

# Influence of management system on the safety level in chosen enterprise

**M. Spilka\*, A. Kania**

Institute of Engineering Materials and Biomaterials, Silesian University of Technology, ul. Konarskiego 18a, 44-100 Gliwice, Poland

\* Corresponding author: E-mail address: monika.spilka@polsl.pl

Received 30.01.2010; published in revised form 01.03.2010

## Industrial management and organisation

### ABSTRACT

**Purpose:** In this paper the analysis of influence of management system on safety level in extractive industry was carried out. The effects of the occupational health and safety management system implementation were presented. The necessity of threats monitoring and preventive treatments were showed.

**Design/methodology/approach:** In this article the essence of industrial safety was presented. The problem of occupational risk and the results of threats on the work position were talked over. Moreover, the occupational health and safety management according to PN-N-18001 standard was characterized.

**Findings:** The analysis of enterprise functioning, developed in respect of infrastructure and occurring threats taking into consideration industrial safety after occupational health and safety management system introduced was carried out.

**Research limitations/implications:** According to continuous improvement principle the necessity of supervise actions in direction to improvement of health and work conditions of workers exist.

**Practical implications:** The implementation of the occupational health and safety management system brings profits as reducing of heavy and fatal accidents index. In enterprises observed minimizing of negative health effects caused by industrial accidents.

**Originality/value:** In this paper indicated that present coal-mining needs effective system actions which should be directed on threats reducing causing industrial accidents.

**Keywords:** Safety and health management; PN-N-18001 standard; Occupational risk; Coal-mining

#### Reference to this paper should be given in the following way:

M. Spilka, A. Kania, Influence of management system on the safety level in chosen enterprise, Journal of Achievements in Materials and Manufacturing Engineering 39/1 (2010) 95-102.

## 1. Introduction

During competitive market, advanced technologies and the intensive exploitation of resources, the number of natural and technical threats grew up considerably. The large economic growth rate causes increase of occupational risk among various branch workers. The responsible approach to management caused interest the industrial safety matter.

The occupational health and safety management is the part of management system in enterprise [1,2]. PN-N-18001 is a standard

according to which we can build effective functioning system of industrial safety management [3]. According to continuous improvement the enterprise must fulfill not only legal requirements but systematic preventive actions and fast incompatibility correction also [4]. All activities undertake in the range of occupational health and safety management system must be understand and accepted by personnel and management. Because of that so important is formation of high culture of the safety with tools usage e.g. courses and trainings, promotive workings connected with industrial safety, competitions about the industrial safety matter and audits.

## 2. Industrial safety matter

Safe conditions and safe behaviour in the work do not form intrinsically, but first they must be shaped according to schedule. Undertaking workings directed on support and improvement of work conditions, equipment and workers behaviour are necessary.

The safety is often defined as lack of not accepted risk of damages, and the health protection as guarantees contained in legal standards establishing such working conditions, to assure the good physical, psychical and social conditions according to WHO (World Health Organization) definition. Industrial safety is the whole legal standards and research, organizational and technical measures which aim are creation such working conditions to perform the job in the productive way, without exposing on the unfounded accident or occupational disease risk and excessive physical and psychical load [5].

First in the world standard relating to occupational health and safety management systems - voluntary British BS 8800 standard published in 1996 deserves on the special attention. The aim of this standard was facilitation enterprises creation and introduction of such occupational safety management system which can be integrated with the general organization management system.

## 3. Occupational risk and threats effects on the work position

Threat is the release of energy accumulation in the environment in uncontrolled way, causing damage or losses, and particularly - accident or man disease [6].

Threatening factors are divided on: dangerous, harmful or arduous according to consequence of influence on the organism. Arduous factors can occur harmful (threatening health) or dangerous (threatening life) depend on concentration or intensity. Work in the conditions of above mentioned factors creates dangerous of unfavourable results for health and life appear. Probability of appear these sequences and their range define as the occupational risk [7].

Definition of the occupational risk is also contained in the Directive 96/82/UE. The risk means the probability of appearance of harmful effects during the definite time or in the definite situations.

However, the occupational risk doesn't consist of the factors causing danger for human health (Fig. 1).

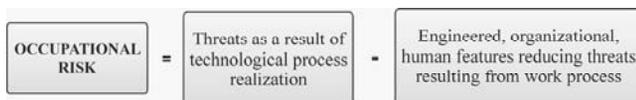


Fig. 1. Concept of occupational risk [8]

The occupational risk belongs to duties resulting from the regulations and it should be realized on every work position. The basic aims of the occupational risk are [7]:

- verification if threats occurring on the work positions are identified and the occupational risk connected with them is known;

- proving both the worker and control with regulatory body, that threats analysis is carried out and proper protective measures are implemented;
- accomplishment of the proper choice of the work positions equipment, materials and organization of the work;
- settlement of priorities in actions tending towards elimination or limitation of the occupational risk;
- assurance of continuous improvement of the industrial safety.

The threat is the specific factor which in definite circumstances could be the cause of the damage of the system element. The one or more threats can be contribute on every dangerous situation. The occupational threat is the threat with which we meet during practice. The factors of the occupational threat are divided on two groups [9]:

- causing industrial accidents, that is injury factors; physical factors acting on the people in the sudden way belong to them;
- causing occupational diseases; harmful and burdensome factors belong to them:
- physical factors - noise, vibration, microclimate, radiation, magnetic and electrostatic field, industrial dusts;
- chemical factors - toxic, allergenic, carcinogenic, mutagen substances, these factors influence on the people through respiratory tracts, skin and mucous membranes and alimentary tract;
- biological factors - microorganisms;
- psychophysical factors - the physical and psychological load.

The employer, according to the labor code decisions is obliged to the assurance on every work position full safety and workers health protection. Realization of this duty is possible after carried out the thorough evaluation of the industrial safety condition on these work positions and the evaluation of the influence of all factors on this condition. The occupational risk evaluation is considered as the basic way of the active work environment monitoring and it makes possible elimination or limitation of threats before their negative effects will occur [10].

The occupational risk evaluation is the multistage process; the way of its carrying out presents Fig. 2.

## 4. Industrial safety management system according to PN-N-18001 standard

In the aim of the effective industrial safety management is advisable the implementation of the proper industrial safety management system which can be system based on PN-N-18001 standard requirements making possible all organizational units elaboration and realization of the optimal industrial safety policy [11,12].

The planning is the element connecting with established industrial safety policy realization in the occupational health and safety management system. The essential of the industrial safety system planning is the consideration: relationships among the economic activity of the enterprise and planning of the range of the industrial safety, limitations in the range of the industrial safety problems management and problems relating to activation of planned tasks from the range of the industrial safety. The planning of the actions during implementation of the industrial

safety management system should be based on results of preliminary inspection of the industrial safety management if it was carried out [5].

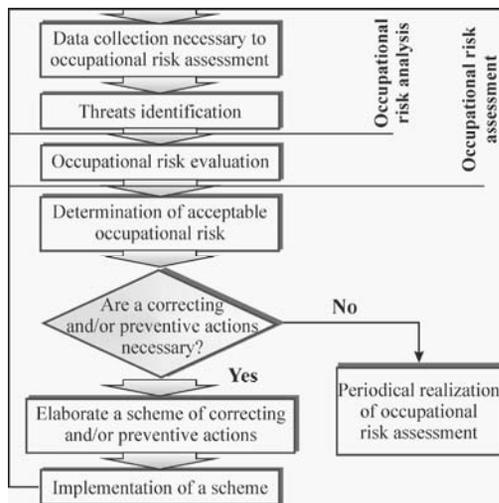


Fig. 2. Occupational risk assessment and resulting from its actions [5]

The management and the competent unit are responsible for a stage of the industrial safety management system implementation.

In the implementation of the occupational health and safety management system we can distinguish eight stages which connections were showed in Fig. 3.

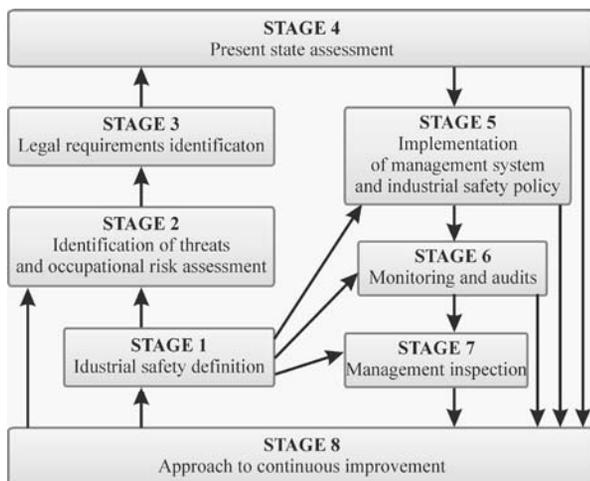


Fig. 3. Dependences and connections between stages of occupational health and safety management system implementation [11]

Implementation in the organization of the occupational health and safety management system is a proof of definite maturity level of this enterprise. The aim of the occupational health and safety management system documentation is simplification of communication of the organization intentions and the presentation of coherent principles procedure for the industrial safety policy

aims achievement and showing efficiency of functioning and the continuous usefulness of this system [13].

We can distinguish following groups of documents [12,14]:

- ♦ industrial safety policy and general, detailed aims relating to the occupational health and safety management system;
- ♦ book of the industrial safety (usually worked out by enterprises, but it is not required standard). It describes the whole the occupational health and safety management system and the way of realization by the enterprise of PN-N-18001 standard requirements; in the larger enterprises can be elaborated several books, worked out for individual departments separately;
- ♦ procedures and instructions of the industrial safety; procedures describe the proceeding mode in the particular problems of the industrial safety management; instructions are extension of the procedures. They describe detailed requirements relating to operations, they establish the way of proceeding and they are exact instruction, indication and recommendation (instructions should be worked out by persons who know in detail described processes and operations);
- ♦ notations - this is e.g. register of the investigations and the harmful factors measurements results, report about the work conditions, statistical accident card etc. (required by the standard decision, regulations, in relation to connected documents).

## 5. Influence of management system on the industrial safety level in chosen enterprise

In the analyzed extractive industry enterprise is implemented, affirmed and confirmed the certificates integrated quality and environment management system, compatible with ISO 9001:2000 and ISO 14001:2004 (certification in 2007) and the occupational health and safety management system compatible with PN-N-18001 (certification in 2004).

The occupational health and safety management system should be directed on elimination of threats causing the industrial accidents and occupational diseases [15]. System activities conducted in the analyzed enterprise have the significant influence on the improvement of the industrial safety conditions.

### 5.1. Analysis of person quantity defining who working in occupational threat conditions

According to the continuous improvement principle of the occupational health and safety management system, activities eliminating or minimizing occurrence of the threats in the work environment are applied in the enterprise:

- exact cooperation with State Sanitary Inspection and Environmental Laboratory in the range of investigations and measurements of harmful and burdensome factors for health organization;

- systematic controls of the work conditions in the coal-mining on all work positions in relation to observed regulations and principles of the industrial safety are carried out;
- techno-organizational actions, aiming to decrease of the number of threats in the work environment and the improvement of sanitary-hygienic conditions are taken;
- individual protective protecting before influence of dangerous and harmful factors for workers are ensured.

In the effect of activities tending towards improvement of work conditions in the analyzed organization since 2002 we can observe decrease of employees number in the threat conditions in the work environment (Fig. 4).

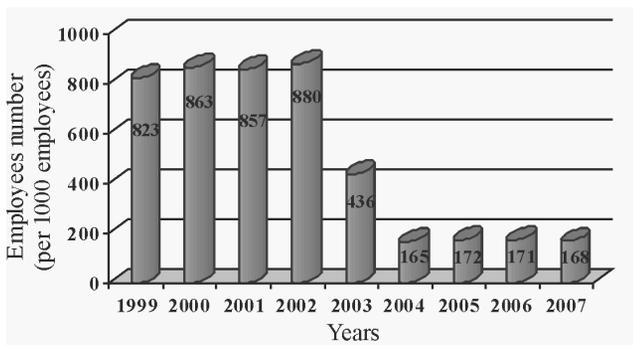


Fig. 4. Factor of employees number in conditions of harmful factors threat (per 1000 employees)

## 5.2. Analysis of occupational diseases structure defining

The coal-mining in Poland is the economy branch, in which the large degree of the occupational risk of workers exists. According to this probability of occupational disease occurrence is large too. Above mentioned results from the fact of occurrence in the work environment of different threats e.g. dustiness, noise, vibrations, chemical substances. The probability of appearance of the occupational diseases is different for every worker and depends on concentration or intensity of harmful factor in the work environment and the time of exposition. The individual immunity of the organism is also essential; it depends on life, nutrition manner, addictions and genetic load.

In the analyzed organization the most occupational diseases noted in 1998 - 62 cases (Fig. 5). In the following two years registered decrease of falling ill cases. The number of applications in 2000 amounted 22 and it was 59.26% decrease in relation to last year. In the following eight years considerable oscillation occurred. In 2001 - 2004 the number of noted diseases achieved 41 - 51 obtaining the largest value in 2003. In 2005 - 2008 the number of falling ill decreases significant and it was situated in 22 - 30, achieving the largest value in 2008.

The specification taking into consideration the number of employees in definite years more effectively illustrates formation of occupational diseases.

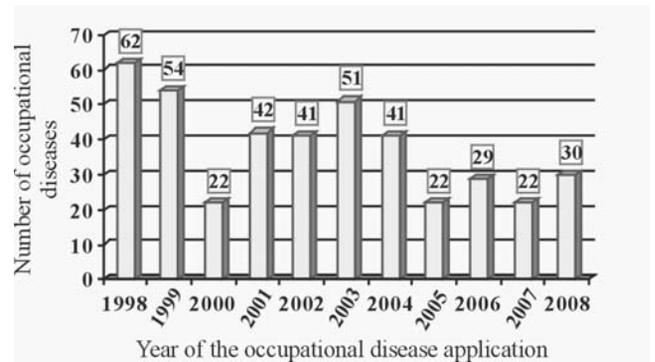


Fig. 5. Total number of occupational diseases in the analysed enterprise

In spite that the situation considerable improves in the comparison 90th years, the indicator of incidence of disease keeps on the very high level (especially in the comparison with values established for the country) and it begins to increase again. The result of such situation is e.g. the fact that period of the occupational diseases development average 10 - 20 years, that is why one observes the results of neglects and poor prophylaxis from the end of 80, 90th years.

The process of the coal-mining industrial conversion influences on directions of morbidity formation in the analyzed period. In spite, that the total number of occupational diseases after 1998 showed the falling tendency. The considerable reduction of the employment caused increasing and variation of morbidity coefficient per 100 000 employees in coal-mining after 2002 (Fig. 6).

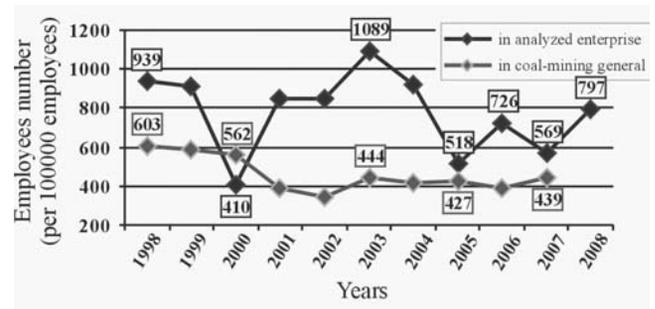


Fig. 6. Number of occupational diseases in analysed enterprise relation to coal-mining branch in 1998 - 2008 (per 100 000 employees)

## 5.3. Analysis of accident rate in the analysed enterprise in 1998 - 2008

The level of the safety culture is connected with the level of the industrial safety which can be characterized accident rate number. Defining of the causes and the circumstance of industrial accidents is the employer duty, and their analysis is helpful in

direction of preventive workings. These actions are the important element in the process of continuous improvement of the occupational health and safety management.

The analysis of industrial accidents can be carried out in three basic forms which characteristic was presented in Table 1.

Table 1. Kinds of accidents analysis

Kind of analysis	Comparison of quantity	Example
absolute	quantity of specific occurrences	by consequences load
indicatory	occurrences according to specific indicators characterizing analyzed phenomenon	intensity factor dynamics factors
generic	occurrences according to specific criteria	by event occurrence place

**Analysis of absolute accident rate**

The comparison of the number of industrial accidents in the analysed enterprise with division of the consequences load was contained in Table 2.

Table 2. Number of weak, dangerous and fatal accidents in the analysed enterprise in 1998 - 2008

Kind of accident	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
a Fatal accident	0	0	2	4	4	2	0	0	8	0	0
b Dangerous accident	1	2	0	0	3	1	1	0	1	1	1
a+b total	1	2	2	4	7	3	1	0	9	1	1
c Weak accident	95	90	69	42	54	56	79	64	59	68	109
a+b+c total	96	92	71	46	61	59	80	64	68	69	110

In the analysed enterprise weak accidents dominate. The most weak accidents (109) and accidents in general (110) appeared in 2008. The statistics is high because of the group accident (exogenous fire) which occurred in this year.

From the analysis of presented data results, that decrease in the range of fatal accidents in the analysed enterprise after 2002 occurred. The exception is 2006 when during liquidational works the inflammation and the explosion of methane and coal dust occurred. In this group accident died 8 persons of the own personnel and 15 workers of the service company.

**Analysis of indicatory accident rate**

The industrial safety service in the analysed enterprise takes care about information of the workers in the range of industrial

accidents level. The workers have also the access to the information system concerning industrial safety management in the enterprise. It concentrates on the accident rate statistics.

To make possible doing the comparisons of the accident rate condition the indicators of the accidents frequency and the accidents load were established. The indicators of the accidents frequency are the quotient of the number of accidents per characteristic size. Switching off deadly incidents the coefficient of the weight however defines the quantity of the days of sick leave falling on one incident.

The indicator of the accidents load is defined as the number of days with sick leaves per one accident without fatal accidents. The one of indicators illustrating the scale of the accident rate phenomenon is the intensity accidents indicator per 1000 employees  $W_z$  in the defined given reporting period.

$$W_z = \frac{I_w}{Z} \cdot 10^3 \quad (1)$$

where:

$I_w$  – quantity of industrial accidents in the analysed period

$Z$  – total average e

In the analysed enterprise is the similar tendency of this indicator formation as the coal-minings in general (Fig. 7).

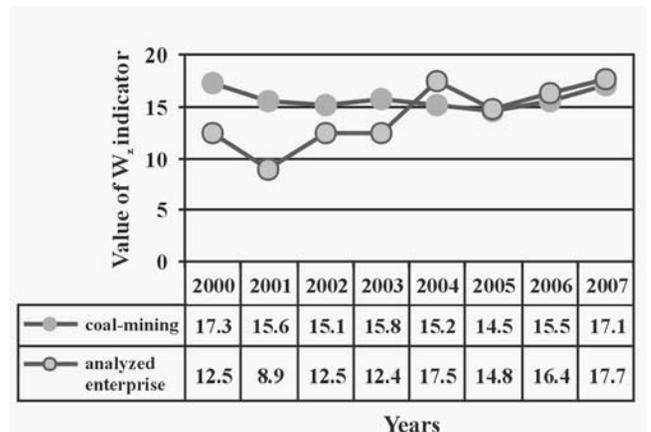


Fig. 7. Indicator of industrial accidents intensity per 1000 employees in the analysed enterprise

**Analysis of generic accident rate**

On the basis of data, relating to accident rate in the analysed enterprise, the Table 3 was elaborated. Correlate in it the data taking into consideration industrial accidents according to the dangerous event causing injury.

In 2008 it was noted more than in recent years different events causing the industrial accidents. 35.5% of all events classified as “the others”, in it 17.3% were caused the fire. Significant part (28%) in the group “other event” is the excessive effort or the harmful movement.

Table 3.  
Statistic of industrial accidents according to occurrences causing injury in the analysed enterprise

Classification according to dangerous occurrence									
Kind of occurrence	2000	2001	2002	2003	2004	2005	2006	2007	2008
Fall of rocks from roof or side wall	7	2	4	8	6	4	7	5	17
Falling, rolling or slide of rocks or the other objects	20	10	14	12	21	19	11	20	10
Contact with machines and devices in the movement (in it with transported object)	14	9	16	10	12	18	10	8	14
Stumbling, slipping or fall of persons (in it from height)	19	15	18	19	24	18	20	25	23
Working tools or objects injury	7	2	1	2	2	1	4	3	7
Other event	4	8	8	8	15	4	16	8	39
Total	71	46	61	59	80	64	68	69	110

#### 5.4. Monitoring of threats and preventive actions

In the analysed enterprise, after the precise analysis of the safety condition techno-organizational actions are projected. The aim of them is industrial accidents prevention. Many preventive activities (connected with threats control: methane, explosion of the coal dust, crump, climatic, substances and dangerous preparations) are written in the organization activity.

All environmental and technical threats are identified by appointed in this aim team, which analyses the existing condition. In the analysed enterprise tend towards to the work conditions improvement with the regard of local conditions, techno – motive documentation, law regulations and with usage of experience and the knowledge of engineering and technical personnel of the coal-mining.

The condition of methane threats with specialist methanometric control rooms is permanently monitored.

The threat of coal dust explosion is monitored through taking the tests of the dust and the coal dust settlement control also.

The coal-mining possesses the system of automatic CO - metric which monitors the fire threat.

The continuous observations of the crump threat condition in the basis of geophysical, seismological and seism acoustic methods are carried out. In the aim of reduction of these threats long-term activities are carried out. They based on the proper mining of these layers.

The climatic threat of work condition is estimated through the value of the air temperature in this place, its humidity and the cooling intensity.

The work in the mining excavation is forbidden when the air temperature measured in this place with dry thermometer exceed 33°C.

The water and radiational threat doesn't occur in the analysed enterprise at present.

The technical threats from the side of machines and devices, installation of the hydraulic filling, devices and demethane piping and others technical objects are monitored through reviews, made in the suitable time by persons responsible for keep of these objects, according to procedures.

The industrial accidents prevention and pursue to the systematic improvement of conditions in the enterprise is connected with high costs intend on prevention. Expenses on safety in the longer perspective of the time provide to the effects in the form:

- decrease of the size of threats on the work positions, decrease of occupational diseases and industrial accidents in the consequence,
- improvement of the comfort and the work conditions;
- increase of the personnel consciousness in the range of the industrial safety,
- improvement of the personnel qualifications.

The assurance of the industrial safety in the analysed enterprise requires e.g. supplying safety equipment, support in the efficiency condition of the collective protection measures, purchase of the personal protection equipment and working clothing, systematic medical examinations, monitoring of the work conditions and many different factors.

The most capital expenditures (56%) coal-mining assigns on monitoring and techno-organizational activities, preventing natural threats (Fig. 8).

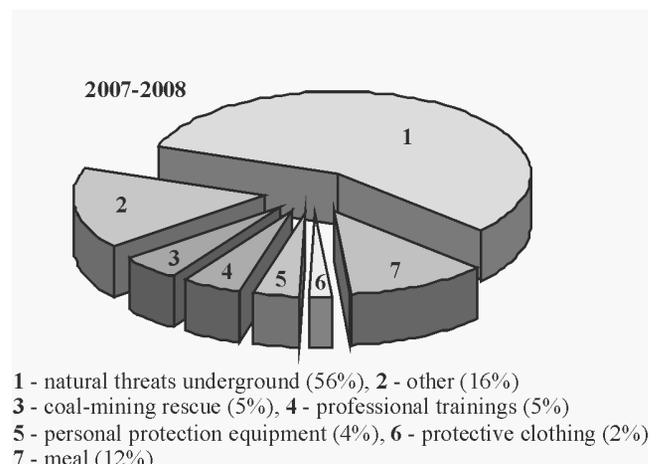


Fig. 8. Structure of assign on the industrial safety in the analysed enterprise

Table 4. Effects of the occupational health and safety management system implementation

Area	Effects after occupational health and safety management system implementation
Documentation	<ul style="list-style-type: none"> <li>• Elaboration of systematic and actualized system documentation (uniform form of procedures, instruction and notions).</li> <li>• Improvement of the information flow among workers and supervision persons as a result of internal computer system which is the effective tool of the information management in the enterprise.</li> </ul>
Competence and consciousness of workers	<ul style="list-style-type: none"> <li>• Improvement of the personnel qualification through specialist courses and trainings.</li> <li>• Usage of multimedia presentations introductions and training films relating to the industrial safety problems.</li> <li>• Active participation of workers in the self-control programme what causes the increase of consciousness and motivation.</li> </ul>
Monitoring	<ul style="list-style-type: none"> <li>• Active and reactive actual monitoring with using modern monitoring and measuring devices.</li> <li>• Systematic safety analysis on the basis of results carried out.</li> </ul>
Safety production	<ul style="list-style-type: none"> <li>• Production cycle is carried out with usage of the complex mechanization works and modern systems supervising the production with natural threats monitoring.</li> </ul>
Prophylaxis of threats	<ul style="list-style-type: none"> <li>• Financial, technical and organizational means assignment for continuous improvement of the work conditions and the safety assurance in the organization.</li> <li>• Appointment of teams investigating the threats which received the proper range of duties adequate to the kind of monitored threats.</li> <li>• Permanent control of the chemical composition of the coal-mining air, humidity and cooling intensity carrying out.</li> <li>• Actual seismological and seism acoustic observation using.</li> <li>• Systematic increase of expenditures on the elimination and the limitation of threats: methane, explosion of the coal dust, fire, crump, fall of roofs and others are noted.</li> </ul>
Occupational diseases	<ul style="list-style-type: none"> <li>• Decrease of the persons number who are employees in the harmful, burdensome conditions and in the conditions of the mechanical threat.</li> <li>• Effective detectability of falling ills on pneumoconiosis in the early stage of the disease among active professionally miners.</li> <li>• Decrease of the average size of proportional ed by occupational diseases.</li> </ul>
Industrial accidents	<ul style="list-style-type: none"> <li>• Decrease of the fatal and dangerous accident rate (except of the 2006).</li> <li>• Decrease of the accidents load indicator with decrease of the proportional health impairment caused by the industrial accidents.</li> </ul>
Enterprise image	<ul style="list-style-type: none"> <li>• Consolidation of the positive image of the enterprise among actual consumers and contractors.</li> <li>• Increase of the competitiveness on the energy resources market through the improvement of the hygienic conditions and the quality assurance of the product and processes.</li> </ul>

In the analysed enterprise preventive actions relating to putting new places and work positions into operation are also carried out. It makes possible improvement of conditions on the work positions of the employees (fig. 9).



Fig. 9. Stages of the new safety work position creation

### 5.5. Effects of the occupational health and safety management system implementation

On the basis of organization functioning results analysis according to safety and work conditions improvement it was found that owing to preventive techno-organizational actions and continuous improvement of the management system the enterprise achieved many advantages (Table 4).

## 6. Conclusions

Implementation of the occupational health and safety management system brought the enterprise many advantages. However, the areas exist which require improvement or threats analysis and occupational risk assessment carried out again. Systematic monitoring and prevention are assumptions of a model of the management system based on continuous improvement idea. Increase or hesitations of the disease indicators and accident rate should be signal for the enterprise to designing of new techno-organizational solutions to the industrial safety improvement. For the sake of specific character of the analysed enterprise every improvement of the safety conditions should be treated in success category.

## References

- [1] M. Spilka, A. Kania, R. Nowosielski, Integration of management systems on the chosen example, Journal of Achievements in Materials and Manufacturing Engineering 35/2 2009 204-210.
- [2] R. Nowosielski, M. Spilka, A. Kania, EMS as a basis of sustainable technological process achievement, Journal of Achievements in Materials and Manufacturing Engineering 29/2 (2008) 199-206.

- [3] D. Szewieczek, T. Karkoszka, Integrated method of technological processes estimation in materials engineering, *Journal of Achievements in Materials and Manufacturing Engineering* 24/1 (2007) 456-465.
- [4] M. Dudek-Burlikowska, D. Szewieczek, The Poka-Yoke method as an improving quality tool of operations in the process, *Journal of Achievements in Materials and Manufacturing Engineering* 36/1 (2009) 95-102.
- [5] T. Lis, K. Nowacki, Occupational health and safety management in industrial plant, Silesian University of Technology Publishers, Gliwice, 2005 (in Polish).
- [6] A. Tabor, A. Pieczonka, Occupational health and safety management, University of Technology of Cracow, Cracow, 2003 (in Polish).
- [7] W. Zawieski, Occupational risk evaluation, CIOP Publishers, Warsaw, 2004 (in Polish).
- [8] D. Smoliński, Occupational risk evaluation: procedures, documentation formula and examples of calculations, Centre of Consulting and Personnel Improvement, Gdansk, 2003 (in Polish).
- [9] J. Szlązak, N. Szlązak, Occupational health and safety, AGH Publishers, Cracow, 2005 (in Polish).
- [10] A.R. Albuquerque, J.B. Kliewer, I.P. de Arruda Campos, C. Studziński, M. Kliewer, Risk evaluation supported by annotated paraconsistent logic: a study of a vehicle manufacturer, *Journal of Achievements in Materials and Manufacturing Engineering* 32/1 (2009) 81-91.
- [11] J. Łunarski, Industrial safety management systems in enterprise, University of Technology of Rzeszow, Rzeszow, 2006 (in Polish).
- [12] PN-N-18001. Occupational health and safety management systems. Requirements, PKN, Warsaw, 2004 (in Polish).
- [13] Marcinkiewicz, Duties of assurance of healthy and safety work conditions: guide for employers, Elamed Publishers, Katowice, 2007 (in Polish).
- [14] A. Tabor, M. Rączka, A. Pieczonka, Occupational health and safety management. Vol. 4. Implementation and certification of occupational health and safety management system according to OHSAS 18001 and PN-N-18001, University of Technology of Cracow, Cracow, 2003 (in Polish).
- [15] R.B. Ward, The management of accidents, *Journal of Achievements in Materials and Manufacturing Engineering* 32/1 (2009) 75-80.