MINISTRY OF LABOUR AND SOCIAL PROTECTION
LABOUR PROTECTION DEPARTMENT
NATIONAL RESEARCH INSTITUTE FOR LABOUR PROTECTION

RISK ASSESSMENT METHOD
FOR
OCCUPATIONAL ACCIDENTS AND DISEASES

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The present work has been drawn up by
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Authors:
Dr. Eng. Stefan PECE
Ec. Aurelia DASCALESCU

Computer editing:
Eng. Doru DARABONT
Tech. Magdalena STERPU

CONTENTS

INTRODUCTION

The starting point for the optimisation of the activity for the prevention of work-related accidents and diseases in a system is represented by the risk assessment of such system.

Regardless of whether a workplace, a workshop or a company is involved, such an analysis allows to form the hierarchical order of hazards depending their dimension and the efficient assignment of resources for priority measures.

Risk assessment implies the identification of all risk factors within the system under examination and the quantification of their dimension, based upon the combination between two parameters: severity and frequency of the maximal possible consequences for the human body.

Thus, partial risk levels are obtained for each risk factor, respectively the global risk levels for the entire system (workplace) under examination.

This risk assessment principle is already included in the European standards (CEI 812/85, respectively EN 292/1-91, EN 1050/96) and constitutes the basis for different methods with practical applicability.

Thus, the Romanian standard SR 292-1/96, adopted in Romania after the already mentioned European standard, specifies in its chapter 6 that "the factors that must be taken into consideration, when assessing risks, are:

a) the probability of occurrence of a lesion or damage to health;
b) the maximal foreseeable severity of such lesion or damage to health".

The compulsoriness of risk assessment at workplaces in our country results from the current law of Romania for this domain that was harmonised with the legislation of the European Union concerning health and safety at work.

Thus, art. 10 of the General work protection norms, adopting paragraph 2, point b, art. 6 of the Framework-Directive 391/89/CEE, provides:

"…. the manager of the enterprise must:

a) assess risks for to the workers' health and safety, in order to determine prevention measures …"

By art. 16 of the General work protection norms, risks assessment is established, as the primary attribution of the staff of work protection compartments:

"The attributions of the staff of work protection compartments are:

a) to assess risks of accidents and diseases at workplaces and to propose adequate protection measures, that will constitute the annual program for work protection, with assistance from the specialised institutions; risk assessment implies the identification of all risk factors that may result in work-related accidents or diseases and the determination of the risk level, based on the combination between the severity and the probability of the maximal foreseeable consequence”.

In order to facilitate the compliance with such obligation provided by law for the managers of enterprises, we present the risk assessment method for workplaces, drawn up by I.C.S.P.M., based on the analysis of the current methods from other countries and their adjustment to the concrete conditions of Romania.

The method was approved in 1993 by the Ministry of Labour and Social Protection and experimented until now in the majority of industrial field, for approx. 1,000 workplaces.

Furthermore, based on this method, a number of 50 physical persons, selected among labour protection inspectors, have been trained and authorised as assessors, within the framework of PHARE programme. The process of assessors' training is currently developing.

You will find next a description of the assessment method, of the work instruments, of the stages and the concrete mode of application. An example of the method application is also presented.

This paper is dedicated to all those who have, by law, attributions concerning the assessment of risks at workplaces, respectively: managers of enterprises, staff of work protection compartments, as well as those who have the task of control and guidance for the activity in this domain, that is to the work protection inspectors. Its only purpose is to render sensitive the persons who are interested in the assessment issues and it does not constitute a substitute to authorised assessors training courses.

1. THEORETICAL PREMISES

Risk-security relation

In specialised terminology, the safety of the person in the work process is considered to be that state of the work system in which the possibility of work-related accidents and disease is excluded.

In the usual language, safety is defined as the fact of being protected from any danger, while risk is the possibility to be in jeopardy, potential danger (Source: Explicative dictionary of Romanian language, published under the care of the Academy of Romania).

If we take into consideration the usual senses of these terms, we may define safety as the state of the work system in which the risk of accident or disease is null.

As result, safety and risk are two abstract notions, mutually exclusive.

In reality, because of the characteristics of any work system, such absolute character states may not be reached. There is no system in which the potential danger of accident or disease could be completely excluded; there is always a “residual” risk, even if only because of the unpredictability of human action. If there are no corrective interventions, along the way, this residual risk will increase, as the elements of the work system will degrade, by “ageing”.

Consequently, systems may be characterised by “Safety levels”, respectively “Risk levels”, as quantitative indicators of the states of safety/risk. Defining safety as a risk function $y = f(x)$, where:

$$y = \frac{1}{x},$$

it may be asserted that a system is safer when the risk level is lower, and reciprocally. Thus, if the risk is null, from the relation between the two variables it results that safety tends towards the infinite, while if risk tends towards the infinite, safety vanishes (Fig.1).

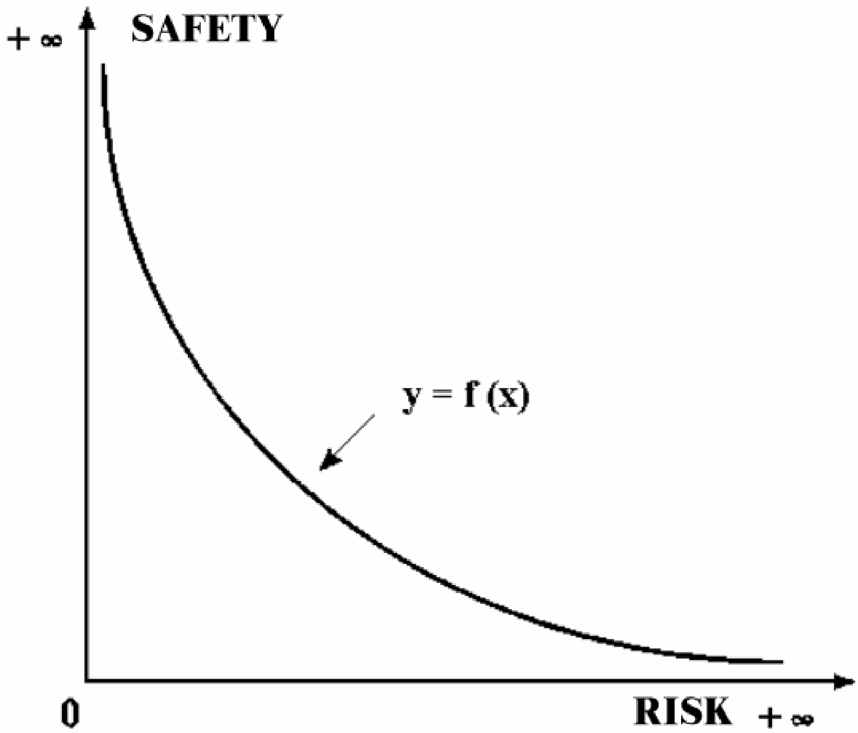

Fig. No. 1. Risk-safety relation

In this context, in practice must be admitted both a minimal risk limit, respectively a risk level other than null, yet sufficiently low to consider that the system is safe, and a maximal risk level, equivalent to such a low safety level that the operation of the system should no longer be permitted.

Acceptable risk notion

In the field of work protection, the specialised literature defines risk as the probability of occurrence of an work-related accident or disease in a work process, with a certain frequency and severity of consequences.

Indeed, if we assume a certain risk level, it is possible to make its representation depending on the severity and probability of occurrence of the consequences, by the area of a rectangle *F1*, vertically developed; it follows that the same area may also be expressed by a square *F2* or by a rectangle *F3*, horizontally developed (see fig. 2).

In all three cases, the risk is the same. Consequently, we may assign to certain severity-probability couplings the same level of risk.

If the three rectangles are united by a line traced through the vertexes opposite to the axes of reference, a curve with hyperbole allure is obtained, describing the connection between the two variables: severity-probability. For the representation of risk depending on severity and probability, the CEN-812/85 defines such a curve as "risk acceptability curve" (fig. 3).

This curve allows the distinction between acceptable risk and unacceptable one. Thus, the risk of occurrence of an event *A,* with severe consequences but low frequency, located under the acceptability curve, is considered to be acceptable, while the risk of an event *B*, with less severe consequences but high probability of occurrence, with its coordinates located above the curve, is considered as unacceptable. For instance, in the case of an atomic power plant, measures are adopted in such way that the risk of an atomic event – risk for the occurrence of event *A* – is characterised by an extreme severity of consequences, but extremely low probability of occurrence. In exchange, for the risk represented by event *B*, say a road accident in the current activity of a driver, although this type of event generates consequences less severe than an atomic accident, the probability of occurrence is so great (very high frequency) that the workplace of the driver is considered to be unsafe (unacceptable risk).

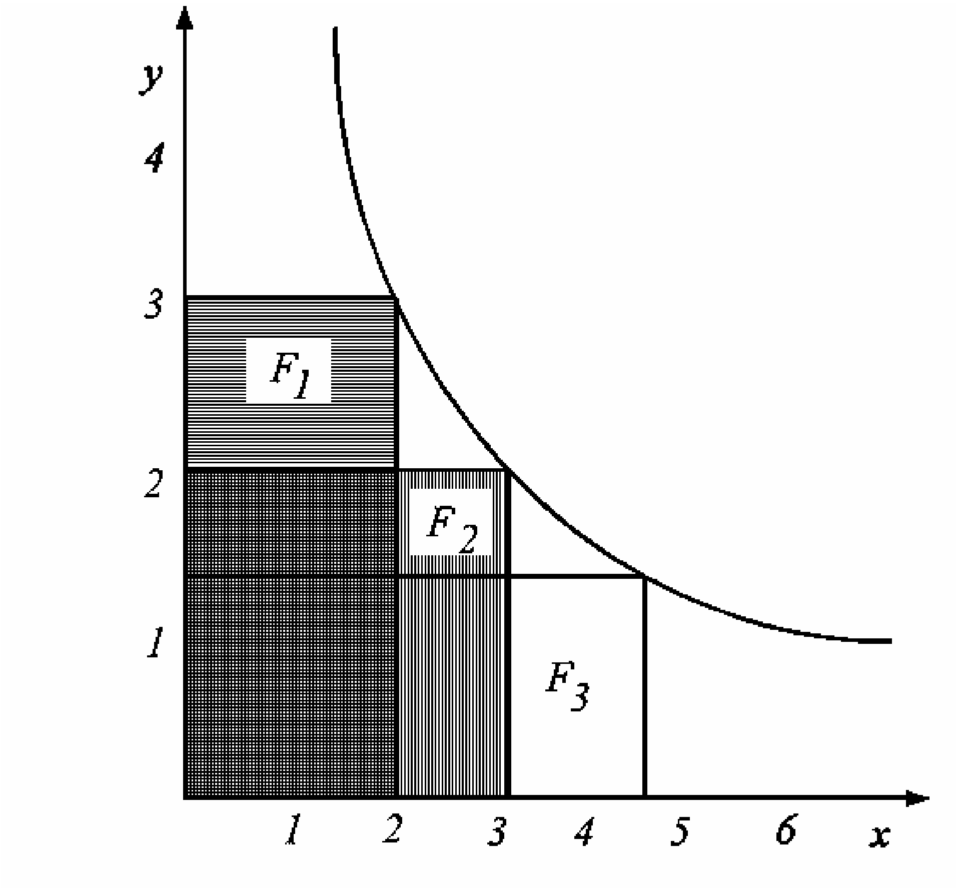

Fig. 2 – Graphic representation of the equivalence or risks characterised by different severity-probability couplings

y – severity

x - probability

Any safety study has the objective to ascertain the acceptable risks.

Treating risk in such way raises two problems:

- how to determine the coordinates of risk (severity/probability coupling);
- which coordinates of risk should be selected for the delimitation of acceptability areas from those of unacceptability.

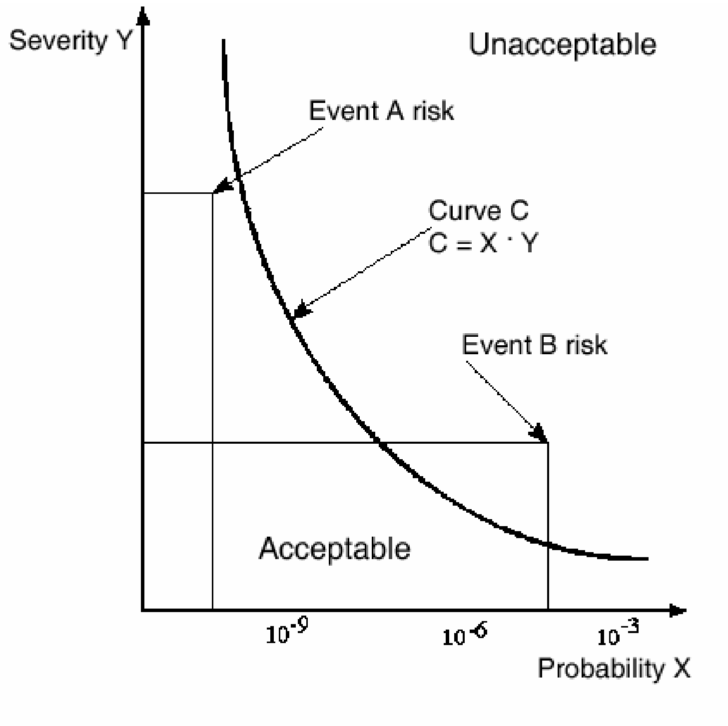

Fig. 3. Risk acceptability curve

In order to solve those problems, the premise for the elaboration of the assessment method was the risk – risk factor relation.

It is a known fact that the existence of risk in a work system is attributable to the presence of work-related accident and disease risk factors. Therefore, the elements that are instrumental for the characterisation of risk, thus to the determination of its coordinates, are actually the probability for the action of a risk factor to lead to accident and the severity of the consequence of the action of the risk factor on the victim.

Consequently, in order to assess the risk/safety it is necessary to follow the next stages:

a. – the identification of the risk factors from the system under examination;

b. – the determination of the consequences of the action on the victim, respectively the severity of such consequences;

c. – the determination of the probability of their action on the worker;

d. – attribution of risk levels depending on the severity and probability of the consequences of the action of risk factors.

a. The theoretical model of the genesis of work-related accidents and diseases, drawn up by the National Research Institute for Labour Protection, broaches in systematic manner the causality of such events, allowing the creation of a pragmatic instrument for the identification of all the risk factors within a system (Annex no. 1).

In the conditions of a work system that is real, in operation, there are not sufficient resources (time, financial, technical ones, etc.) to make possible the simultaneously tackling of all risk factors for work-related accidents and disease. Even if they exist, the efficiency criterion (both in the limited sense of economic efficiency, as in the sense of social efficiency) forbids such action. For this reason, it is not justified to take them integrally into consideration in the safety analysis, either. From the multitude of risk factors that may finally link together, having the potential to result in an accident or a disease, those factors that may represent direct, final causes are the ones that must be eliminated, in order to guarantee that the occurrence of such an event is impossible: thus, it is mandatory to focus the study on these factors.

b. It is easy to differentiate risks, depending on the severity of the consequence. Regardless of the risk factor and of the event that might be generated by the latter, the consequences on the worker may be classified in accordance with the categories defined by the law: <u>temporary work disablement</u>, <u>invalidity</u> and <u>decease</u>. Further more, the maximal possible consequence of each risk factor may be asserted with certainty. For instance, the maximal possible consequence of electrocution will always be decease, while the maximal possible consequence of exceeding the normative noise level will be work-related deafness – invalidity. In the event of work-related accidents or diseases such as these are specified by the medical criteria of clinical, functional and work capacity assessment diagnosis, elaborated by the Ministry of Health and the Ministry of Labour and Social Protection (Annex 2), knowing the types of lesions and damages, as well as their potential localisation, it is possible to estimate for each risk factor the type of lesion to which the latter may eventually lead, *in extremis*, the organ that would be affected and, finally, the type of consequence that will occur: disablement, invalidity or decease. On their turn, these consequences may be differentiated in several classes of severity. For instance, invalidity may be classified in I-st, II-nd or III-rd degree, while disablement may be of less than 3 days (minimal limit set by law for the definition of work accident; between 3-45 days and between 45-180 days. As in the case of the probability of occurrence of accidents and diseases, the severity of consequences may be classified in several classes, as follows:

– class 1: negligible consequences (work disablement of less than 3 days);

– class 2: limited consequences (work disablement between 3-45 days, requiring medical treatment);
– class 3: medium consequences (work disablement between 45-180 days, medical treatment and hospitalisation);
– class 4: important consequences (III-rd degree invalidity);
– class 5: severe consequences (II-nd degree invalidity);
– class 6: very severe consequences (I-st degree invalidity);
– class 7: maximal consequences (decease).

c. As with regard to frequency, it is a known fact that accident or disease are random events. Therefore, risk factors will be differentiated by the fact that each of them leads to the occurrence of an accident/disease, while the probability differs. Thus, the probability for an accident to happen because of the hazardous motions of the movable parts of a drilling machine is different than the one of an accident caused by lightning. Likewise, one and the same factor may be characterised by another frequency of action on the worker, in different moments of the operation of a work system or in analogous systems, depending on the nature and on the state of the generating element. For instance, the probability of electrocution by direct touch when handling a power-supply device is higher if the latter is old and the protection isolation of its conductors is torn, than if it is a brand new one.

Yet, from the point of view of promptness and efficiency, it is not possible to work with probabilities that are strictly determined for each risk factor. In certain cases, this could not even be calculated, as in the case of factors relating to the worker. The probability to act in a manner that generates accidents may not but be approximated. In other situations, the calculation required for the rigorous determination of the probability of occurrence of the consequence is so toilsome, that it would eventually be even more costly and time-consuming than the actual application of preventive measures. This is why it would be better, as a rule, to determine the probabilities by estimation, and to classify them by ranges. For the purpose we pursue, for instance, it is easier and more efficient to approximate that a certain accident is likely to be generated by a risk factor characterised a frequency that is lower than once every 100 hours. The difference is insignificant, as against more rigorous values of 1 every 85 hours or 1 every 79 hours, yet the event may be classified, in all three cases, as very frequent. For this reason, if we use the intervals specified in CEI-812/1985, we obtain 5 groups of events, as follows:

- extremely rare: $P < 10^{-7}/h$;
- very rare : $10^{-7} < P < 10^{-5}/h$;

- rare: $10^{-5} < P < 10^{-4}$/h ;
- low frequency: $10^{-4} < P < 10^{-3}$/h ;
- frequent: $10^{-3} < P < 10^{-2}$/year
- very frequent: $P > 10^{-2}$/h.

Now, we will attribute to each group a probability class, from 1 to 6, thus saying that event E_1, which has a probable frequency of occurrence $P_1 < 10^{-7}$/h is classified in probability class 1, while event E_6, which has a probable frequency of occurrence $P_6 > 10^{-2}$/h is classified in probability class 6. Thus, we obtain a probability quotation scale, such as the one in Annex 3.

d. Having at disposal these two scales – for the quotation of the probability and of the severity of consequences of the action of risk factors (Annex 3) – we may associate to each risk factor in a system a coupling of characteristic elements, severity - probability, thus setting down a risk level for each coupling.

For the attribution of risk/safety levels we used the risk acceptability curve.

Because severity is a more important element, from the point of view of the finality concerning labour protection, as assumption it was admitted that the influence of severity on the risk level is much greater than frequency. Therefore, in correspondence with the 7 classes of severity have been set down 7 risk levels, in ascending order, respectively 7 safety levels, given the inverse proportional relation between the two states (risk – safety):

- N_1 – minimal risk level → S_1 – maximal safety level
- N_2 – very low risk level → S_2 – very high safety level
- N_3 – low risk level → S_3 – high safety level
- N_4 – medium risk level → S_4 – medium safety level
- N_5 – high risk level → S_5 – low safety level
- N_6 – very high risk level → S_6 – very low safety level
- N_5 – maximal risk level → S_5 – minimal safety level

If we take into consideration all the possible combinations of the specified variables, by couplings, we obtain a matrix $M_{g,p}$ with 7 rows – g, representing severity classes, and 6 columns – p, representing probability classes.

$$
M_{g.p} = \left\| \begin{array}{cccccc}
(1,1) & (1,2) & (1,3) & (1,4) & (1,5) & (1,6) \\
(2,1) & (2,2) & (2,3) & (2,4) & (2,5) & (2,6) \\
(3,1) & (3,2) & (3,3) & (3,4) & (3,5) & (3,6) \\
(4,1) & (4,2) & (4,3) & (4,4) & (4,5) & (4,6) \\
(5,1) & (5,2) & (5,3) & (5,4) & (5,5) & (5,6) \\
(6,1) & (6,2) & (6,3) & (6,4) & (6,5) & (6,6) \\
(7,1) & (7,2) & (7,3) & (7,4) & (7,5) & (7,6)
\end{array} \right\|
$$

The graphic representation of the matrix (fig. 4) in a system of rectangular coordinates leads to a rectangle, with the abscissa that constitutes the set of probability classes and the y-coordinate constituting the set of severity classes, while its area - the set of possible risk level: $\sum_{R=1}^{7} N_R$.

Also, using each of the couplings, we trace a rectangle considered as representing a risk; we will attribute to each of the micro-areas a risk level, so that by joining we will obtain: $\sum_{R=1}^{7} N_R$.

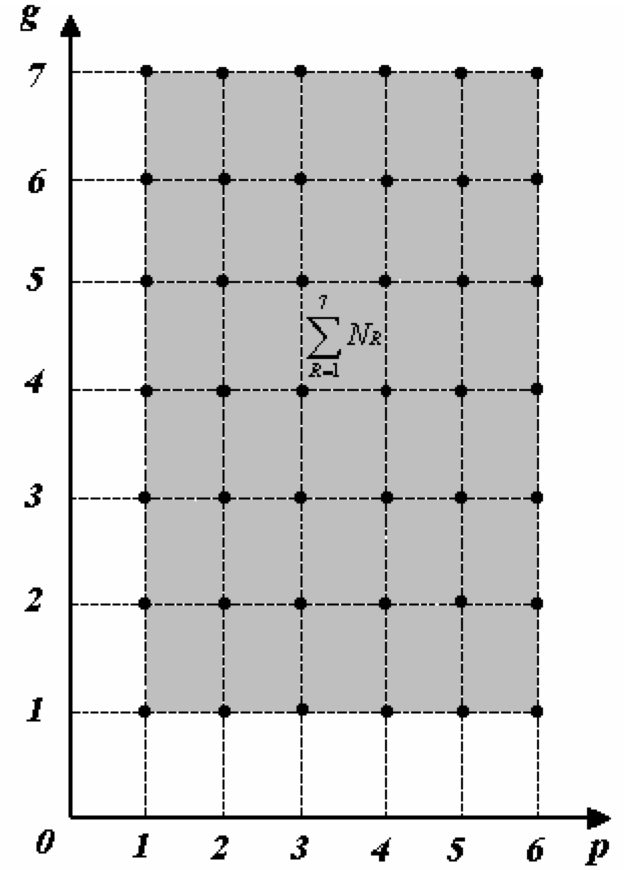

Fig. 4. Graphic representation of the couplings matrix of severity-probability variables (set of the risk levels)

g = severity class; p = probability class

Note:

The following conventions were accepted, for practical reasons, when drawing up the graphic construction:

- both on the O-g axis and the O-p axis, the corresponding classes have been represented by equal segments, although the differences between the severity of the events, from one class to the other, as well as - in the case of probability classes - the time intervals, that constituted the basis for such determination, are not equal;
- for the intervals representing severity classes were used longer segments than for those which delimit frequency classes ($1^{1'2}$- 1), precisely because of the assumption that severity carries a much greater weight when determining the risk.

By successive superposition, in certain conditions, of the risk acceptability curve over the representation obtained for the set of risk levels, couplings have been classified in accordance with risk levels, as explained further.

Maintaining the logic of the representation of classes by equal segments, it results that the curves delimiting risk levels must be equidistant. Consequently, we divide the large diagonal of the rectangle, which signifies the sum of the sets of risk levels, into 7 equal segments, by which curves will be lined out.

Level 1 – minimal acceptable risk level: The limit of the first segment, on the right side, is one of the points by which the curve of level 1 will be lined out. We take now into consideration all the couplings in which severity enters with value 1 (line 1 of the matrix $M_{g,p}$). Indeed, all risk factors that have the disablement for less than 3 days, as possible consequence, may be considered as associated with the minimal accepted risk level, while the events that occur do not form the object of prevention (these are not work accidents and are usually treated as incidents, while their elimination will form the object of actions concerning the increase of labour comfort, and not as matters of safety). The limit coupling is the one for which the value of severity is 1, while the value of probability is 6.

Through the points, thus set down, we line out a curve that has the allure of the acceptability curve, set by CEN-812/85 (fig. 5 a).

The area delimited by the sides of the rectangle and the curve that was lined out will represent risk level 1. All risk factors that may be characterised by couplings which have coordinates that generate points either located inside the area thus delimited or on the curve will be considered of risk level 1, respectively safety level 7.

Out of matrix $M_{g,p}$, from the graphic representation (fig. 5 a), it results that to risk level 1 correspond the sub-matrix:

$$\underset{P=1}{\overset{6}{M}}{}_{1,P} = \|(1,1)\ (1,2)\ (1,3)\ (1,4)\ (1,5)\ (1,6)\|$$

and element (2,1).

Level 2-7: Through the points delimiting the segments set down on the diagonal of the rectangle of the set of risk levels, we line out the curves for the levels 2 … 6, parallel to the curve of minimal acceptable risk level (fig. 5 b). As above, the section delimited by the curve of level 1 and the immediately superior curve will represent level 2; risk level 2 shall be allocated to all risk factors for which the couplings severity-probability generate points located within this area or on its superior limit.

Level 3,4, …, 6 are similarly attributed. Level 7 is allocated to the area delimited by the curve of level 6 and by the two superior sides of the rectangle.

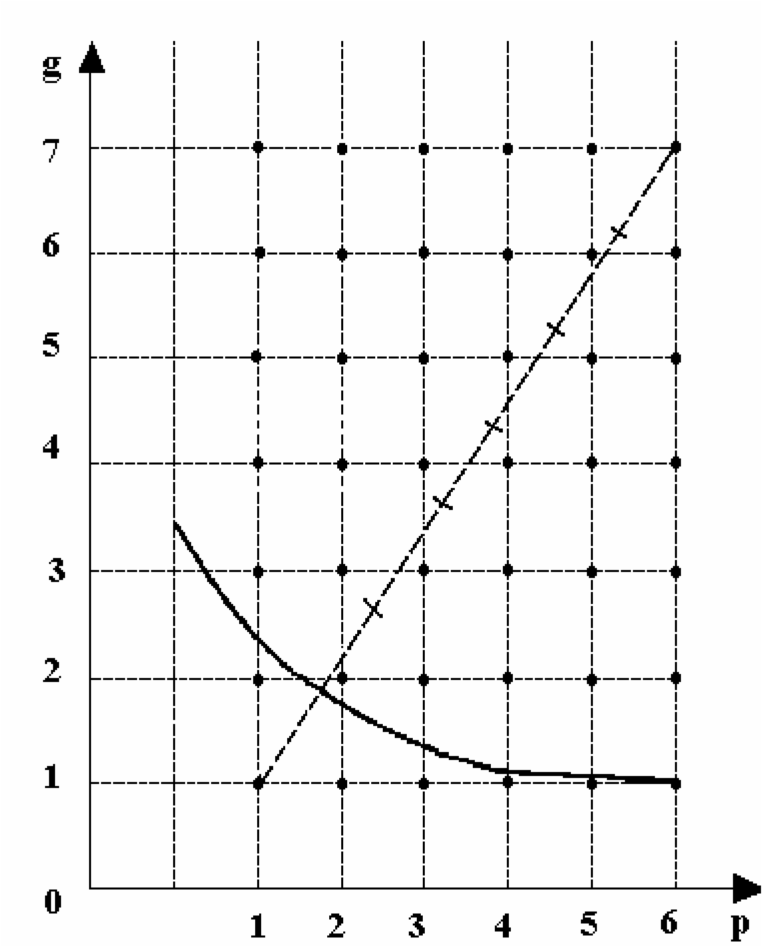

Fig. 5 a. Lining out of level risk curves.

Setting down points through which level curves are lined out;

level curve 1 (minimal acceptable risk)

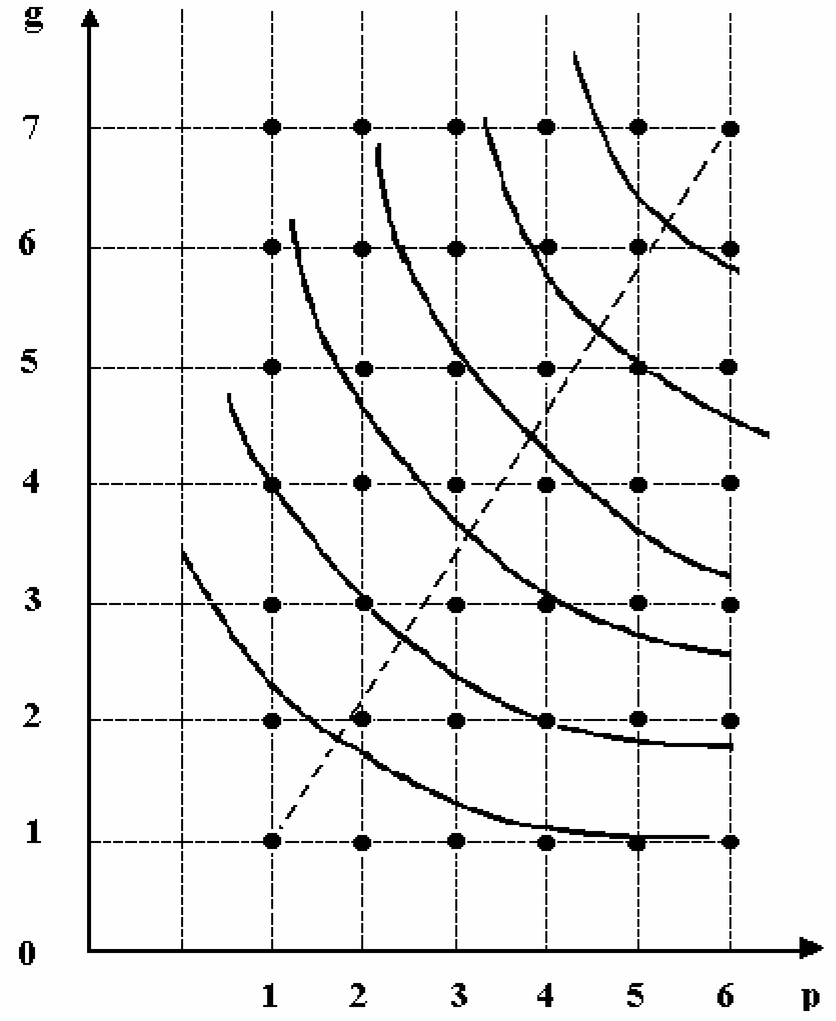

Fig. 5 b. Lining out risk levels curves.

Lining out curves for levels 2-7; maximal acceptable and critical risk level

Risk level 1 – coupling g-p: (1,1) (1,2) (1,3) (1,4) (1,5) (1,6) (2,1);

Risk level 2 – coupling g-p: (2,2) (2,3) (2,4) (3,1) (3,2) (4,1);

Risk level 3 – coupling g-p: (2,5) (2,6) (3,3) (3,4) (4,2) (5,1) (6,1) (7,1);

Risk level 4 – coupling g-p: (3,5) (3,6) (4,3) (4,4) (5,2) (5,3) (6,2) (7,2);

Risk level 5 – coupling g-p: (4,5) (4,6) (5,4) (5,5) (6,3) (7,3);

Risk level 6 – coupling g-p: (5,6) (6,4) (6,5) (7,4);

Risk level 7 – coupling g-p: (6,6) (7,5) (7,6)

Interpreting the representation in fig. 5 b, it results that at least one sub-matrix from matrix $M_{g,p}$ corresponds to each risk level:

- level 2: $\begin{cases} \underset{p=2}{\overset{4}{M}}{}_{2,p} = \| (2,2)(2,3)(2,4) \| \\ \underset{p=1}{\overset{2}{M}}{}_{3,p} = \| (3,1)(3,2) \| \end{cases}$ and element (4,1);

- level 3: $\begin{cases} \underset{p=5}{\overset{6}{M}}{}_{2,p} = \| (2,5)(2,6) \| \\ \underset{p=3}{\overset{4}{M}}{}_{3,p} = \| (3,3)(3,4) \| \\ \underset{g=5}{\overset{7}{M}}{}_{g,1} = \| (5,1)(6,1)(7,1) \| \end{cases}$ and element (4,2);

- level 4: $\begin{cases} \underset{p=5}{\overset{6}{M}}{}_{3,p} = \| (3,5)(3,6) \| \\ \underset{p=3}{\overset{4}{M}}{}_{4,p} = \| (4,3)(4,4) \| \\ \underset{g=2}{\overset{3}{M}}{}_{5,g} = \| (5,2)(5,3) \| \\ \underset{g=6}{\overset{7}{M}}{}_{2,g} = \| (6,2)(7,2) \| \end{cases}$

- level 5: $\begin{cases} \underset{p=5}{\overset{6}{M}}{}_{4,p} = \| (4,5)(4,6) \| \\ \underset{p=4}{\overset{5}{M}}{}_{5,p} = \| (5,4)(5,5) \| \\ \underset{g=6}{\overset{7}{M}}{}_{3,g} = \| (6,3)(7,3) \| \end{cases}$

- level 6: $\underset{p=4}{\overset{5}{M}}{}_{6,p} = \| (6,4)(6,5) \|$ and elements (5,6), (7,4);

- level 7: element (6,6) and sub-matrix $\underset{p=5}{\overset{6}{M}}{}_{7,p} = \| (7,5)(7,6) \|$

From the already defined relation risk-safety it is immediately deduced that risk level 7 represents a critical level, where the safety of the system is minimal. Beyond this limit, safety tends to zero, thus the unfolding of the work process is no longer permitted, because it would be equivalent to the occurrence of the accident/disease. As for the risk factors characterised by the couplings (6,6), (/,5), (7,6), it is possible to assert that they will lead fast and certainly to the occurrence of the extreme event – decease)imminent danger).

Normative regulations from the majority of countries do not permit for such critical level to be reached. This is why, in general, limits are set for each risk factor, either maximal limits, under the form of values, in the case of factors with form of manifestation characterised by measurable elements, or interdictions – factors for which measurements are not possible. Such norms correspond to a maximal acceptable risk level, differing from country to country, depending on social and economic conditions.

The method for the assessment of labour risk/safety, that is presented bellow, was elaborated starting from these premises.

2. METHOD DESCRIPTION

2.l. Object and finality

The purpose of the method is the quantitative determination of risk level for a workplace, based upon the systemic analysis and risk assessment concerning work-related accidents and diseases. The application of the method is finalised with two documents:

- WORKPLACE ASSESSMENT CARD, including the partial risks levels for each risk factor and the global risk level for the workplace;
- PREVENTION ACTIONS CARD, including the totality of technical and organisational measures provided by the norms an standards in force, for each and every risk factor.

The workplace assessment card, thus drawn up, constitutes the basis for the substantiation of the prevention program for the work-related accidents and diseases at the workplace, sector, division or enterprise that is examined.

2.2. Method principle

The essence of this method consists in the identification of all risk factors of the system (workplace) under examination, based upon pre-established check lists, and the quantification of the risk dimension, taking into account the combination between the severity and the frequency of the maximal foreseeable consequence.

The safety level for a workplace is inversely proportional to the risk level.

2.3. Potential users

The method may be used both in the concept and design stage, and in the operational stage for workplaces. Its application requires complex teams, composed of specialists of the occupational safety field, as well as of the technology under examination (assessors and technologists).

In the first situation, the method constitutes a useful and necessary instrument for designer, in order to integrate occupational safety principles and measures in the concept and design of work systems.

In the operational stage, the method is useful for labour protection compartment staff in enterprises, in order to fulfill the following attributions: the scientific analysis of the state of occupational safety at each workplace and a rigorous substantiation of prevention programs.

2.4. Method stages

The method comprises the following compulsory stages:

- appointment of the team of assessors;
- definition of system (workplace) to be examined;
- identification of risk factors within the system;
- risks assessment for work-related accidents and diseases;
- forming the hierarchy of risks and settling the priorities for prevention;
- proposal of prevention measures.

2.5. Working instruments to be used

The necessary stages for the occupational safety assessment in a system, previously described, are carried out using the following working instruments:

- Risk factors identification list (Annex 1);
- List of the possible consequences of the action of risk factors for the human body (Annex 2);
- Quotation scale of the severity and probability of consequences (Annex 3);
- Risk assessment grid (Annex 4);
- Risks level, respectively safety levels scale (Annex 5);
- Workplace assessment card - centralising document (Annex 6);
- Proposed measures card (Annex 7).

The contents and structure of these instruments are presented further.

- **Risk factors identification list** (Annex 1) is a form that includes, in a easily identifiable and compressed format, the main risk factors categories for work-related accidents and diseases, classified according to the criterion of the generating element within the work system (worker, work task, mean of production and work environment).
- **List of the possible consequences** of the action of risk factors for the human body (Annex 2) is a helpful instrument for the application of the quotation scale for the severity of consequences. It includes the categories of lesions and injuries of the integrity and health of the human organism, the possible location of consequences in relation to the anatomical-functional structure of the body and the generic minimal-maximal severity of the consequence.
- **Quotation scale for the severity and probability** of consequences on the human organism (Annex 3) is a grid for the classification into classes of severity and classes of probability for their occurrence.

  The part of grid concerning the severity of the consequences is based upon medical criteria for clinical and functional diagnosis and assessment of the working capacity drawn up by the Ministry of Health and the Ministry of Labour and Social Protection.

  As for the classes of probability, further to the experiments, a method was finally chosen for the adjustment of the European Union standard concerning risk assessment for machines, taking into consideration the following:
  - class 1 of probability: frequency of occurrence over 10 years;
  - class 2: frequency of occurrence – once every 5-10 years;
  - class 3: frequency of occurrence – once every 2-5 years;
  - class 4: frequency of occurrence – once every 1-2 years;
  - class 5: frequency of occurrence – once every 1 month - 1 year;
  - class 6: frequency of occurrence – once every period of less than one month.
- **Risk assessment grid** (Annex 4) has the form of a table, with lines representing classes of severity and columns representing classes of probability.

  The grid is instrumental for the effective expression of the risks that exist in the system under examination, in the form of the coupling severity/frequency of occurrence.
- **Risks/safety levels scale** (Annex 5), drawn up starting from the risk assessment grid, is an instrument that is used for the assessment of the anticipated risk level, respectively safety level.

  All the couplings severity-probability related to risks levels are presented in the central zone of the form.

- **<u>Workplace assessment card</u>** (Annex 6) is the centralising document of all operations of identification and assessment of work-related accident/disease risks. As such, this form includes:
  - data for the identification of the workplace: enterprise, division (workshop), workplace;
  - data for the identification of the assessor: surname, given name; position;
  - generic components of the work system;
  - indication of identified risk factors;
  - explicit description of the actual forms of occurrence of the identified risk factors (description, parameters and functional characteristics);
  - maximal foreseeable consequences of the action of risk factors;
  - severity class and foreseen probability;
  - risk level.
- **<u>Proposed measures card</u>** (Annex 7) is a form for centralising the necessary prevention measures that are to be taken, resulting from the assessment of the workplace from the point of view of the existing risks of work-related accidents and diseases.

3. APPLICATION OF THE METHOD

3.l. Working procedure

Organisation of the analysis and assessment team

The first step in the application of this method is made by setting up the analysis and assessment team. This team will include occupational safety specialists (authorised assessors) and technologists, qualified experts for the work processes that are to be examined.

Before starting their activity, the members of the team must have detailed knowledge of the assessment method, the instruments to be utilised and the concrete working procedures. A minimal preliminary documentation is also necessary, concerning the workplaces and the technological processes which are to be examined and assessed.

After setting up the analysis and assessment team, respectively acquiring knowledge of the method, its members may run through the actual stages.

Description of the system to be analysed

In this stage, a detailed analysis of the workplace is performed, aiming at:

- identification and description of the components of the system and its mode of operation: purpose of the system, description of the technological process, of working operations, machines and equipment that are utilised – parameters and functional characteristics, tools, etc.;

- express specification of the working task which is incumbent upon the worker within the system (based on job description, the written orders and decisions, verbal dispositions currently given, etc.);
- description of existing environment conditions;
- specification of safety requirements, for each component of the system, based on norms and standards for safety at work, as well as on other pertinent normative acts).

The information that is necessary at this stage are taken from company documents (technological card, technical equipment handbooks, job description of the worker, technical conditions, test bulletins for environment factors, norms, standards and instructions for safety at work). A complementary source of information for defining the system is constituted by discussions with workers from the workplace that is under examination.

Identification of the risk factors within the system

In this stage, it is essential for the quality of the analysis to ascertain, for each component of the assessed work system (respectively workplace), the malfunctions that may occur, based on the pre-established list (Annex l), in all foreseeable and probable operation situations.

For the identification of all possible risks, it is therefore necessary to simulate the operation of the system and to infer the respective deviations. This may be done either by verbal analysis with the technologist, in the case of less hazardous workplaces, in which malfunctions which could generate work-related accidents (or occupational diseases) are almost evident, or by application of the method of the tree of events.

Simulation may also be achieved in concrete manner, on an experimental model or through computer processing.

Regardless of the adopted solution, the working methods are the direct examination and logic inference.

In the case of objective risk factors (generated by the means of production or by the work environment), their identification is relatively easy, as either the parameters and functional characteristics of machines, equipment, installations, and the physical-chemical properties of substances and materials used, or the test bulletins for the environment conditions are known.

As far as the worker is concerned, the operation is a lot more difficult and implies a high degree of indeterminedness. As far as possible, all his foreseeable and probable errors should be analysed, depending on the work task assigned to him, under the form of his omissions and wrong actions, as well as their impact on his own safety and on the other elements of the system.

The identification of the risk factors depending on the work task is achieved, on one hand, by the analysis of the conformity between its contents and the working capacity of the worker to whom this task was assigned, and - on the other hand – by specifying the eventual mistaken concerning operations, working rules, working procedures.

The risk factors that have been identified are inscribed in the WORKPLACE ASSESSMENT CARD (Annex 6), where their concrete form of occurrence must also be specified, at the same time: their description and the dimension of the parameters by which the respective factor is assessed (such as, for instance, resistance to compression or shearing stress, weight and dimensions, Cz curve, etc.)

Risks assessment

The determination of possible consequences of the action of risk factors should be performed by using the list in Annex 2. The severity of the consequences, thus ascertained, is assessed on the basis of the grid in Annex 3). Important information an assessment as accurate as possible of the severity of possible consequences are obtained from the statistics of work-related accidents and occupational diseases occurred at the respective workplace or at similar workplaces.

The determination of the frequency of possible consequences should be performed by using used the scale in Annex 3. The identification with probability classes is to be made depending on the intervals between the occurrence of such events (daily, weekly, monthly, year, etc.), established according to statistics or to the calculation. The respectively periods are subsequently transformed in probabilities, expressed in number of possible events per year.

The result obtained after the previous procedures is identified in the Risks assessment grid (Annex 4) and is inscribed into the Workplace card (Annex 6). By using the risk/safety levels scale are then determined all these levels for each risk factor. Thus, a hierarchy of the dimension of risk at the workplace is obtained, allowing the possibility to set a priority of prevention and protection measures, depending of the risk factor with the highest level of risk.

The global risk level (N_r) at the workplace is calculated as a weighted average of the risk levels established for the identified risk factors. Because the obtained result must reflect the reality as accurately as possible, as weighting element should be used the risk factor rank, which is equal to the risk level.

Thus, the factor with the highest risk level will also have also the highest rank.

The calculation formula for the global risk level is the following:

$$N_r = \frac{\sum_{i=1}^{n} ri \cdot R_i}{\sum_{i=1}^{n} ri}$$

where:

N_r = global risk factor for the workplace;

r_i = rank of the risk factor "i";

R_i = level of risk for the risk factor "i";

n = number of risk factors that have been identified at the workplace.

The safety level (N_s) at the workplace is identified on the Risks/safety levels scale, based on the principle of the inverse proportionality of the levels of risk and safety.

Both the global risk level and the safety level are inscribed in the Workplace card (Annex 6).

In the case of the assessment of macro-systems (department, division, enterprise), the weighted average of the average safety levels determined for each workplace within the macro-system that were analysed (analogous workplaces are considered as one workplace) is calculated, in order to obtain the global work safety level for the workshop/department/division or enterprise under investigation – Ng:

$$N_g = \frac{\sum_{p=1}^{n} r_p \cdot N_{sp}}{\sum_{p=1}^{n} r_p}$$

where:

r_p = rank of workplace "p" (equal as value to the safety level of the workplace);

p = 1 … n

n = number of workplaces that have been analysed;

N_{sp} = average work safety level for the workplace "p".

Determining prevention measures

To determine the measures that are necessary for the improvement of the safety level of the system that is analysed, it is imperative to take into consideration the hierarchy of assessed risks, according to the Risks/safety levels scale, in the following succession:

7 - 1 - if operating with risk levels;

1 - 7 - if operating with safety levels.

The generic hierarchy classification order of prevention measures must also be taken into account, respectively:

- intrinsic prevention measures;
- collective protection measures;
- personal protection measures.

The proposed measures are inscribed in the PROPOSED PREVENTION MEASURES CARD (Annex 7).

The application of the method application should be concluded with the analysis report. This is a informal instrument, which must contain, in clear and concise form, the following:

- the mode of analysis development ;
- the persons who were involved;
- the results of the assessment, respectively the cards of the workplaces, with the risk levels;
- the prevention measures cards.

3.2. Application conditions

In order to achieve the most relevant results by the application of this method, the first prerequisite is for the system to be analysed to be a workplace, well defined as with regard to its purpose and its elements.

Another extremely important condition is the existence of a complex and multi-disciplinary assessment team, to include work safety experts, designers, technologists, physicians, occupational medicine specialists, etc., corresponding to the varied nature of the elements of the work system, as well as of the risk factors. The team leader must be the occupational safety expert, who's leading role will be to attune points of view of the other assessors, in the sense of the subordination and integration of the criteria used by each of them, for the purpose of the analysis: occupational safety assessment.

An advantage of the proposed method is the fact that its application is not limited by the prerequisite of the physical existence of the system to be assessed. It may be used at all stages related to the life of a work system or of one of its elements: concept and design, physical reality, establishment and putting into service, unfolding of the work process.

Because the **concrete forms** of manifestation of risk factors are multiple, even for a relatively simple system, the working procedure within the framework of this method is relatively laborious. Its application, as well as the subsequent risk management at workplaces, based upon its results, requires specialised personnel and computing technique.

3.3. Considerations concerning the use of computers for the application of the method and the computer-aided management of risks

The practical application of the method of risk assessment in the work system is sufficiently laborious, in terms of the amount of information that must be taken into consideration in the case when several workplaces are studied, to ground the use of modern computer techniques. The use of computers is possible, due to certain characteristics of the method, as:

- working procedure to proceed by stages
- existence of a calculation algorithm for the risk level;
- type of connections between the variables taken into consideration for the determination of the risk level.

The computer may be used both for the actual assessment of risks, and for the computer-aided management of risks in the enterprise.

a) During the proper assessment, the use of computer is advisable in two modalities:

- constitution of databases concerning the service life of technical equipment, time of operation, number of exposed persons, time of exposure, respectively statistics of work-related accident and diseases that occurred and their use for the more accurate determination of probability classes;
- automatic computation of partial risk levels and of the global risk level for each workplace, sector, enterprise.

b) The computer-aided management of risks implies the constitution of complete databases and their permanent actualisation, including data from the risk cards and from the measures cards, for all the workplaces under assessment in the enterprise. In such way, in each moment it would be possible to know and to correct, in accordance with the latest assessment, the exact situation of existing risks, of their dimensions (risk levels), of the measures that must be taken, of those that have already been taken, of the responsibilities and competence for the respective measures.

Annex 1

RISK FACTORS IDENTIFICATION LIST

A. WORKER

1. WRONG ACTIONS:

1.1. DEFECTIVE PERFORMANCE OF OPERATIONS
- controls
- handlings
- positioning
- fastenings
- assembling
- adjustments
- incorrect use of protective equipment, etc.

1.2. UNSYNCHRONISED OPERATIONS
- delays
- advances

1.3. PERFORMANCE OF OPERATIONS UNFORESEEN BY WORK TASK
- starting up technical equipment
- interruption of technical equipment operation
- energy supply or interruption of supply (electrical power, energy fluids, etc.)
- circulation, stationing in dangerous areas
- circulation with danger of falling down:
  - at the same level, by:
    - losing balance
    - slipping
    - stumbling
  - from height, by:
    - stepping out of the security area (free falling)
    - losing balance
    - slipping

1.4. COMMUNICATIONS GENERATING ACCIDENTS

2. OMISSIONS:

2.1. Omission of certain operations

2.2. Failure to use protective equipment

(to be continued)

Annex 1 (continued)

B. WORK TASK	
1.	**INADEQUATE CONTENTS OF THE WORK TASK , AS AGAINST SAFETY REQUIREMENTS:** **1.1. Erroneous operations, rules, procedures** **1.2. Absence of certain operations** **1.3. Inadequate working methods (wrong succession of operations)**
2.	**UNDER/OVERSIZED TASK, AS AGAINST THE CAPACITY OF THE WORKER** **2.1. Physical stress:** - static effort - coerced or vicious work positions - dynamic effort **2.2. Psychical stress:** - high rhythm of work - difficult decisions to be taken in short time - repeated short cycle work or extremely complicated operations, etc. - monotony of work
C. PRODUCTION MEANS	
1.	**MECHANICAL RISK FACTORS:** **1.1. Hazardous motions** **1.1.1. Functional motions of technical equipment:** - machine parts in motion; fluids running; displacement of transport means, etc. **1.1.2. Contra-indicated self-starting or self-blocking of operational motions of technical equipment or fluids** **1.1.3. Motions under the effect of gravity:** - slipping; rolling; wheeling; upheaval; free fall; free flowing; overflowing; caving-in, breaking down; sinking **1.1.4. Motions under the effect of propulsion:** -casting of particles or parts; deviation from the normal trajectory; libration; recoil; excessive shocks; jet, eruption

(to be continued)

Annex 1 (continued)

	1.2. Dangerous surfaces or contours: -pricking; sharp; slippery; abrasive; adhesive **1.3. Vessels under pressure** **1.4. Excessive vibrations of technical equipment**
2.	**THERMAL RISK FACTORS:** **2.1. High temperature of objects or surfaces** **2.2. Low temperature of objects or surfaces** **2.3. Flames, flares**
3.	**ELECTRICAL RISK FACTORS:** **3.1. Electric current:** - direct contact; indirect contact; pace voltage
4.	**CHEMICAL RISK FACTORS:** **4.1. Toxic substances** **4.2. Caustic substances** **4.3. Flammable substances** **4.4. Explosive substances** **4.5. Carcinogenic substances** **4.6. Radioactive substances** **4.7. Mutagen substances**
5.	**BIOLOGICAL RISK FACTORS:** **5.1. Suspensions of micro-organisms in the air:** - bacteria; viruses; spirochaete; fungi; protozoa, etc.
C. SPECIAL CHARACTER OF THE ENVIRONMENT - underground; aquatic; sub-aquatic; swamping; air; cosmic, etc.	

Annex 2

LIST OF THE POSSIBLE CONSEQUENCES OF THE ACTION OF RISK FACTORS FOR THE HUMAN BODY
(lesions and injuries of the integrity and health of the human organism)

No.	POSSIBLE CONSEQUENCES	CONSEQUENCES LOCALISED																					
		SKULL	THORAX	ABDOMEN	TEGUMENT	RESPIRATORY APPARATUS	CARDIOVASCULAR APPARATUS	DIGESTIVE APPARATUS	RENAL APPARATUS	OSTEO-ARTICULAR SYSTEM							MUSCULAR SYSTEM	ORGANS OF SENSE				NERVOUS SYSTEM	MULTIPLE
										VERTEBRAL COLUMN	SUPERIOR LIMBS				INFERIOR LIMBS			EYES	NOSE	EAR			
											ARM FOREARM		PALM FINGERS		THIGH , SHANK	LEG				INTERNAL	EXTERNAL		
											R	L	R	L									
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	Wound - cut	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	- prick	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
2.	Contusion	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
3.	Wrench	-	-	-	-	-	-	-	-	-	x	x	x	x	x	x	-	-	-	-	-	-	-
4.	Crushing	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
5.	Fracture	x	x	-	-	-	-	-	-	x	x	x	x	x	x	x	-	-	x	-	-	-	x
6.	Burn - thermal	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	- chemical	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
7.	Amputation	-	-	-	-	-	-	-	-	-	x	x	x	x	x	x	x	-	-	-	-	-	x
8.	Lesions to internal organs	-	-	x	-	x	x	x	x	-	-	-	-	-	-	-	-	-	-	x	-	x	x
9.	Electrocution	-	-	-	x	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x
10.	Asphyxia	-	-	-	-	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11.	Intoxication - acute	-	-	-	x	x	x	x	x	-	-	-	-	-	-	-	-	-	-	-	-	x	x
	- chronic	-	-	-	x	x	x	x	x	-	-	-	-	-	-	-	-	-	-	-	-	x	x
12.	Dermatosis	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13.	Pneumoconiosis	-	-	-	-	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14.	Chronic respiratory diseases caused by organic dust and irritant toxic substances (pulmonary emphysema, bronchitis, etc.)	-	-	-	-	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15.	Bronchial asthma, vasomotor rhinitis	-	-	-	-	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(to be continued)

Annex 2 (continued)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
16.	Diseases caused by exposure to high or low temperatures (shock, caloric collapse, chilblains)	-	-	-	x	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x
17.	Hypoacusis, perception deafness	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-
18.	Blindness	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
19.	Malignant tumors, work-related cancer	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
20.	Chronic arthritis, periarthritis, styloid inflammation, osteochondritis, bursitis, epichondritis, discopathy	-	-	-	-	-	-	-	-	x	x	x	x	x	x	x	-	-	-	-	-	-	x
21.	Vibration disease	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	x	-	x	-
22.	Thrombophlebitis	-	-	-	-	-	-	-	-	-	x	x	x	x	x	x	-	-	-	-	-	-	x
23.	Chronic laryngitis, singer's nodule	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24.	Asthenopia, aggravation of existing myopia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
25.	Cataract	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
26.	Conjunctivitis, kerato-conjunctivitis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
27.	Electro-ophthalmia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
28.	Radiation sickness	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
29.	Illnesses by compression and decompression	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-
30.	Infectious and parasitic diseases	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
31.	Coordination neurosis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-
32.	Cerebro-asthenic syndrome and thermal-regulation disorders (due to high frequency electromagnetic waves)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-
33.	Psychic affections	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-
34.	Other consequences																						

Source: Health Ministry & Labor and Social Protection Ministry

Annex 3

QUOTATION SCALE OF THE SEVERITY AND PROBABILITY OF CONSEQUENCES OF THE ACTION OF RISK FACTORS ON THE HUMAN BODY

SEVERITY CLASSES	CONSEQUENCES	SEVERITY OF CONSEQUENCES
1	NEGLIGIBLE	– minor reversible consequences with predictable disablement, up to 3 calendar days (healing without treatment)
2	LIMITED	– reversible consequences with predictable disablement between 3 - 45 days, which require medical treatment
3	MEDIUM	– reversible consequences with predictable disablement between 45 - 180 days, which require medical treatment including hospitalization
4	IMPORTANT	– irreversible consequences with diminution of the ability to work of maximum 50 % (IIIrd degree invalidity)
5	SEVERE	– irreversible consequences with loss of the ability to work of 50 – 100%, but with capacity of self-service (IInd degree invalidity)
6	VERY SEVERE	– irreversible consequences with total loss of the ability to work and of the self-service capacity (Ist degree invalidity)
7	MAXIMAL	– decease
PROBABILITY CLASSES	**OCCURRENCE**	**PROBABILITY OF CONSEQUENCES**
1	EXTREMELY RARE	Extremely low probability of occurrence of consequences: **$P < 10^{-1}$/year**
2	VERY RARE	Very low probability of occurrence of consequences: **$10^{-1} < P < 5^{-1}$/year**
3	RARE	Low probability of occurrence of consequences: **$5^{-1} < P < 2^{-1}$/year**
4	LOW FREQUENCY	Average probability of occurrence of consequences: **$2^{-1} < P < 1^{-1}$/year**
5	FREQUENT	High probability of occurrence of consequences: **1^{-1}/year $< P < 1^{-1}$/month**
6	VERY FREQUENT	Very high probability of occurrence of consequences: **$P > 1^{-1}$/month**

Source for the second part of the scale (probability classes): adaptation of CEI-812/1985

Annex 4

RISK ASSESSMENT GRID
(COMBINATION BETWEEN SEVERITY OF CONSEQUENCES AND PROBABILITY OF THEIR OCCURRENCE)

			PROBABILITY CLASSES					
			1	2	3	4	5	6
SEVERITY CLASSES	CONSEQUENCES		EXTREM. RARE $P<10^{-1}$/year	VERY RARE $P > 10^{-1}$/year $P < 5^{-1}$/year	RARE $P > 5^{-1}$/year $P < 2^{-1}$/year	LOW FREQ. $P > 2^{-1}$/year $P < 1^{-1}$/an	FREQUENT $P > 1^{-1}$/year $P < 1^{-1}$/ month	VERY FREQ. $P > 1^{-1}$/month
7	MAXIMAL	DECEASE	(7,1)	(7,2)	(7,3)	(7,4)	(7,5)	(7,6)
6	VERY SEVERE	I^ST DEGREE DISABL.	(6,1)	(6,2)	(6,3)	(6,4)	(6,5)	(6,6)
5	SEVERE	II^ND DEGREE DISABL.	(5,1)	(5,2)	(5,3)	(5,4)	(5,5)	(5,6)
4	IMPORTANT	III^RD DEGREE DISABL.	(4,1)	(4,2)	(4,3)	(4,4)	(4,5)	(4,6)
3	MEDIUM	TEMPORARY DISABL. 45 - 180 DAYS	(3,1)	(3,2)	(3,3)	(3,4)	(3,5)	(3,6)
2	LIMITED	TEMPORARY DISABL. 3 - 45 DAYS	(2,1)	(2,2)	(2,3)	(2,4)	(2,5)	(2,6)
1	NEGLIGIBLE		(1,1)	(1,2)	(1,3)	(1,4)	(1,5)	(1,6)

Annex 5

RISKS LEVELS/SAFETY LEVELS SCALE

RISK LEVEL		SEVERITY - PROBABILITY COUPLING	SAFETY LEVEL	
1	MINIMAL	(1,1) (1,2) (1,3) (1,4) (1,5) (1,6) (2,1)	7	MAXIMAL
2	VERY LOW	(2,2) (2,3) (2,4) (3,1) (3,2) (4,1)	6	VERY HIGH
3	LOW	(2,5) (2,6) (3,3) (3,4) (4,2) (5,1) (6,1) (7,1)	5	HIGH
4	MEDIUM	(3,5) (3,6) (4,3) (4,4) (5,2) (5,3) (6,2) (7,2)	4	MEDIUM
5	HIGH	(4,5) (4,6) (5,4) (5,5) (6,3) (7,3)	3	LOW
6	VERY HIGH	(5,6) (6,4) (6,5) (7,4)	2	VERY LOW
7	MAXIMAL	(6,6) (7,5) (7,6)	1	MINIMAL

Annex 6

ENTERPRISE: .... DEPARTMENT:		WORKPLACE ASSESSMENT CARD		NUMBER OF EXPOSED PERSONS: .... EXPOSURE PERIOD:		
WORKPLACE: ……………………………….			ASSESSMENT TEAM:			
WORK SYSTEM COMPONENT	IDENTIFIED RISK FACTORS	ACTUAL FORM OF OCCURRENCE OF THE RISK FACTORS (description, parameters)	MAXIMAl. FORESEEABLE CONSEQUENCE	SEVERITY CLASS	PROBABILITY CLASS	RISK LEVEL
0	1	2	3	4	5	6

Annex 7

PROPOSED MEASURES CARD

No.	WORKPLACE/ RISK FACTOR	RISK LEVEL	PROPOSED MEASURE		
			Measure nomination	Competence/ Responsibilities	Terms

Annex 8

PREVENTION MEASURES HIERARCHY

PRIMARY MEASURES (Ist degree measures)

~~RISK~~ ⇄ HUMAN

RISKS REMOVAL

THE MEASURES MUST HAVE DIRECT EFFECT ON THE SOURCE OF RISK FACTORS (INTRINSIC PREVENTION)

SECONDARY MEASURES (IInd degree measures)

[RISK] ⇄ HUMAN

RISKS ISOLATION

RISK FACTORS ARE PERSISTING, BUT THEIR EFFECT ON PERSONS IS AVOIDED OR DIMINISHED THROUGH COLLECTIVE PROTECTION MEASURES

TERTIARY MEASURES (IIIrd degree measures)

RISK [⇄] HUMAN

RISKS AVOIDANCE

THE INTERACTION BETWEEN RISK FACTORS AND PERSON IS AVOIDED THROUGH ORGANIZATIONAL MEASURES AND REGULATIONS CONCERNING BEHAVIOR

QUATERNARY MEASURES (IVth degree measures)

RISK ⇄ [HUMAN]

HUMAN ISOLATION

THE LIMITATION OF THE ACTION OF RISK FACTORS IS DONE THROUGH PERSONAL PROTECTION

4. APPLICATION EXAMPLE (MINE IGNITER)

WORKPLACE: MINE IGNITER

Work process: Andesite mining from quarry using explosive materials, introduced in outburst holes drilled into the rock by the miner.

Means of production used for transport of explosive materials and andesite mining:

- truck;
- explosive materials (astralite, dynamite, nitramon, firing lanyard, blasting fuses);
- installations for the initiation of the explosion.

Work Task of the mine igniter comprises:

- transportation with motor vehicles of explosive materials from the explosive deposit to the quarry;
- filling of outburst holes with explosive materials;
- preparation of the installation for the initiation of the explosion;
- securing the impact zone.

Work environment: The work process occurs in open air, workers being exposed to bad weather during certain periods of the year.

Card no. 1

ENTERPRISE: S.C.CARB S.A. BRASOV DEPARTMENT: MALNAS	**WORKPLACE ASSESSMENT CARD**					NUMBER OF EXPOSED PERSONS: 2 EXPOSURE PERIOD: 8 hours/shift
WORKPLACE: MINE IGNITER		**ASSESSMENT TEAM:** Eng. Stefan PECE, Eng. M. NICOLESCU, Eng. V. MIRCEA, Eng. S. HAVEL (Head of Department), Eng. A. SARAMET				
WORK SYSTEM COMPONENT	**IDENTIFIED RISK FACTORS**	**ACTUAL FORM OF OCCURRENCE OF THE RISK FACTORS (description, parameters)**	**MAXIMAL FORESEEABLE CONSEQUENCE**	**SEVERITY CLASS**	**PROBABILITY CLASS**	**RISK LEVEL**
0	1	2	3	4	5	6
MEANS OF PRODUCTION - truck - explosive materials - explosion initiation installations	DANGEROUS MOTIONS	1. Accident caused by motion of the motor vehicle, by surprise, during loading, transport and storage of the explosive material from the supplier, own deposit and quarry	DECEASE	7	1	3
		2. Motor vehicle collision or falling during transport of explosive material	DECEASE	7	2	4
		3. Falling of rocks from the slope during the filling of outburst holes with explosive	DECEASE	7	3	5
(to be continued)	ELECTRICAL POWER	4. Electrocution by direct or indirect touching cables with damaged insulation for power supply to excavating machines, drill and electro-compressor	DECEASE	7	3	5

Card no. 1 (to be continued)

Card no. 1 (continued)

MEANS OF PRODUCTION (continued)	EXPLOSIVE SUBSTANCES	5. Explosion caused by external factors (contact of the firing circuit with an electrical source, atmospheric electric discharges) 6. Explosions when performing the operation of liquidation of unexploded holes 7. Explosions due to inadequate quality of the explosive material (batches with quality faults, expired materials, frozen materials which become very sensitive to manipulation)	DECEASE DECEASE DECEASE	7 7 7	3 3 2	5 5 4
WORK ENVIRONMENT	AIR TEMPERATURE	8. Low temperature during winter and high temperature during summer	TEMPORARY DISABLEMENT (T.D.) 3-45 DAYS	2	5	3
	CURRENTS OF AIR	9. Frequent currents of air	T.D. 3-45 DAYS	2	5	3
	NOISE	10. Noise over 90 dB from the HC-848 drill (deafness)	III-rd DEGREE DISABLEMENT	4	2	3
	NATURAL CALAMITIES	11. Lightning, landslides, caving 12. Wind, snow storm	DECEASE III-rd DEGREE DISABLEMENT	7 2	2 5	4 3
	DUSTS LIKELY TO GENERATE PNEUMO-CONIOSIS	13. Andesite dust with SiO2 contents (inhalation, eye affection)	III-rd DEGREE DISABLEMENT	5	3	4
WORK TASK	PSYCHIC STRAIN	14. Psychic strain due to permanent concentration for the performance of work operations using explosive materials	T.D. 3-45 DAYS	2	4	2

(to be continued)

Card no. 1 (continued)

WORKER	ERRONEOUS ACTIONS	15. Transportation of explosive materials with inadequate means (metallic clamshell, etc.)	DECEASE	7	2	4
		16. Inadequate handling (by throwing, slamming, dropping from hands) of explosive material	DECEASE	7	3	5
		17. Filling of drilled holes with sensitive explosive (dynamite), by letting it to fall freely	DECEASE	7	2	4
		18. Failure to use Brickford firing lanyard corresponding to the number of holes that are being fired simultaneously	DECEASE	7	2	4
		19. Tearing out "reufors" from electric fuses	DECEASE	7	2	4
		20. Failure to observe the time limit set to enter the quarry face, after the explosion or the misfire	DECEASE	7	2	4
		21. Failure to observe the outburst dispositions (quantity of explosive, explosion initiation type, holes location monograph, etc.)	DECEASE	7	2	4
		22. Stationing in dangerous areas (within the range of the excavating machine or vehicles, slope)	DECEASE	7	3	5
		23. Falling from the same level, by slipping, unbalancing or stumbling	T.D. 3-45 DAYS	2	4	2
		24. Fall from the edge of the quarry face (20-35 m)	DECEASE	7	2	4
(to be continued)		25. Utilization of ferrous metallic tools (sparks)	DECEASE	7	1	3

Card. No. 1 (to be continued)

Card no. 1 (continued)

(continued)	OMISSIONS	26. Failure to use protective equipment (hard hat)	DECEASE	7	3	5
		27. Failure to secure the site of initiation of the explosion (adequate distances and protective constructions)	DECEASE	7	2	4

The global risk level is:

$$N_{r2} = \frac{\sum_{i=1}^{27} r_i R_i}{\sum_{i=1}^{27} r_i} = \frac{7(5\times 5)+12(4\times 4)+6(3\times 3)+2(2\times 2)}{7\times 5+12\times 4+6\times 3+2\times 2} = \frac{634}{124} = 4{,}08$$

$N_{r2} = 4{,}08$

Card no. 2

PROPOSED MEASURES CARD

No	WORKPLACE/ RISK FACTOR	RISK LEVEL	PROPOSED MEASURE		
			Measure nomination	Competence/ Responsibilitie s	Terms
0	**1**	**2**	**3**	**4**	**5**
1	Rocks falling on the slope when filling mining holes with explosive	5	Mandatory detachment with levers, before drilling and filling holes	Head of dept. Mining foreman	Permanent
2	Electrocution by direct or indirect touching cables with damaged insulation for power supply to excavating machines, drill and electro-compressor	5	Replacement of the cables with damaged insulation. Quarterly verification of electrical insulation.	Head of dept. Chief of energy office	Permanent
3	Explosion attributable to external factors (contact of electrical firing circuit from an electric source, electrical discharges in the atmosphere)	5	Insulation of the firing circuit. Performance of firing operations in favorable weather.	Head of dept.	Permanent
4	Explosions when performing the operation of liquidation of unexploded holes	5	The liquidation of unexploded holes shall be performed only in the presence of the mining foreman, observing the procedure specified by NPM-EMZ, art. 178-197	Head of dept. Head of work protection compartment	Permanent
5	Inadequate handling (by throwing, slamming, dropping from hands) of the explosive material	5	Prescriptions in art. 3.1. – 3.15. of Law no. 126/1995 shall be observed when handling explosive materials	Head of dept. Head of work protection compartment	Permanent
6	Stationing in dangerous areas (within the range of the excavating machine or vehicles, slope)	5	Safety distance shall be observed when in the presence of machines on quarry face	Head of dept. Mining foreman	Permanent

Card no. 2 (to be continued)

Card no. 2 (continued)

7	Failure to use protective equipment (hard hat)	5	Periodic supply of personal protective equipment; endowment of workers in accordance with the Normative-framework; non-admittance of workers at work without the personal protective equipment	Head of dept. Head of work protection compartment Mining foreman	Permanent
8	Motor vehicle collision or falling during transport of explosive material	4	Prescriptions in art. 3.12. – 3.15. of Law no. 126/1995 shall be observed when transporting explosive materials	Head of dept. Chief of transport unit	Permanent
9	Explosions due to inadequate quality of the explosive material (batches with quality faults, expired materials, frozen materials which become very sensitive to manipulation)	4	The verification of explosive materials shall be made according to art. 6.1. – 7.4. of Law no. 126/1995 shall be observed	Head of dept. Chief of explosive store. Mining foreman	Permanent
10	Lighting, landslides or caving	4	The operations of filling drilled holes and firing shall be performed only when allowed by meteorological conditions	Head of dept. Head of work protection compartment Mining foreman	Permanent
11	Andesite dust with SiO2 contents (inhalation, eye affection)	4	Utilization of masks against dust	Head of dept. Head of work protection compartment	Permanent
12	Transportation of explosive materials with inadequate means (metallic clamshell, etc.)	4	Explosive materials transportation shall be made according to the provisions of Law no. 126/1995	Head of dept. Chief of transport unit	Permanent
13	Filling of drilled holes with sensitive explosive (dynamite), by letting it to fall freely	4	Filling of drilled holes shall be made with a string, according to art. 126 of NPM-EMZ	Head of dept. Mining foreman	Permanent

Card no. 2 (to be continued)

Card no. 2 (continued)

14	Failure to use Brickford firing lanyard corresponding to the number of holes that are being fired simultaneously	4	The monograph of holes location, drawn up before the blast, shall be observed	Head of dept. Head of work protection compartment	Permanent
15	Tearing out “reufors” from electric fuses	4	The handling of electric shall be made according to the procedure in Law no. 126/1995	Head of dept. Mining foreman	Permanent
16	Failure to observe the time limit set to enter the quarry face, after the explosion or the misfire	4	Entering the quarry face shall only be permitted after the free pass signal	Mining foreman	Permanent
17	Failure to observe the outburst dispositions (quantity of explosive, explosion initiation type, holes location monograph, etc.)	4	The blast monograph shall be observed	Head of dept. Mining foreman	Permanent
18	Fall from the edge of the quarry face (20-35 m)	4	Installation of warning signs against the hazard of falling down from the quarry	Head of dept. Mining foreman	Permanent
19	Failure to secure the site of initiation of the explosion (adequate distances and protective constructions)	4	Minimal recommended distances shall be observed, depending on the quantity of explosive	Head of dept. Mining foreman	Permanent
20	Low temperature during winter and high temperature in the summer	3	Adequate protective and work equipment	Head of dept. Head of work protection compartment	Permanent
21	Frequent currents of air	3	Adequate protective and work equipment	Head of dept. Head of work protection compartment	Permanent
22	Noise over 90 dB from the HC-848 drill (deafness)	3	Internal and external type protective devices	Head of dept. Head of work protection compartment	Permanent

Card no. 2 (to be continued)

Card no. 2 (continued)

23	Wind, snow storm	3	Adequate protective and work equipment	Head of dept. Head of work protection compartment	Permanent
24	Accident caused by motion of the motor vehicle, by surprise, during loading, transport and storage of the explosive material from the supplier, own deposit and quarry	3	The prescriptions of Law no. 126/1995 shall be observed when loading, transporting and depositing explosive materials	Head of dept. Head of work protection compartment	Permanent
23	Use of ferrous metallic tools (producing sparks)	3	The use of metallic tools is forbidden when filling holes	Head of dept. Mining foreman	Permanent
26	Falling from the same level, by slipping, unbalancing or stumbling	2	Circulation ways shall be cleaned and carefully maintained	Head of dept.	Permanent
27	Psychic strain due to permanent concentration for the performance of work operations using explosive materials	2	Rest pause of 15 minutes after each 45 minutes of work	Head of dept. Mining foreman	Permanent

5. CONCLUSIONS

1. This assessment method belongs to category of analytical, semi-quantitative methods, complying with European standards in this field (CEI 812/85, EN 292-1/93 and EN 1050/96).
2. The basis for the assessment of occupational accidents and diseases risks is constituted by the above mentioned standards and by the provisions Articles 10 and 16 of the General Labour Protection (National) Norms.
3. The application of the method is to be made only by specialists (assessors), duly trained and authorised for such activity.
4. The assessment team will include the inspector of the undertaking and the technologist, in addition to the proper assessor. The team may also include representatives of the trade union and of the employer.
5. Before commencing the assessments, all members of the assessment team must have knowledge of the assessment method as well as, up to a certain degree, of the workplace to be examined.
6. The application of the method results in two cards for each workplace:
   - the risk assessment card;
   - the proposed measures card.
7. The application of this method into the enterprise will allow:

a) to identify all risk factors at workplaces, operation that is necessary in order to <u>authorise</u> the enterprise and to draw up its <u>own instructions</u> concerning safety at work;

b) to scan the existing situation of each workplace, in such manner as to ascertain acceptable risks or risks situated under the risk acceptability curve;

c) to ascertain the dimension of risks (risk levels) at each workplace, as well as their hierarchy;

d) to set priorities regarding prevention measures for each workplace, respectively the optimal utilisation of resources assigned for such purpose;

e) to set a hierarchy of workplaces from the point of view of danger and noxiousness;

f) to compare different workplaces as with regard to occupational accident and disease hazards, with applications for the optimal use of economic lever factors;

g) to manage the risks at workplaces with computer-aid techniques, if databases are established with the results of the assessment.

ANNEX 9

SPECIFIC TERMINOLOGY

Work process:

Succession in time and space of the combined actions of the performer and means of production within the work system.

Work system:

Aggregate constituted with a view to perform a work process by one or several performers, their working task, means of production and working environment, whose components interact on the basis of an information circuit. By definition, work-related accidents and diseases occur exclusively within the work system, being the results of risk factors generated by the system.

Performer:

Person directly involved in the execution of a working task.

Working task:

The totality of actions that must be executed by the performer, by the instrumentality of the means of production, and in certain environment conditions, in order to achieve the purpose of the work system.

Means of production:

The aggregate of means of work (buildings, installations, machines, tools, means of conveyance, etc) and objects of work (raw materials, intermediate goods, etc) utilised in the process of goods production process.

Work environment:

The aggregate of physical, chemical, biological and psycho-social conditions in which one or several performers carry on their working task.

Work-related accident or disease risk:

The possibility of occurrence of an accident or disease, with a certain frequency and severity of consequences.

Work-related accident or disease risk factors (abbreviated Risk factors):

Factors that correspond to the elements involved in the performance of the work process (characteristics, states, processes, phenomena, behaviors) that may provoke, in certain conditions, work-related accidents or diseases.

Note : Risk factors are potential causes of work-related accidents and diseases, depending on the performer, the working task, the means of production and the working environment. Their identification, at the level of each element of the work system, represents the first step in the assessment of risks, as well as an important goal of the prevention activity.

Risks assessment:

Activity aimed to determine the dimension of risks (risk level) within a work system; it consists of identifying risk factors and quantifying work-related accidents and diseases risks. Quantifying risks implies determining the risk level, based upon the combination between the probability of occurrence of a work-related accident or disease and the severity of the consequences for the performer (temporary disablement, invalidity, decease).

Assessor:

Natural or legal person qualified to assess work-related accidents and diseases risks.

Risk level:

Conventional aggregate and cumulative indicator expressing the dimension of the existing work-related accidents and diseases risks within a work system. It is determined during the assessment activity, on the basis of the combination between the severity and the probability of the maximal foreseeable consequences of the action of existing the risk factors within that system on the staff.

Acceptable risk level:

Risk level accepted by social conventions as far as safety at work is concerned.

Safety at work:

Such state of the elements involved in the performance of the work process that precludes risk factors to have effects upon the performer. It is an ideal state that the prevention activity tends to reach. In reality, there are various levels of safety at work, characteristic for each work system, with different corresponding risk levels of work-related accidents or diseases, none of them excluding completely all risks.

Safety level:

Conventional indicator expressing globally the state of safety at work within a work system. It is determined indirectly, by ascertaining the risk level, being inversely proportional to the latter.

Safety function:

Function of a technical equipment or mean of production allowing either risks to be eliminated or reduced, or their presence to be signaled.

Prevention of work-related accidents and diseases:

Aggregate procedures and measures adopted or planned, at all working stages, in order to prevent or reduce risks.

Intrinsic prevention:

Prevention achieved by introducing safety criteria in the draft and design of technical equipment, technologies, constructions, etc., acting on shape, location, mode of installation, construction and functioning principle, without adding elements which are specially conceived for the achievement of safety at work. Intrinsic prevention implies elimination of risks at design stage.

Work-related accidents and diseases prevention measures:

Technical and organisational modalities for the achievement of safety at work.

Protection (against the occurrence of work-related accidents and/or diseases):

Aggregate measures consisting of the utilisation of specific means aiming at the protection of performers against risks that have not been eliminated by intrinsic prevention.

Collective protection:

Protection consisting of the utilisation of technical protection means meant to provide protection for two or more performers.

Personal protection:

Protection consisting of the utilisation of personal protection means meant to provide protection for one performer.

Conditional protection:

Protection consisting of the utilisation of technical protection means for which the safety function depends upon the performer.

Unconditional protection:

Protection consisting of the utilisation of technical protection means for which the safety function is independent of the performer.

Protection mean:

Product meant for protection against work-related accident(s) or disease(s).

Work safety norm:

Aggregate of regulations and legal provisions by which requirements are specified for the unfolding of an activity in conditions of safety at work.

BIBLIOGRAPHY

1. **** - Directive 89/391/CEE on the introduction of measures to encourage improvements in the safety and health of workers at work
2. **** - CEN-812/85 Standard: Machines safety. Analysis of failure modes and of their effects.
3. SR EN 292-1/1996 - Safety of machinery. Basic concepts, general design principles.
4. CEI-300-3-1,1991 - Gestion de la sureté de fonctionnement. Partie 3: Guide d'application. Secton 1: Technique d'analyse de la sureté de fonctionnement. Guide méthodologique.
5. CEI-1078, 1991 - Techniques d'analyse de la sureté de fonctionnement. Méthode du diagramme de fiabilité.
6. EN 1050/1996 - Safety of machinery. Principle for risk; Assessment.
7. DÃSCÃLESCU A., PECE Şt. - Elaboration of the enterprise analysis methodology from the point of view of safety at work, I.C.S.P.M., 1993.
8. PECE Şt. - Work-related accidents and diseases risks assessment method in the activity of the National Electric Power Administration, I.C.S.P.M., 1994
9. PECE Şt. – *A-priori* analysis methods for occupational risks, I.N.I.D., Bucharest, 1993;
10. PECE Şt. – Method for the assessment of safety at work at micro-systems (workplace) level - Risk and safety at work, I.C.S.P.M., no. 3-4/1994.