# Risk assessment of the complex harmful factors

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Abstract
The article presents data on the intensity of the action of harmful physical factors and the nature of work for a number of trade workers of Kryvbass mines. The issues of equivalence action of harmful factors when comparing the intensity of the action of different indicators, which are presented in absolute terms (times) and in relative terms (dB dBA; dBV) are considered. Risk assessment from harmful factors is based on the analysis of data on the magnitude of excess quantities of maximum permissible values for the main professions in underground mineral production. It was held the study of data on the occurrence of diseases from exposure to dust and noise considering the intensity of their performance and length of service. The reduced excess for these hazards is in the range R (I) of 0.2 to 0.8. This technique makes it possible to establish safe work (years) for the main professions of workers in underground mining, and develop the proposals for continued professional and general life expectancy for workers in the most harmful factors conditions. This will increase the level of professional health of workers and, consequently, reduce occupational diseases in mines.
Key words: PROBABILITI OF OCCUPATIONAL DISEASES, BASIC HARMFUL FACTOR, RISK OF OCCUPATIONAL DISEASE

**Relevance**

Expansion of industrial production and its intensification requires development of methods for objective assessment of their impact on workers, both during their career and after.

These works on developing methods of risk assessment of methodologies include FMEA and RPS methodology [1], but these techniques relate to the subjective ones and require involvement of a large number of professionals in different industries, developing methodologies for evaluating of expert opinion. Usage of concept of probability and its expression in points conflicts with the definition adopted in this safety classification and used in public works and theory of probability.

**Publications and investigation analysis**

Thus, according to FMEA methodology, which refers to the subjective methods of risk evaluation in the system of safety control (SSC), it is calculated via priority degree (PD) as:

$$PD = З \cdot О \cdot Д,$$

where З - seriousness of consequences from harmful factors, point; О - likelihood of the risk, point; Д - ability to detect and respond to a situation, point.

Depending on the value of PD risks are classified by level of importance on low (PD=1÷50), limit (R=51÷100) and unacceptable (PD > 151).

According to RPS techniques risk assessment is carried out by the expression:

$$R = P \cdot S,$$

where R – risk, point; P - probability of harmful effects of factors, point; S - severity of consequences from harmful factors, point.

If there are statistics data, probability P is determined through the number of cases over time. Based on the values of R and S risk is classified into low R (R<6), moderate (R 6÷12) and significant (R>12).

According to point assessment method which includes assessment of basic risk and residual risk assessment, risk assessment is performed by the expression [2]:

$$P = B \cdot \Pi \cdot B_p,$$

where R - the risk value; B - consequences of severity; Π - duration of exposure of risk assessment; $B_p$ - assessment of the likelihood of danger.

Valuing risk assessment is classified into insignificant P (P≤100), low (100<P≤ 1000), medium (1000<P≤2000), high (2000<P≤4000), very high (P>4000).

**Problem statement**

Since the risk assessment for existing industries and risk assessment methods are subjective methods, it is necessary to conduct a research that would allow more objective assess of risks from harmful factors.

**The material presentation**

Risk assessment from harmful factors is based on the analysis of data on the magnitude of excess quantities of the maximum permissible values for the main professions in the underground mineral production. Such analysis is made on the basis of job evaluation of the conditions and nature of work in Kryvyi Rih mines and mines "Nova", city of Zhovti Vody. Measurements are conducted by a sanitary laboratory of Research Institute SRISL KNU [3]. The results of processing of the data are presented in Table 1.

The data presented in tabl.1 show that the most harmful factors which, when integrated actions cause the greatest risk of occupational diseases include: fibrogenic action dust, noise, vibration heavy load (transfer of overweight subjects).

The analysis shows that the excess of fibrogenic action dust of valid values are within 1,5÷8 times, noise - 6÷8 times, vibration - 1,5÷3,0 times, the severity of labor - 1,1÷1,9 time. Increasing action of a number of these factors is also due to stress, as a risk factor for their own lives and in which the humidity exceeding 1,05÷1,3 times more [4-5] of permissible.

To be able to assess the intensity of various factors, the values of which are presented in absolute terms (times) and in relative terms (dB) it is completed the transfer (dB) at times based on their compliance with safety classification according to the working conditions and the introduction of weighting coefficients based on the ratio of the incidence of fibrogenic dust action as basic harmful factor and other hazards.

Data for equivalence action of harmful factors in determining the intensity in dB and times are presented in Table. 2

Based on the data, presented in Table 2 and taking into account the data of the relationship between the number of employees who have occupational diseas-

**Table 1.** Excess of hazards (in times) in the workplaces in underground conditions

| № | Workplace | Hazards factors | | | | |
|---|---|---|---|---|---|---|
| | | Dust | Noise | Vibration | Severity | Humidity |
| 1 | Shaftman | 4÷6 | 6÷8 | 1,5÷2,0 | 1,2÷1,7 | 1,1÷1,2 |
| 2 | Driller | 3÷4 | 6÷8 | 2,0÷3,0 | 1,5÷1,7 | 1,2÷1,25 |
| 3 | Underground miner | 1,5÷2,5 | 5÷6 | - | 1,2÷1,3 | 1,16÷1,2 |
| 4 | Blaster | 2÷6 | 1,5÷2 | - | 1,2÷1,3 | 1,05÷1,13 |
| 5 | Timber man | 2÷3 | 6÷8 | - | 1,2÷1,9 | 1,05÷1,2 |
| 6 | Chute drawer | 1,5÷2 | 5÷6 | - | 1,1÷1,8 | 1,1÷1,13 |
| 7 | Drill runner | 4÷6 | 5÷6 | 1,5÷2,0 | 1,1÷1,2 | 1,2÷1,22 |
| 8 | Lorry-load runner | 1,5÷2,5 | 5÷6 | 2,0÷3,0 | - | 1,0÷1,10 |
| 9 | Locomotive operator | 1,5÷2,5 | 4÷5 | 1,5÷2,0 | - | 1,03÷1,2 |

**Table 2.** Order of the correspondence between the definition of intensity of harmful factors in times and dB

| | The degree of harmful factors | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 3.1 | 3.2 | 3.3 | 3.3 | 3.4 | 3.4 | 3.4 | 4 |
| Levels of noise pressure, dB | 80,1÷85 | 85,1÷90 | 90,1÷95 | 95,1÷100 | 100,1÷105 | 105,1÷110 | 110,1÷115 | >115 |
| Fibrogenic dust action, times | 1,1÷2,0 | 2,1÷4 | 4,1÷6 | 6,1÷8,0 | 8,1÷10 | 10,1÷12 | 12,1÷14 | >14 |
| Intensity, dB | 0,1÷5 | 5,1÷10 | 10,1÷15 | 15,1÷20 | 20,1÷25 | 25,1÷30 | 30,1÷35 | >35 |
| Weight coefficient 0,73 | 0,08÷1,45 | 1,46÷3,0 | 3,1÷4,4 | 4,5÷5,8 | 5,9÷7,3 | 7,4÷8,8 | 8,9÷10 | >10 |
| Intensity, dB | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 |
| Intensity, dB, times | 1 | 1,45 | 3,0 | 4,4 | 5,8 | 7,3 | 8,8 | 10 |

es from exposure to complex fibrogenic dust, noise, vibration, gravity works presented one of the indicators of risk of occupational diseases as:

$$I = k \cdot I_1 + \sum (\kappa_i \cdot I_i) / n$$

where I - intensity of existing harmful factors, times; k=1 - weight for the most harmful factors; $I_1$ - the value of the excess over critical allowable rate of the most harmful factors, times; $K_1$ - weights of harmful factors that increase the dangers of the main factors; $I_i$ - intensity of additional harmful factors (times); n - number of additional factors.

The value of weighting coefficients $k_i$ is obtained by studying data on the incidence of workers who work in underground conditions for different periods of time - from 25 to 10 years.

It was held the study of data on the occurrence of diseases from exposure to dust and noise considering the intensity of their performance and length of service. The reduced excess for these hazards is in the range R (*I*) of 0.2 to 0.8.

The value of increasing the likelihood of disease due to the actions of other increasing action of hazards presented as:

$$\Delta P (I) = 0{,}1 \cdot \Delta I \cdot tg\ \acute{\alpha}$$

where the angle ά - determined with taking into account the average value of the intensity of the complex action of harmful factors.

Graph for the determination of ΔR (*I*) are shown in Fig. 1.

Data on weights $K_i$ for a number of professions such as shaft man, driller, underground miner, blaster, timber man, chute drawer are shown in Table 3.

In the case of fibrogenic dust action as a basic harmful factors in the complex and increasing of main

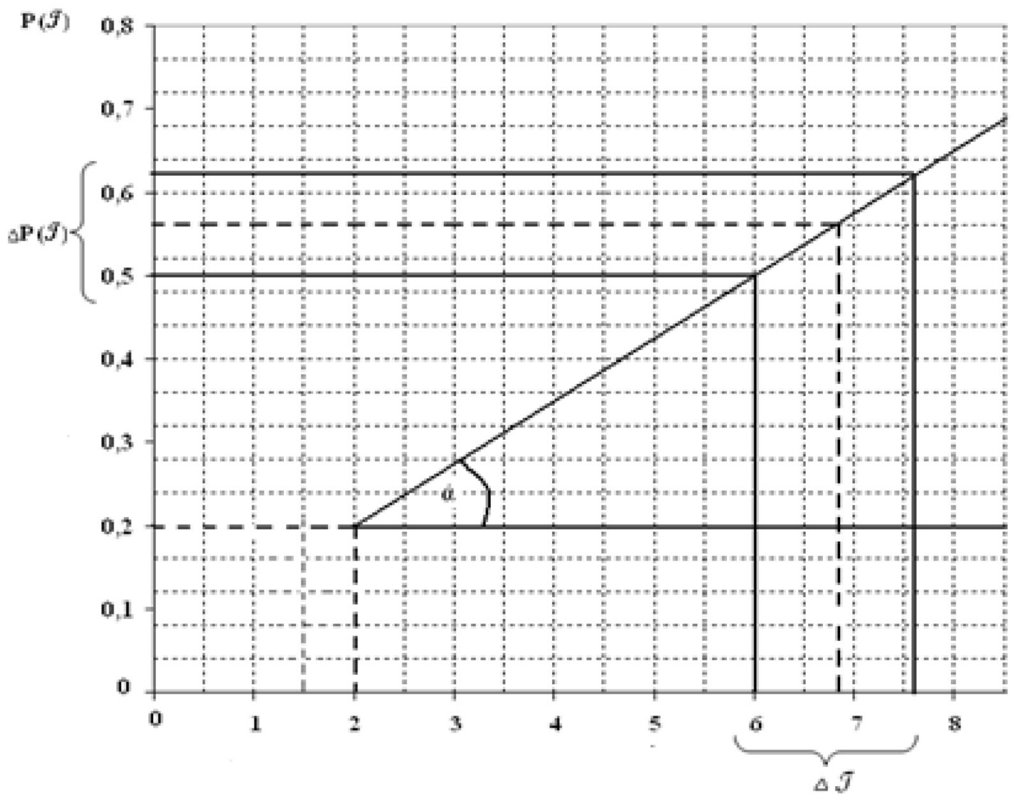


**Figure 1.** Graph to determine ΔR (*I*) for different professions at the installed angle ά on the medium growth intensity Δ I of the complex action of harmful factors

**Table 3.** Determination K and $K_i$ coefficients

| Professional disease | Number of sick | | Harmful factors | Weight coefficients К; К$_i$ |
|---|---|---|---|---|
| Dust disease | 627 | ∑2389 | fibrogenic dust action | 1,0 |
| Chronically dust bronchitis | 1762 | | | |
| Musculoskeletal system disorders | 1297 | | noise | 0,54 |
| Cochlear neuritis | 1211 | | vibration | 0,51 |
| pneumatic hammer disease | 801 | | heaviness moisture | 0,34 |

factors taken K = 1 and $K_i$ dust it is as proportional to the relative number of diseases as exposure to dust.

Calculated values I for maximum parameters of harmful factors are presented in Table 4.

**Table 4.** Determination of the intensity I factors

| № | Work place | Dust, m | Noise, vibration, heaviness, moisture, $m_i$ | I |
|---|---|---|---|---|
| | | $I_1$ | Δ I | $I_2$ |
| 1 | Shaftman | 6,0 | 1,60 | 7,60 |
| 2 | Driller | 4,0 | 1,67 | 5,67 |
| 3 | Underground miner | 2,5 | 1,54 | 3,04 |
| 4 | Blasters | 6,0 | 0,84 | 6,84 |
| 5 | Timber man | 3,0 | 1,91 | 4,91 |
| 6 | Chute drawer | 2,0 | 1,55 | 3,55 |
| 7 | Drill runner | 6,0 | 1,26 | 7,26 |
| 8 | Lorry-load runner | 2,5 | 1,56 | 4,06 |
| 9 | Locomotive operator | 2,5 | 1,29 | 3,79 |

In order to use one of the risk indicators I (intensity of harmful factors) data on the probability of disease from exposure to certain harmful factors are reviewed. Using formula (5) it is estimated Δ I and I, for determining the value of ΔR (I), Table. 5.

**Table 5.** Determination of increasing likelihood of disease from the effects of additional harmful factors

| Profession | $I_1$ | ΔI | $I_2$ | $P_1(I)$ | ΔP (I) | $P_2(I)$ | tg ά |
|---|---|---|---|---|---|---|---|
| Shaftman | 6,0 | 1,10 | 7,60 | 0,45 | 0,20 | 0,65 | 69 |
| Driller | 4,0 | 1,67 | 5,67 | 0,25 | 0,20 | 0,45 | 56 |
| Underground miner | 2,5 | 1,54 | 3,04 | 0,12 | 0,09 | 0,21 | 57 |
| Blast er | 6,0 | 0,84 | 6,84 | 0,45 | 0,06 | 0,51 | 88 |
| Timber man | 3,0 | 1,90 | 4,90 | 0,15 | 0,17 | 0,32 | 47 |
| Chute drawer | 2,0 | 1,55 | 3,55 | 0,10 | 0,08 | 0,18 | 56 |

**Conclusions**

This technique makes it possible to establish a safe work (years) for the main professions of workers in underground mining, and develop the proposals for continued professional and general life expectancy for workers in the most harmful factors conditions. This will increase the level of professional health of workers and, consequently, reduce occupational diseases in mines.

**References**

1. Methodical recommendations. Labor protection management system. Procedure of risk assessment in the field of labor. Minsk, 2012
2. Public Joint Stock Company “Uzhnyi Gorno-obogatitelnyi Combinat”. Procedure of the risk assessment. Krivoy Rog POT 0200 -2011
3. Job evaluation of working conditions. Approved by the Cabinet of Ministers from August 1, 1992 , №442
4. The safety classification of work on indicators of harmful and dangerous environment factors, severity and intensity of the work process # 528 as of 27.12.2001 y.
5. Krivoy Rog ResearchInstitute of Hygiene and Occupational Diseases. Professional occupational mobility of workers mettalurgical industry of USSR for 1984-1988. Krivoy Rog, 1990, 75p.
6. Krivoy Rog Research Institute of Hygiene and Occupational Diseases. Analysis of occupational mobility in Dnepropetrovsk region as of 1989 and recommendations for prevention. Krivoy Rog, 1990, 56 p.
7. Ukrainian Research Institute of Industrial Medicine. Collection of statistical data on the occupational mobility of workers of metallurgical complex of Ukraine. Ministry of Industry for the years 1991-1995. Krivoy Rog - 1996 – 79p.