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Hazards and occupational risk for the workplace of mine rescuer

Zagrożenia i ryzyko zawodowe na stanowisku ratownika górniczego

Abstract

This publication concerns the problems of occupational safety and health in hard coal mines, the basic elements of which are occupational risk and mine hazards. The paper constitutes an analysis of general, industry-specific and detailed requirements encompassing selected legal regulations and guidelines indicated in professional literature pertaining to occupational risk assessment. The elaboration contains the authors' proposal of requirements regarding occupational risk assessment for the workplace of mine rescuer, which includes the workplace description as a research object and the selection of rules and methods of risk assessment.

Key words: *occupational safety and health, occupational risk, mine hazards, mine rescuer, hard coal mines*

Streszczenie

Publikacja dotyczy problematyki bezpieczeństwa i higieny pracy w górnictwie węgla kamiennego, której podstawowymi elementami są ryzyko zawodowe i zagrożenia górnicze. Praca stanowi analizę wymagań ogólnych, branżowych i szczegółowych, które obejmują wybrane przepisy prawne i wytyczne literaturowe dotyczące oceny ryzyka zawodowego. Opracowanie zawiera autorską propozycję wymagań dotyczących oceny ryzyka zawodowego na stanowisku pracy ratownika górniczego, która obejmuje opis stanowiska pracy jako obiektu badań oraz dobór zasad i metod oceny ryzyka.

Słowa kluczowe: *bezpieczeństwo i higiena pracy, ryzyko zawodowe, zagrożenia górnicze, ratownik górniczy, kopalnie węgla kamiennego*

Introduction

Mine rescue is an integral part of the national internal safety organization in the scope of providing aid in hazard situations relating to people or mining plant operations. It is also an element of the technical and industrial rescue system functioning within the National Emergency and Fire System (KSR-G).

The current requirements concerning occupational risk assessment in mine rescue may be classified based on various criteria. When it comes to the specifics of workplace of mine rescuer in hard coal mines, these criteria include i.a.:

- legal requirements – resulting from the analysis of the specified legal basis, which contains general provisions (act [1] and executive acts such as

the ordinances [2, 3, 4]), industry-specific provisions for mining and mine rescue (act [5] and executive acts, e.g. the ordinances [6, 7,8]), the provisions regarding the service in the State Fire Service (act [9] and ordinances [10, 11, 12]), as well as detailed provisions pertaining to selected work processes and hazards (e.g. act [13] and ordinances [14, 15, 16, 17]);

- guidelines indicated in professional literature – resulting from the analysis of specific publications, that have general applications irrespective of the business type (e.g. Koradecka et al. [18], Zawieska et al. [19], Romanowska-Słomka and Słomka [20], Krause and Romanowska-Słomka [21], Krause [22, 23]) or industry specific and detailed applications dependent on the business type, work processes and hazards (e.g. Szlązak J. and Szlązak N. [24, 25], Konopkoet al. [26, 27], Krause [28], Grodzicka [29]).

Also the mining plants' internal provisions concerning mine rescue should be considered, along with the provisions of mine rescue services of the entrepreneur and entities professionally engaged in mine rescue, especially the guidelines of the Central Mine Rescue Station in Bytom (CSRG).

One should also consider the guidelines provided in technical standards, especially the PN-N-18002:2011 [30] standard, which is currently the most quoted source of rules for the organization of occupational risk assessment, including the problems of acquiring of required information, hazard identification, risk estimation and determination of risk acceptability.

The binding legal acts do not directly provide the methods of occupational risk assessment, including the rules of selecting these methods, but they do contain provisions for different type of work processes, special risk groups as well as groups and types of hazards.

To develop the requirements regarding the methods of occupational risk assessment, basic theoretical and methodological problems must be solved. These include i.a. the selection of research assumptions for the identification of research subject and the selection of research methods.

The basic assumptions concerning occupational risk assessment in mine rescue as exemplified by the hazards occurring in hard coal mining may be arbitrarily divided i.a. into two groups of criteria encompassing the description of the workplace as the research object and the selection of rules and methods of occupational risk assessment.

Workplace description as the research object

This part of the paper presents an analysis of the requirements concerning the methodology of occupational risk assessment pertaining to the identification of workplace as the research object, i.a. with respect to the work process, working conditions and work organization.

In documenting the occupational risk assessment, the description of the workplace is the key element. It should encompass i.a. detailed information required to identify hazards, estimate the risk level and to determine the risk acceptability.

The description of the workplace in view of occupational risk assessment should contain i.a. detailed information on the work measures and objects, work processes and hazards, collective and individual protective measures and persons working at the workplace [2].

The characteristics of specifics of workplaces in mine rescue in hard coal mines should consider the following criteria:

- general criteria including i.a.: the purpose and the structure of rescue service, type of professional qualifications, authorization to take up or perform the work, physical and mental fitness for the work, type of qualifications required for the service, type of work process in rescue service, type of work process in view of the health or life hazard conditions, type of work process in view of work organization, employment structure in the plant, structure of people exposed in view of special risk groups, changes in the conditions of work performance, changes in the locations of work performance, type of hazard in the working environment;
- industry-dependent criteria – detailed and internal (e.g. Factory Mine Rescue Station – KSRG and Central Mine Rescue Station – CSRG), including i.a.: the purpose and the subject of mine rescue, the organizational structure of the rescue team, employment structure in the rescue team, physical and mental fitness for work in an underground mining plant, qualifications in mining and mine rescue, physical and mental fitness for working in mine rescue, type of work process in mine rescue, type of natural hazard, type of mining hazard, type of specialized emergency service, type of rescue operation.

The criterion of the purpose of the rescue service encompasses i.a. the division into providing emergency first aid, fighting fires and evacuating employees.

The criterion of the structure of the rescue service specifies the number of employees appointed for activities consisting in providing emergency first aid, fighting fires and evacuating employees as well as training and equipping them. These factors should be adjusted to the type and scope of the conducted activity, the number of employees and other persons staying at the premises of the plant as well as the type and level of hazards.

The criterion of the type of professional qualifications encompasses professional training and experience and concerns i.a. the education or abilities (schools, studies, courses, trainings) and period of service (e.g. general, in the industry or at the workplace).

The criterion of authorization to take up or perform the work specifies i.a. the required qualifications or necessary abilities, the physical and mental fitness for the job (based on initial, periodical and test medical examinations), training regarding the provisions and rules of occupational safety and health (based on the initial and periodical trainings).

The criterion of the physical and mental fitness for work – in case of a job requiring special mental and physical fitness – encompasses i.a. the following requirements: age, sex, medical examinations, psychological examinations.

The criterion of the type of qualifications required for performing the service – based on the example of the State Fire Service – provides for i.a. the following requirements: education, physical fitness test, interview, physical and mental fitness for performing the service, preferences due to education, training or abilities.

The criterion of the type of the work process in rescue service – based on an example of the State Fire Service firefighter – encompasses the following professional duties: control and identification activities, rescue operations, exercises, trainings, duty hours.

The criterion of the type of the work process in view of health and life hazard conditions provides for i.a. the following classifications: work in occupational safety and health conditions (where OHS provisions and rules are fulfilled), work in health hazard conditions (e.g. work in special conditions, work in environments with exceeded allowable concentrations and intensities of factors harmful to health), work in life hazard conditions (e.g. special work, work requiring special physical and mental fitness), or work in direct health and life hazard conditions (e.g. especially hazardous work, work where the OHS provisions and rules are not fulfilled).

The criterion of the type of the process in view of the work organization encompasses i.a. the division into individual or collective workplace (work performed by one or several employees, workers) and a single or multi-profession workplace (one or several professions, specializations, qualifications required).

The criterion of the employment structure in the plant specifies i.a. the classification based on: the employment method (employee working based on an employment agreement or a worker working on another basis), the prevalence of physical or mental effort (e.g. blue and white collar workplaces).

The criterion of the structure of people exposed in view of special risk groups encompasses i.a. the division depending on: sex (men and women, including pregnant women and breastfeeding women), age (juveniles, young persons, adults and elderly persons), experience (e.g. inexperienced and experienced persons), propensity to take up risk (e.g. persons hedging risk, persons taking up risk, persons not expressing excessive risk aversion and propensity).

The criterion of change in the conditions of work performance includes i.a. the classification of the workplace as a workplace with stable conditions (where several similar works, activities are being performed in view of hazards and risk level) or as a workplace with variable working conditions (workplace with several different works, activities in view of hazards and risk level).

The criterion of change in the locations of work performance provides for i.a. the division into a stationary workplace (a workplace with a fixed location in which the work is performed and operation at a single workplace) and a non-stationary workplace (a workplace with a changing location in which the work is performed or operation at several workplaces).

The criterion of the type of hazard in the working environment provides for i.a. the classification based on: causes of the activity (physical, chemical, biological and psychophysical factors, e.g. physical effort), consequences of the

activity (dangerous, harmful to health and burdensome factors), measurement possibilities (measurable and non-measurable factors).

The criterion of the purpose of mine rescue provides for the division into immediate aid in case of life or health hazard of persons staying in the mining plant, safety of the mining plant operations or public safety and performing preventive works that aims to prevent an immediate threat to the safety of persons or the mining plant operations.

The criterion of the subject of mine rescue provides for a division into mine rescue services of the entrepreneur and entities professionally engaged in mine rescue (including entities fulfilling the requirements of rescue unit).

The criterion of the organizational structure of the rescue team encompasses the division into the following units: rescue brigades (for the mine rescue service of the entrepreneur), rescue brigades and specialized emergency services (for the rescue unit), rescue brigades on duty, professional specialized emergency services and rescue brigades on duty for groups of mining plants (for an entity professionally engaged in mine rescue).

Within a mining plant, specialized rescue brigades may be organized to perform activities requiring special abilities during rescue operations and preventive works, while in an underground mining plant, specialized rescue service may be established for conducting rescue operations and preventive works requiring special techniques, such as industrial rope access or diving.

The criterion of employment structure within a rescue team determines the number of team members and the composition thereof, considering the types of hazards occurring in the mining plant, including natural hazards, where the type and the risk level is dependent on the type of the mining plant, the type of the mined mineral as well as the frequency of the hazards and their locations.

The number of mine rescuers in rescue team of underground mining plant is dependent on the number of persons present underground during a day and is determined separately for each of the mining plant operations.

The criterion of physical and mental fitness for work in an underground mining plant encompasses i.a. the following requirements: age, medical examinations, psychological examinations.

The criterion of qualifications in mining and mine rescue provides for the required professional education and experience and concerns i.a. the persons performing the following duties: mining plant maintenance manager and deputy manager, maintenance division's manager and deputy manager, higher-level supervisors, supervisors of the underground mining plant operations, mining surveyor, mining geologist, mining geophysicist in an underground mining plant, management of entities professionally engaged in mine rescue, specialized services of a mining plant operations.

The criterion of physical and mental fitness for work of mine rescue encompasses the following requirements [8]: age, specialized medical examination (qualifying examinations for candidates for mine rescuers, initial examinations, periodical and test examinations for mine rescuers), specialized psychological examinations (qualifying examinations for candidates, initial and periodical

examinations for mine rescuers).

The criterion of qualifications in mine rescue provides for the following requirements [8]: experience, specialized trainings in mine rescue (including a course for candidates for mine rescuers, periodical course for mine rescuers, a course for mine rescuers of specialized rescue brigades), rescue exercises (including periodical control exercises).

The criterion of the type of work process in mine rescue, as exemplified by the workplace of mine rescuer, provides for the following professional duties [8]: rescue operations, preventive works, rescue exercises, duty hours (rescue emergency service), specialized courses and trainings.

The criterion of the type of natural hazards occurring in hard coal mines provides the following classification [6] (including hazard levels, categories and classes): rock burst hazard, methane hazard, gas and rock breakouts, coal dust explosions, climatic hazard, water hazard and radiation hazard.

The criterion of the type of natural hazards in hard coal mines encompasses i.a. the division based on the spheres (lithospheric and atmospheric hazards) and the likelihood of causing a disaster (hazards that might or might not cause a disaster).

The criterion of the type of mining hazard in hard coal mines provides i.a. a classification based on the sphere (lithospheric, atmospheric and technospheric hazards) as well as the causes of the activity (physical, chemical, biological and psychophysical hazards as well as mining-specific hazards including natural, mechanical, electric and blasting-related hazards).

The criterion of the type of the professional specialized emergency service in rescue unit in mining plants provides for the following division into emergency services in underground mining plants: measurement service, mine air inertization service, firefighting service, mining-technical service, water service, mobile rescue winch service.

The criterion of the type of rescue operation in view of the types of the hazards in underground mining plants provides for the following classification [8]: rescue operation in case of underground fires in non-methane fields, rescue operation in case of underground fires in methane fields, rescue operation conducted in difficult microclimate conditions, rescue operation conducted in a situation where several hazards co-occur, rescue operation conducted in conditions of power and mechanical failures, rescue operation conducted in cases of water inflow, floodings and formation of sinks, rescue operation in case of rock bursts and fall of rocks into the workings, rescue operation in case of gas inflow into the workings as well as in case of gas and coal dust explosions and gas and rock breakouts.

The criterion of the type of the rescue operation in hard coal mines provides for i.a. the division depending on the used rescue equipment (fire fighting operation, operation in case of fall of rocks with and without the use of self-rescuers) as well as depending on the participation of the victims (rescue operation with and without the participation of the victims).

The selection of rules and methods for occupational risk assessment

This part of the paper analyses the requirements concerning the methodology of occupational risk assessment pertaining to the selection of rules and research methods that is, i.a. the acquisition of data, the identification of hazards, the estimation of risk and the determination of risk acceptability.

The criteria for the selection of occupational risk assessment methods in mine rescue should give consideration i.a. to the following classification of research methods:

- the basic criterion – the type of the stage of occupational risk assessment (methods of data acquisition, hazard identification and risk estimation);
- auxiliary criteria – the precision of occupational risk assessment (basic methods, auxiliary methods and advanced methods) and the type of data and information (qualitative, quantitative and mixed methods).

The procedure of selecting the strategy of occupational risk assessment in mine rescue should encompass i.a. the following stages:

- the selection of the initial, detailed or advanced type of assessment;
- the application of comparative analysis of the risk assessment results;
- ensuring the participation of hazards and risk assessment specialists;
- the use of group decisions or an expert opinion survey.

The decision-making strategy for the occupational risk assessment in mine rescue should encompass i.a. the following rules of conduct:

- group (team) decisions are advised – risk assessment is conducted by a risk assessment team, usually based on a decision made commonly by the members of the team;
- an expert opinion survey is also advised – the risk assessment is conducted by a team of specialists (experts), based on selected survey techniques;
- individual decisions are not advised – individual assessments, usually based on the knowledge and experience of the decision-maker.

For the assessment of occupational risk, occupational risk assessment teams should be established, including i.a.:

- a person managing employees (as a chairman);
- an occupational safety and health service employee (as a coordinator);
- employees and/or their representatives, e.g. experienced rescue team members;
- experts – in case of high risk works, e.g. occupational physician, mining hazards expert and occupational risk assessment expert.

The procedure of the improvement of the occupational risk assessment in mine rescue should encompass i.a. the following stages:

- the general assessment – the determination of legal requirements and guidelines indicated in professional literature, aimed at the development of basic assumptions for the occupational risk assessment;
- the detailed assessment – the adaptation of the assumptions to the working conditions, aimed at the development of an example of the occupa-

tional risk assessment documentation for a given workplace;

- the practical assessment – the verification of the results of the occupational risk assessment, aimed at comparing the hazards and risk with the current working conditions at a workplace.

Selected methods of data acquisition that may be used for occupational risk assessment in mine rescue include i.a.:

- document analysis method – indirect and direct method of data acquisition including the description and interpretation of a broad set of documents. The analysis encompasses events and behaviours, the sources of data encompass all proofs of facts and events including i.a. the qualitative, quantitative and formal analyses;
- observation method – a direct method of data acquisition providing for intended, planned and systematic perception, collection and analysis of facts, phenomena or processes. The analysis should concern behaviours and events, e.g. risky behaviours, including i.a. direct and indirect observations, open and covert observations as well as standardized and non-standardized observations;
- survey method – an indirect data acquisition method encompassing the collection of information and surveying of opinions based on questions asked by interviewers to respondents by means of questionnaires. The analysis should concern behaviours and events, e.g. an indirect survey (questionnaire and interview) and a direct survey (brainstorm and experts' assessment);
- case study method – an indirect data acquisition method encompassing a detailed study of a complex phenomenon in its actual context, e.g. a single event or person. The analysis concerns events and behaviours, e.g. an occupational accident (fatal, severe or group), the sources of information include i.a. document analyses, observations and surveys;
- checklists – a direct method of data acquisition, consisting in the comparison of the current and the perfect conditions using verifying questions and identification of discrepancies. The analysis concerns events and behaviours, e.g. ergonomics checklists; sources of data include i.a. observation, surveys and document analysis;
- other data acquisition methods including work study methods encompassing i.a. the work valuation and standardization methods (including techniques for the observation and measurement of time of work), e.g. chronometric measurements, photographing the working day, snapshot surveys and methods-time measurements (MTM method, several versions).

Selected methods of identifying hazards that may be used for occupational risk assessment in mine rescue include i.a.:

- checklists (CL) – an inductive, qualitative or quantitative method, sets of questions or procedures developed based on provisions, norms and standards, serving the verification of the actual condition against the desired state, usually by applying “yes” or “no” answers;

- TOL systematics – a deductive, qualitative or quantitative method, a systematic approach in the analysis of accidents and events potentially resulting in accidents. It is based on the study of the causes of such events in view of the working conditions (T), work organization (O) and the human behaviour (L);
- SCAT method (Systematic Cause Analysis Technique) – a deductive, qualitative or quantitative method, a systematic approach in the analysis of accidents and events potentially resulting in accidents. It is based on the study of direct and indirect causes of such events at five analysis levels;
- what-if analysis (WI) – an inductive, qualitative or quantitative method; sets of questions starting with the words “what would happen if...” – a logical sequence of possible responses of the object (such as a machine or human) to the initiating event is determined;
- JSA method (Job Safety Analysis) – an inductive, qualitative or quantitative method, a systematic approach in the analysis of hazards related to the performed tasks; potential hazards related to the performed activities are determined;
- HRA method (Human Reliability Analysis) – a systematic approach in the analysis of human errors and the human reliability, encompassing a group of inductive, qualitative and quantitative methods including i.a. THERP, HEART, HCR, TESEO and SLIM;
- ETA method (Event Tree Analysis) – an inductive, graphical, qualitative or quantitative method, a horizontal tree encompassing events and logical gates; a logical sequence of events from the initiating event to the hazard is being developed;
- FTA method (Fault Tree Analysis) – a deductive, graphical, qualitative or quantitative method, a top-down tree encompassing events and logical gates; the logical combinations of the events that lead to a top event are being identified;
- other methods of hazard identification (as required), e.g. the group of deductive or inductive methods or the group of qualitative or quantitative methods.

Selected methods of risk estimation that may be used for occupational risk assessment in mine rescue include i.a.:

- quantitative method according to PN-N-18002 standard (risk indicator) – an indicatory, quantitative method for measurable factors (for which allowable values have been specified). The risk assessment encompasses the comparison of the values characterizing the exposure (determined based on tests and measurements) and the corresponding allowable value. The risk indicator results from the comparison (3 categories);
- qualitative method according to PN-N-18002 standard (risk matrix) – a qualitative matrix method intended for non-measurable and measurable factors (for which the allowable values have not been specified). The risk assessment encompasses 2 parameters: the probability of the occurrence of the hazard (3 categories) and the severity of the results of the hazard

- (3 categories). The risk level is read from a table (3 or 5 categories);
- PHA method (Preliminary Hazard Analysis) – a qualitative-quantitative, matrix-indicator method. The risk assessment encompasses 2 parameters: the probability of losses (5 categories) and the level of losses (5 categories). The risk indicator is read from a table (3 categories);
 - JSA method (Job Safety Analysis) – a qualitative-quantitative, matrix-indicatory method. The risk assessment encompasses 2 parameters: consequences (4 categories) and the probability of consequences (5 categories) calculated as a sum of the frequency of the occurrence of the hazard (5 categories), the probability of the occurrence of the event (5 categories) and the possibility to limit the losses (5 categories). The risk indicator is read from a table (3 categories);
 - Score Risk (Risk Score) method – a qualitative-quantitative, indicatory method. The risk assessment encompasses 3 parameters: the probability of occurrence of the hazard (7 categories) the exposure of humans to the hazard (6 categories) and the potential results (human and material losses) of the occurrence of the hazard (6 categories). The risk indicator is calculated as a product (5 categories) – there are several versions of this method (risk indicator interpretation);
 - risk lever indicator method (WPR) – a qualitative-quantitative, indicatory method. The risk assessment encompasses 4 parameters: the probability of occurrence of an event (7 categories), the frequency of exposure (7 categories), type of losses (7 categories) and the range of losses (5 categories). The risk indicator is calculated as a product (8 categories);
 - five steps to risk assessment (FS) – a qualitative-quantitative, indicatory method. The risk assessment encompasses 4 parameters: the probability of an event (8 categories), the frequency of exposure (6 categories), the results of an event (7 categories) and the number of exposed persons (4 categories). The risk indicator is calculated as a product (4 categories);
 - FMEA method (Failure Mode and Effects Analysis) – a qualitative-quantitative, indicatory method. The risk assessment encompasses 3 parameters: the probability of an occurrence of error (10 categories), the significance of the error to the user (10 categories) and the possibility of detecting the error (10 categories). The risk indicator is calculated as a product (no categories) – full, simplified or progressive assessment;
 - other risk assessment methods (as required), e.g. representing the matrix group (risk matrix), indicatory methods (risk indicator) or graphical methods (risk graph, risk nomogram).

The general rules of determining occupational risk acceptability have been specified in the PN-N-18002 standard, which – in case of unacceptable risk (high risk on three-point scale and high and very high risk on a five-point scale) – advises that the work should not be commenced or continued until the risk is limited to an acceptable level.

The sequence of application of protective measures according to PN-N-18002 standard: technical measures eliminating or limiting the hazard at the

source (should be applied first), collective protective measures, organizational measures and personal protective measures (to be applied when other measures are insufficient).

According to ALARP (As Low As Reasonably Practicable) rule, three areas with different risk levels may be distinguished:

- the area in which the risk is unacceptably high and may not be limited using available measures – work in such an area is unacceptable;
- the area in which the risk may be accepted under the condition of maintaining continuous control – preventive activities should be instituted in such an area;
- the area in which the risk is negligible and does not have to be controlled, as no risk level increase is anticipated.

Work in mine rescue during a rescue operation is initiated in the conditions of unacceptable risk, when there is a life or health hazard to persons in the mining plant, safety of the mining plant operations or public safety.

In mine rescue, the basic assumption should be made that the risk level may be acceptable during the rescue operation, because the rescue team members:

- exhibit adequate health and psychological predispositions;
- take part in specialized trainings in the field of mine rescue;
- work as teams in rescue brigade supported by rescue equipment.

Summary and conclusions

Based on the analysis of general, industry-specific and detailed requirements encompassing selected legal provisions and guidelines provided in professional literature, the following conclusions were formulated:

- The tasks of mine rescue include bringing aid to victims and performing preventive works in case of threat to the safety of persons or the mining plant operations. The duties of mine rescuer include the participation in rescue operations, preventive works, rescue exercises, duty hours, courses and trainings.
- The subjects of mine rescue are the mine rescue service of the entrepreneur and entities professionally engaged in mine rescue, including rescue units. The organizational units for a rescue team are rescue brigades and specialized emergency services, including rescue brigades on duty, professional specialized emergency services and rescue brigades on duty for groups of mining plants.
- The employment structure within a rescue team determines the number of persons and its composition depending on: the number of persons staying underground during a day, the type of mining hazards, including the type of natural hazards (rock burst, methane, gas and rock breakouts, coal dust explosion, climatic hazard, water hazard and radiation hazard), the type of specialized emergency services (measurement service, air inertization service, firefighting service, mining-technical service, water service, mobile rescue winch service).

- For the purposes of occupational risk assessment in mine rescue, the characteristics of the work process at the workplace of mine rescue should encompass i.a. the following criteria: the physical and mental fitness for work (specialized medical and psychological examinations, specialized trainings, age and experience, propensity to take up risk), work in life or health hazard conditions, teamwork and multi-profession workplaces (rescue brigade, specialized emergency service), change in the conditions of work performance (workplaces with fixed and varying working conditions), changes in the locations of work performance (stationary and non-stationary workplaces).
- The characteristics of the hazards in the working environment for the purposes of occupational risk assessment should encompass i.a. the following criteria: the sphere of the mine environment (lithospheric, atmospheric and technospheric hazards), measurement possibilities (measurable and non-measurable factors), consequences of the activity (dangerous, harmful to health and burdensome factors), causes of the activity (physical hazards, chemical hazards, biological hazards, psychophysical hazards and mining-specific hazards, including natural hazards, mechanical hazards, electric hazards and blasting-related hazards).
- The characteristics of research methods for the purposes of the selection of methods of occupational risk assessment in mine rescue should encompass i.a. the following criteria: type of the risk assessment stage (data acquisition, hazard identification and risk estimation), the precision of risk assessment (basic, auxiliary and advanced), type of data and information (qualitative, quantitative and mixed).
- To conduct the risk assessment for mine rescue, it is advised to apply group decisions and surveys of experts' opinions as well as to establish risk assessment teams that should include i.a.: a person managing the employees, an occupational safety and health service worker, the employees and/or their representatives, specialists, e.g. occupational physician, specialist in the field of hazards and risk assessment.
- The strategy of risk assessment improvement in mine rescue should encompass the general, detailed and practical assessment concerning: the development of basic assumptions for occupational risk assessment, the development of an example of the documentation of occupational risk assessment for a given workplace, the comparison of types of hazards and risk level with the current conditions at the workplace, respectively.
- The work in mine rescue during a rescue operation is commenced in the conditions of unacceptable risk to the persons employed in the mining plant, while the risk level for mine rescues may be acceptable if the members are qualified in mine rescue and exhibit physical and mental fitness for the work as well as in case of teamwork within a rescue brigade while being equipped with rescue equipment.

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