCTION

The mining industry keeps focus on continuous improvement of safety at work as well as introducing new activities to achieve it. The efficiency of these activities can be raised if the safety management system is implemented. The right management is the best way to keep the satisfactory level of health and safety at work which is crucial matter due to rules of law, social responsibility and opportunity to reduce the costs of extraordinary events [10].

Safety at the workplace and responsible behavior of employees are not a coincidence. Safety should be developed according to a program created in advance by an organization. The program could be non-formalized or formalized based on norm PN-N-18001 (OHSAS) which is one of the most useful tool of improvement of work quality.

The article includes a safety at work analysis of chosen coal mines. The objects of comparison were two coal com-

panies located in Upper Silesia Coal Basin – one Polish and one Czech (fig. 1.) [3].

The safety at work in mining depends on geological conditions of a deposit, amount of extraction and its intensity, technology, legal system and awareness of workers. [3] Due to the similarity of geology and technology, the mines localized in Upper Silesian Coal Basin – the analysis seems to be justified.

Publication includes not only the comparative analysis of safety conditions but also some solutions which could be implemented in other countries.

### SAFETY AT WORK IN COAL MINING INDUSTRY

Underground coal extraction in Upper Silesia is characterized by severe geological conditions with the presence of almost all known natural dangers recognized in the worlds mining. The technical, organizational, work-environmental conditions and threats are tend to get worse every year.

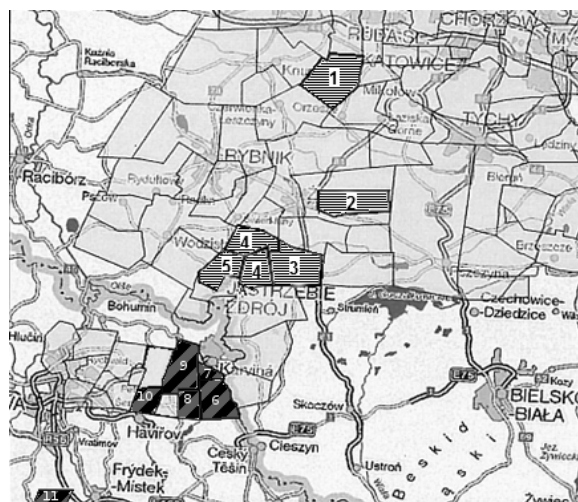


Fig. 1. Current coal fields of JSW and OKD [3]

Legend: horizontal stripes – mining fields of JSW, nr 1-5 mines of JSW, diagonal stripes – mining fields of OKD, nr 6-10 mines of OKD

**Table 1**  
**Main threats causing the most injuries in underground mines [2, 6]**

Natural	Technical	Personal
<ul style="list-style-type: none"> <li>- rock bursts,</li> <li>- explosions and inflammations of gas and dusts,</li> <li>- outbursts of gas and rocks</li> <li>- flood and quicksand,</li> <li>- fires,</li> <li>- staying in a toxic atmosphere.</li> </ul>	<ul style="list-style-type: none"> <li>- contact with working machines and devices,</li> <li>- detonation of explosives,</li> <li>- failure of pressure devices,</li> <li>- contact with hot factor and dangerous substance,</li> <li>- contact with live machines, devices, wires</li> </ul>	<ul style="list-style-type: none"> <li>- downfall, stumble, falling over,</li> <li>- accidental contact with another worker (participant in the technological process)</li> </ul>

The main factors influencing on current safety in mines of Southern part of Upper Silesian Coal Basin are:

- 1) far advanced level of deposit extraction which has lowered the crust stability,
- 2) high and quickly raising mining depth (circa 5-8 meters a year),
- 3) exploitation of multi – seam deposits (edges, rests and pillars),
- 4) common „under level” seam exploitation (more difficult and inefficient ventilation),
- 5) long-term negligence in equal and sufficient investment of mining industry,
- 6) popularity of outsourcing in underground works [6, 8].

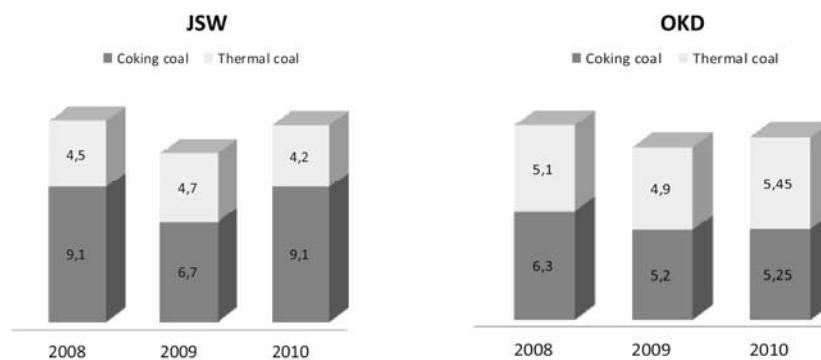
The table 1 includes the main threats causing the biggest amount of injuries in Polish and Czech coal mines in the last 6 years. The table was created according to the reports of Wyższy Urząd Górniczy and Státní Báňská Správa – Polish and Czech state mining industry authorities.

#### PRESENTATION OF ANALYZED COMPANIES

The object of comparative analysis were 2 chosen hard coal producers operating in Upper Silesian Coal Basin (pic. – fig. 2): Jastrzębska Spółka Węglowa Ostravsko Karvinské Doly. The tables 2-4 include basic comparative data which characterize the companies. The table 4 refers to the acts of mining law in Poland and Czech Republic.

The data in the table indicate the close similarity of both companies. JSW and OKD employ 22700 and 18000 workers (difference 20%), they produce almost the same amount of hard coal (difference 16%). The companies extract coal only in underground mines.

The production volume of two companies seems to be very similar. Due to reduction of demand on global markets JSW and OKD decided to decrease their extraction in mines. The both coal companies make the most profits from selling coking coal.



**Fig. 2. Coal production of JSW and OKD [1, 4]**

**Table 2**  
**Analyzed coal companies: JSW and OKD**

Company name	JSW	OKD
Country	Poland	Czech Republic
Number of active collieries	5	4
Total employment	22700	18000
Coal production [mln Mg]	12.6	10.6
Average depth of exploitation [m]	- 850	- 930

**Table 3**  
**The collieries of analyzed companies, data from 2010 [1, 4] – indicated number on the map refer to fig. 1**

Jastrzębska Spółka Węglowa					
Number on map	4	2	5	1	3
Colliery name	Borynia-Zofiówka	Budryk	Jas-Mos	Krupiński	Pniówek
Annual production, [mln Mg]	3.87	3.06	1.59	2.19	2.62
Reserves, [mln Mg]	100	236,5	30	60,3	88,5
Ostravsko Karvinské Doly					
Number on map	9, 10	6	7, 8	11	
Colliery name	Karviná	ČSM	Darkov	Paskov	
Annual production, [mln Mg]	4.1	2.9	3.2	1.0	
Reserves, [mln Mg]	89	45	37	24	

**Table 4**  
**Comparison of current Polish and Czech mining safety regulations**

JSW	OKD
Ustawa z dnia 9 czerwca 2011 r. Prawo geologiczne i górnictwo (Mining and geology act) (2011/163/981) Ustawa z dnia 26 czerwca 1974 r. Kodeks pracy (1974/24/141) (Labour code) Rozporządzenie Ministra Gospodarki z dnia 28 czerwca 2002 r. w sprawie bezpieczeństwa i higieny pracy, prowadzenia ruchu oraz specjalistycznego zabezpieczenia przeciwpożarowego w podziemnych zakładach górniczych (H&S at work in mines, conducting the mining enterprise, underground fire protection act)	Zákon ČNR č. 61/1988 Sb., o hornické činnosti, výbušninách a o státní báňské správě (Mining activity, explosives and mining state authority act) Zákon č. 262/2006 Sb., zákoník práce (Labour code) Vyhláška ČBÚ č. 22/1989 Sb., o bezpečnosti a ochraně zdraví při práci a bezpečnosti provozu při hornické činnosti a při dobývání nevyhrazených nerostů v podzemí (H&S at work in mines, conducting the mining enterprise and other works underground)

**RESEARCH METHODOLOGY**

The evaluation of safety at work in the enterprises was conducted using the external benchmarking method which consists of comparison of some activity [5]. Comparing the two companies is a right way to find the best practices and later to implement them.

*Justification of comparison*

There is no universal method to check if the benchmarking conduction is justified and useful in indication and solving a problem. Choosing the object of comparative analysis had been preceded by a preliminary recognition that prove enough number of features between the companies to choose a benchmarking.

The table below contains criteria by which it was considered that comparison could be carried out and bring some benefits.

**Table 5**  
**Comparative criteria of two coal companies (own study)**

Criterion	Description
Production volume	Similar production and investment opportunities
Form of mining Seam characteristics	The same natural conditions as well as chosen extraction form
Employment level	A little difference in employment; the number of predicted accidents should be at least similar
Location	Comparable level of technical development
Legal system	Legal regulations in mining are almost the same in two countries

It is good to mention that the both mining companies are characterized by different tradition, organizational culture and awareness of employees (tab. 6).

**Table 6**  
**Criteria which differentiate two chosen coal companies (own study)**

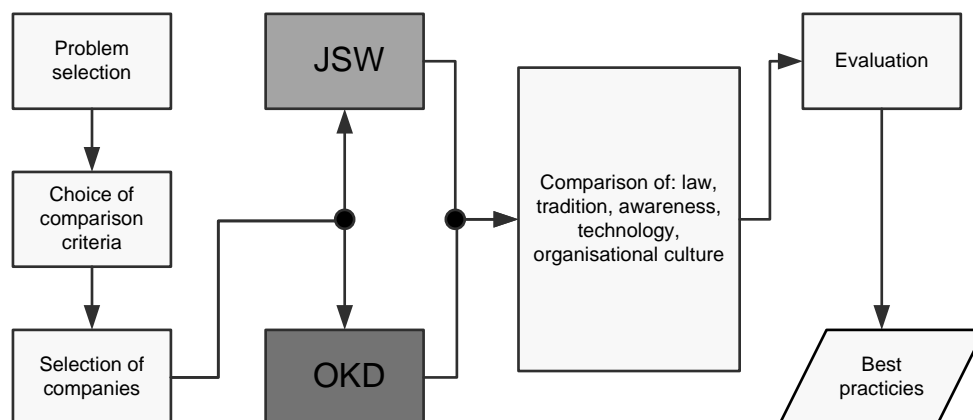
Coal mining in Czech Republic has got a local character and it is not considered as a leading branch of economy.

Criteria	JSW	OKD
Tradition	Alive awareness element in Upper Silesia. Mining as a basic branch of economy	Mining as a branch of economy
Awareness	Created by Integrated Management System	Continuous creating the knowledge and awareness in many ways

JSW and OKD had chosen different ways to improve safety in their collieries: JSW believes that Integrated Management System is the best tool to achieve better results, OKD not only uses the system activities but also other means to encourage its employees to work safer.

*Research methodology*

The research was undergone according to the diagram (fig. 3).



**Fig. 3. Comparison diagram of the two companies**

Methodology of research included critical evaluation of the data shared by the companies as well as analysis of widely accessible materials available in the internet. The carried out research refers to the 6 years of companies activity. The length of the analyzed period seems to allow to get a proven evaluation.

There were 4 analyzed indicators of safety at work in JSW and OKD:

- LTIFR – Lost Time Injury Frequency Rate – the number of confirmed accidents at work divided by a million work hours,
- Accident rate per million extracted Mg of coal,
- Accident rate per 1000 employees a year,
- Fatal accident rate per million extracted Mg of coal.

## PRESENTATION OF RESEARCH RESULTS

### LTIFR

The number of confirmed accidents per million work hours in the companies are presented in the fig. 4 [9].

In 2005-2010 we can see a great improvement in safety level in OKD, in this period the rate decreased below 10. In JSW the accident rate is constant (LTIFR around 11), the lack of positive changes forces the company to consider the need of building a better awareness in safety at work.

At the end of 2010 the companies were at the similar level of safety at work. Furthermore OKD accident statistics include also events that happened to the outsourcing workers [1, 4].

### Accident rate per million extracted Mg of coal

The figure 5 presents the data from all Polish and Czech coal mining facilities. The diagram refers to the all accidents happened in the mines regardless of place of employment.

In Polish collieries there are no significant changes in accident rate. Between 2005 and 2008 the indicator shows even a growing number of accidents per volume of extracted coal.

The Czech mines manager to reduce the rate from 70 to below 30 (2005-2010), what should be considered as a success [2, 6].

### Accident rate per 1000 employees a year

The diagram contains only accidents that happened only to the workers of JSW and OKD (fig. 6).

The rate has been successfully decreased in years 2006-2010 in OKD. At the beginning of the period about 45 from 1000 had been injured at work annually, in 2010 the number was about 17. Accident rate for JSW in years 2005-2010 fluctuated around 16 and 19 with no significant annual changes [1, 4].

### Fatal accident rate per million extracted Mg of coal.

The diagram (fig. 7) refers to all fatal accidents that happened in mines of both companies regardless of place of employment.

The presented diagram does neither show any significant trends in the field of safety. It is very hard to explain why the trends are equal in all researched years. The average rate of fatal accidents in both companies was almost the same [2, 6]: JSW = 0.34; OKD = 0.35

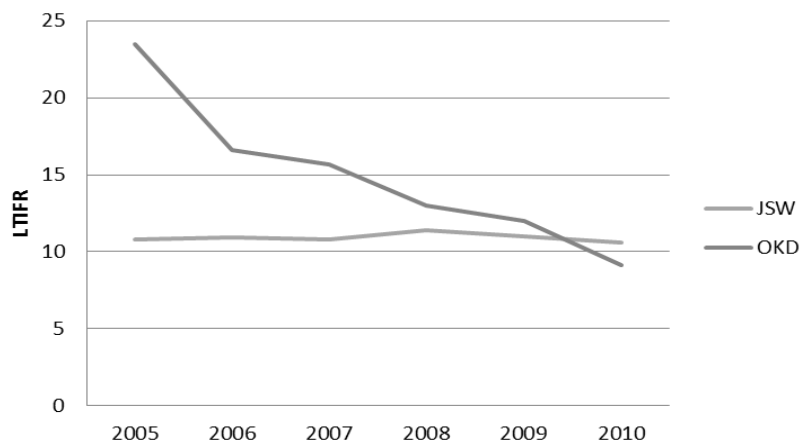


Fig. 4. LTIFR in analyzed companies

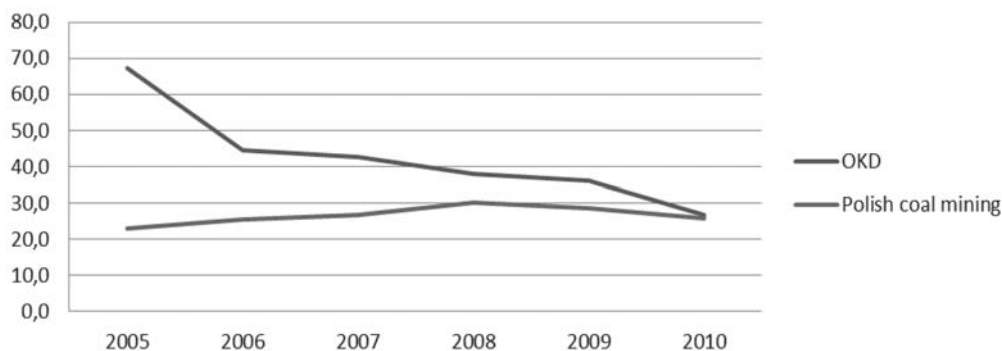


Fig. 5. Accident rate per million extracted Mg of coal in OKD and Polish mines

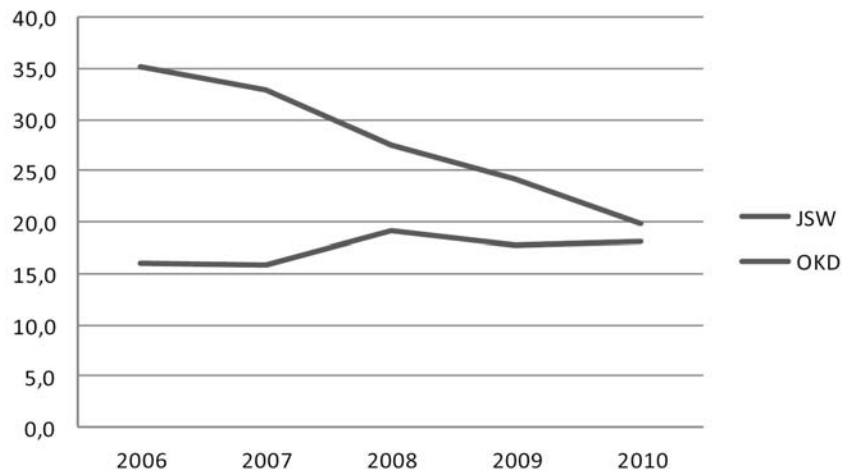


Fig. 6. Accident rate per 1000 employees a year

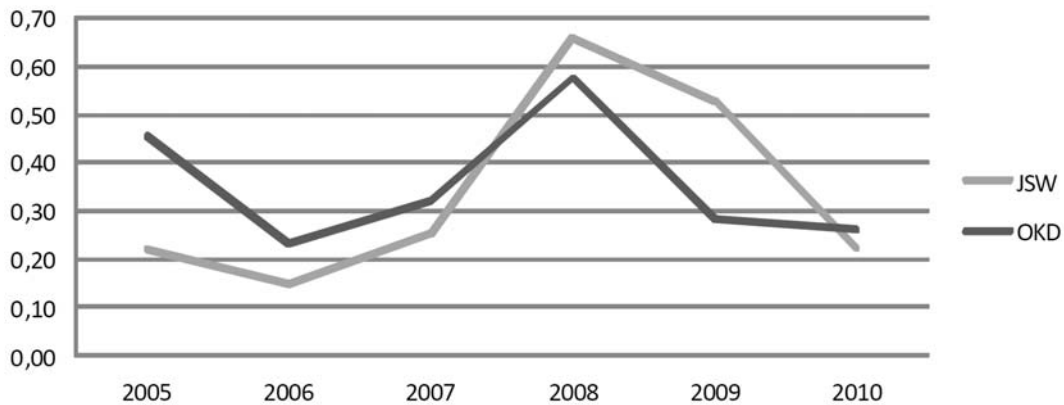


Fig. 7. Fatal accident rate per million extracted Mg of coal

## RESULTS AND CONCLUSIONS

There are many indicators which are helpful to evaluate activity of mining industry. The efficiency of a particular mine can be proven by: unit cost of coal extraction and processing, average quality product parameters or financial results of company.

The safety at work rate is another type of an indicator. Keeping the high level of health and safety contributes to:

- reduction of costs caused by the accidents (interruption, rescue action, case study),
- efficient production planning,
- positive external and internal marketing effects.

Carried out comparative analysis has proven:

- close similarity of both enterprises in: production, employment, number of facilities and organization,
- the significant improvement of safety in OKD,
- constant accident rates in Polish mining,
- almost identical fatal accident frequency rate in both companies,
- similar, current safety level in two companies (beginning of 2011),
- a great differences between ways of creating awareness of employees.

The results of the analysis are following conclusions:

- Hard coal mining industry is characterized by a high accident rate (amount of accidents per 1000 workers annually). The reason of this fact is probably primary risk caused by the underground mining-geological conditions. The main elements of risk are natural, technical and personal dangers.
- Reduction of threats associated with accident rate is realized by safety regulations and principles related

to preventions, deterring the natural and technical dangers. It is also good to mention that wide experience of personnel and technology can also provide a safer work conditions.

- In 2004 JSW implemented management system of health and safety at work. The introduction was carried out with realities taken into account breaking the existing barriers and traditions affecting the safety level. It used to be a common problem that safety in mining was only associated with the condition of equipment and human capabilities. The deciding influence on creating the accident rate relies on knowledge of employees and frequency of their irresponsible behavior. The constant accident rate in JSW forces to take into consideration activities to form a better awareness of workers and their participation in creating safety culture.
- OKD in researched period was tend to reduce its accident rate. It may prove the efficiency of implemented system activities in safety at work. The management declare all the processes performer underground and on surface must fulfill all the safety regulations. The company is going to eliminate all the threats and nuisance. The aim can be achieved with the full support and engagement of the employees.
- Special importance was given in the Czech Republic by workers building a safe working environment for themselves and people around them. The safe behavior is highly rewarded with material prizes such as cars or trips. The significant reduction of accident rate in OKD may be an evidence of correct strategy and can be considered as a best practice which is worth of propagation.

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