

## Characteristics of selected methods of risk assessment

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### SUMMARY

The risk assessment forms the basis for the employer's use of work organisation and the creation of workplaces to protect employees against accident risks and the impact of harmful and disruptive factors. Risk assessment is also the basis for the identification and elimination by the employer of risks to the health and life of workers through the use of appropriate technologies, equipment, materials and substances that do not cause such risks. In cases where it is not possible to reduce the risk by this route, the employer is obliged to apply appropriate collective protection measures and, as a last resort, personal protective equipment. If

significant changes are introduced, the occupational risks associated with the new risks must be assessed. Each time new machinery is purchased, new substances or technologies are introduced which may give rise to new risks, the risks involved must be reassessed. The aim of this work is to characterise the selected methods by which a comprehensive risk assessment can be carried out at the workplace.

**Keywords:** *risk assessment, assessment methods, occupational hazards*

## **INTRODUCTION**

Pursuant to Article 226 of the amended Labour Code, the employer is obliged to assess and document occupational risk, as well as to inform employees about the risk related to the work performed [1].

Similar requirements are also introduced by the Ordinance of the Minister of Labour and Social Policy of 26 September 1997 on general regulations on health and safety at work, which obliges the employer to carry out and document the assessment of occupational risk occurring during specific works and to apply the necessary preventive measures to reduce the risk [2].

These requirements result directly from the European Union directive. Pursuant to Article 6 of the Framework Directive 89/391/EEC, the employer should take the necessary measures to ensure the safety and health of workers, including the prevention of occupational risks. When taking these measures, the employer should take into account the basic principles of prevention formulated in the directives [3].

At present, there are already many developed methods of risk assessment, however, in the Polish conditions, only some of them are very popular [4]. The aim of this work is to characterize selected methods of risk assessment at the workplace.

## **RISK ASSESSMENT ACCORDING TO THE POLISH STANDARD PN-N-18002**

An estimation of the occupational risks associated with the individual hazards identified at workstations is based on identification:

- the likelihood of the occurrence of hazards
- the severity of the harmful effects of these hazards.

The magnitude of the risk (R) associated with hazards is the product of the severity of the harmful effects of the hazard (C) and the probability of their occurrence (P).

$$R = C * P$$

Risk estimation (R) shall be carried out on a three- or five-step scale. Below, a five-step scale will be applied in accordance with the guidelines of the Polish Standard.

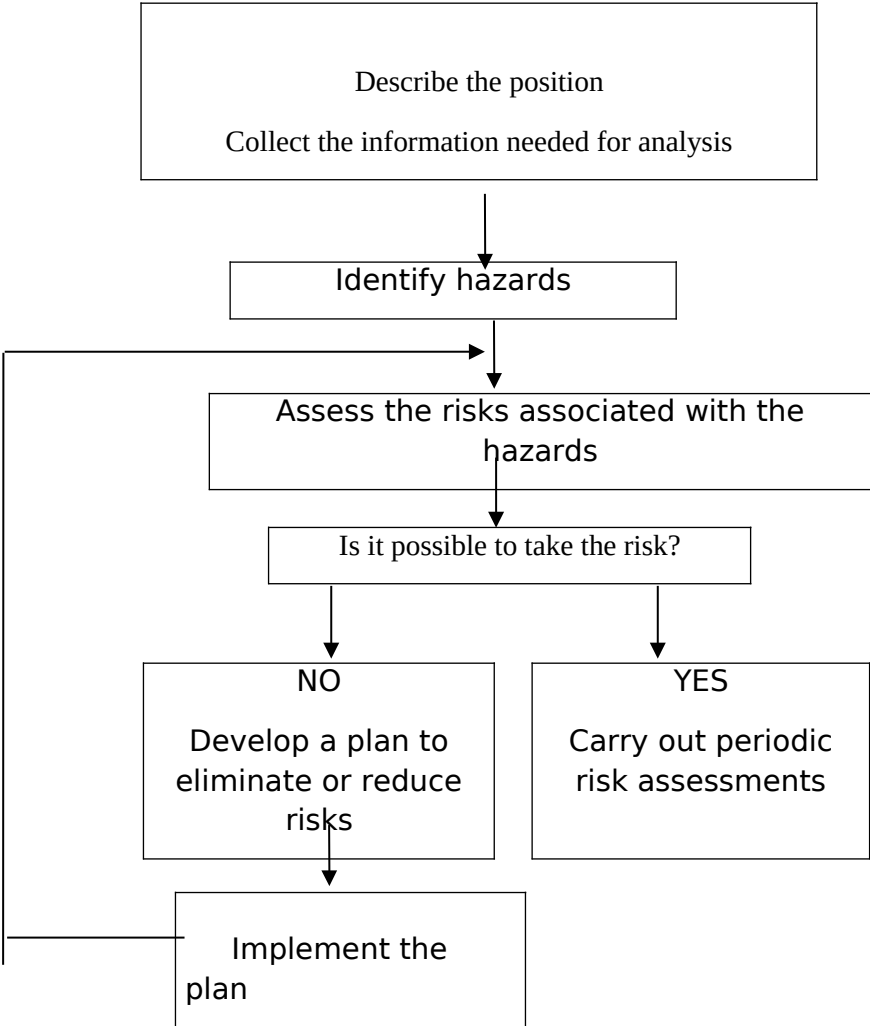


Fig. 1 Risk assessment process at the workplace

Tab. 1: Occupational risk estimation on a five-step scale :

| PLAUSIBILITY    | HEAVINESS OF CONSEQUENCES |             |                 |
|-----------------|---------------------------|-------------|-----------------|
|                 | Small                     | Medium      | Large           |
| Unlikely        | Very small<br>1           | Small<br>2  | Medium<br>3     |
| Likely          | Small<br>2                | Medium<br>3 | Large<br>4      |
| Highly probable | Medium<br>3               | Large<br>4  | Very large<br>5 |

These variables are determined using the following guidelines:

- Low-harmful consequences include those injuries and illnesses that do not cause long-term discomfort and absenteeism; these are temporary health problems such as minor injuries and injuries, eye irritation, symptoms of minor poisoning, headaches, etc. The Commission will continue to work on the basis of the principles of subsidiarity and proportionality,
- Medium-harmful consequences include those injuries and illnesses that cause minor but prolonged or recurrent problems and are associated with periods of absence; these are e. g. injuries, second-level burns on a small area of the body, skin allergies, uncomplicated fractures, musculoskeletal overload syndromes (e. g. tendonitis), etc. The consequences of such injuries and illnesses are those that cause minor but prolonged or recurrent illnesses and are associated with periods of absence; these are e. g. injuries, second-level burns on a small area of the body, skin allergies, uncomplicated fractures, musculoskeletal overload syndromes (e. g. tendonitis), etc.
- Highly harmful consequences include those injuries and illnesses that cause serious harm and permanent ailments and/or death; these are e. g. 3rd degree burns on a large body surface, amputations, complex fractures, cancer, toxic damage to internal organs and the nervous system, vibration syndrome, occupational hearing loss, asthma, cataracts, etc.
- unlikely are those consequences of risks that should not occur during the entire working life of the worker,

- probable are those consequences of hazards that can occur no more than several times during the worker's working life,
- highly probable are those consequences of risks that can occur several times during an employee's working life.

On the basis of these indications, a risk analysis card should be drawn up for workers in the positions to be assessed. The symbols appearing in the columns are explained below: "The "severity of consequences", "Probability", "Risk", and "Admissibility of occupational risk".

| Symbols for risk assessment: |                 |
|------------------------------|-----------------|
| BD                           | Very large      |
| D                            | Large           |
| S                            | Medium          |
| M                            | Small           |
| BM                           | Very small      |
| MP                           | Unlikely        |
| P                            | Likely          |
| WP                           | Highly probable |

| Symbols for determining the acceptability of occupational risks: |                            |
|--|----------------------------|
| A  | Tolerable level of risk    |
| NA   | Unacceptable level of risk |

| OCCUPATIONAL RISK ASSESSMENT | ADMISSIBILITY OF OCCUPATIONAL RISK | NECESSARY ACTIONS  |
|------------------------------|------------------------------------|--|
| Very large - 5               | Unacceptable                       | Work may not be commenced or continued until the occupational risk has been reduced to an acceptable level.  |
| Large - 4                    |                                    | If the occupational risk is related to the work already carried out, measures to reduce it must be taken immediately (e. g. by applying protective measures). The planned work may not be commenced until the occupational risk has been reduced to an acceptable level. |
| Medium - 3                   | Tolerable                          | It is advisable to plan and take measures to reduce occupational risks.  |
| Small - 2                    |                                    | It is recommended that consideration be given to further reducing the level of occupational risk or to ensuring that occupational risk remains at most at the same level.  |
| Very small - 1               |                                    | No action required   |

If the risk is estimated at "very large" or "large" levels, i. e. an unacceptable level of risk, immediate action should be proposed to reduce the risk to an acceptable level. In this case, a 'corrective and/or preventive action plan' card should be established, following the model below, to help organise the changes made. Work should not start until the risk has been reduced to an acceptable level.

| Lp | Description of the project | Implementation of the task |                    |                         | Expected results  |  |
|----|----------------------------|----------------------------|--------------------|-------------------------|---|--|
|    |                            | Deadline for completion    | Responsible person | Estimated amount [ PLN] | Identification of the type of hazards or nuisances that may be eliminated | Number of people to whom working conditions will be improved |
|    |                            |                            |                    |                         |   |  |

In the case of the estimation of occupational risk at "medium" or "small" levels, i. e. acceptable risk level, it is recommended to plan and take measures to reduce the level of risk or to ensure that it is maintained at the same level at the most.

In the case of a "very small" risk assessment, no action is necessary. This is an acceptable level of risk [5].

## RISK ASSESSMENT BY THE PHA METHOD

PHA (Preliminary Hazard Analysis) method, often used in the initial stages of workstation design, work planning, preliminary assessment of technological lines and industrial installations. The assessment team determines the list of hazards, situations and dangerous events that may occur in all points of the area under consideration. Hazards are assessed and the likelihood of their occurrence and the degree of anticipated effects (injury, loss of health) are determined. In the final stage, the means of monitoring the safety status are established. Several levels are usually used to determine the severity/degree of damage and the likelihood of it occurring. The "Table 2" presents examples of grades of evaluation used in the PHA method [6].

The value of the product of the determination of damage levels and probability forms the basis for risk reduction decisions in the planning of works.

Table 2. :

| Level | Degree of damage                          | Likelihood                                 |
|-------|---|--|
| 1.    | Minor injuries, minor damage              | Very unlikely                              |
| 2.    | Light injuries, measurable damage         | Unlikely, occurring once every 10 years    |
| 3.    | Severe injury, significant damage         | Ad hoc events (once a year)                |
| 4.    | Individual fatal accidents, severe damage | Quite frequent events (e. g. once a month) |

|    |   |   |
|----|---|---|
| 5. | Collective fatal accidents, very large scale damage on site | Frequent regular events (e. g. once a week) |
|----|---|---|

The tables on the basis of which the risk acceptability decision can be made are also used: Table 3.

Table 3.:

| Characteristics of S and P parameters and risk values W |  |                      |                                       |               |  |
|---|--|----------------------|---------------------------------------|---------------|--|
| Degree of damage  |  | Likelihood of damage |                                       | Risk          |  |
| S=1   | Minor injuries, minor damage                                 | P=1                  | Very unlikely                         | W=1           | Acceptable risk                                |
| S=2   | Light loads, measurable damage                               | P=2                  | Unlikely to occur once every 10 years | Up to<br>W=6  |  |
| S=3   | Heavy loads, measurable damage                               | P=3                  | Ad-hoc events occurring once a year   | W=8           | Acceptable acceptance of risk after evaluation |
| S=4   | Individual fatal accidents, quantifiable damages             | P=4                  | Quite frequent monthly events         | Up to<br>W=15 |  |
| S=5   | Collective fatal accidents, quantifiable damages, breakdowns | P=5                  | Frequent weekly events                | W=16          | Unacceptable risks                             |
| S=6   | Disasters, quantifiable damage, many deaths                  | P=6                  | Very likely                           | Up to<br>W=36 |  |



## RISK SCORE APPROACH TO RISK ASSESSMENT

The Risk Score Method has been developed in the USA. It is a method that meets the requirements of all international standards. In this method, each parameter is assigned a certain value, based on the developed tables. Each value (effects, exposure, probability) should be multiplied by oneself and in this way a numerical estimation of the risk is obtained, which is then converted into a risk category.

Formula of risk estimation with the Risk Score method:

$$R = S \times E \times P$$

Where:

**R** – Estimated value of occupational risk

**S** – Effect, loss (potential)

**E** – Exposure to a hazard

**P** – Likelihood of the occurrence of an event with respect to the losses in question

To determine the elements of risk assessment (S, E, P) for a given risk, the method defines the following criteria (a numerical value corresponding to the description is inserted into the formula):

Characteristics of parameters of the Risk Score method

| <b>Worth</b> | <b>Loss</b>         | <b>1. Potential losses</b> |                        |
|--------------|---------------------|----------------------------|------------------------|
|              |                     | <b>Human losses</b>        | <b>Material losses</b> |
| <b>100</b>   | Serious catastrophe | Many deaths                | Over 25 mln PLN        |
| <b>40</b>    | Catastrophe         | Several fatalities         | 5-25 mln PLN           |
| <b>15</b>    | Very large          | Fatalities                 | 500 tho.-5 mln PLN     |
| <b>7</b>     | Large               | Severe bodily injury       | 25-500 tho. PLN        |
| <b>3</b>     | Medium              | Absenteeism                | 5-25 tho. PLN          |
| <b>1</b>     | Small               | Provision of first aid     | Under 5 tho. PLN       |

## 2. Exhibition

| <b>Worth</b> | <b>Description</b>               |
|--------------|----------------------------------|
| <b>10</b>    | Permanent                        |
| <b>6</b>     | Frequent (daily)                 |
| <b>3</b>     | Occasional (once a week)         |
| <b>2</b>     | Occasional (monthly)             |
| <b>1</b>     | Minimum (several times per year) |
| <b>0,5</b>   | Minor (once a year)              |

## 3. Likelihood

| <b>Worth</b> | <b>Description</b>          | <b>Opportunity in %</b>  |
|--------------|-----------------------------|--------------------------|
| <b>10</b>    | Very likely                 | 50% (1 in 2)             |
| <b>6</b>     | Quite likely                | 10% (1 in 10)            |
| <b>3</b>     | Unlikely but possible       | 1% (1 in 100)            |
| <b>1</b>     | Only occasionally possible  | 0,1% (1 in 1000)         |
| <b>0,5</b>   | Unthinkable                 | 0,01% (1 in 10 000)      |
| <b>0,2</b>   | Practically impossible      | 0,001% (1 in 100 000)    |
| <b>0,1</b>   | Only theoretically possible | 0,0001% (1 in 1 000 000) |

After calculating the value of occupational risk by multiplying the values for the three aforementioned factors, the numerical result obtained is assigned to the appropriate category, according to the classification described in the following chapters.

### **Risk categories: tolerable/unacceptable risk**

| <b>Risk categories</b> | <b>Worth [R]</b> | <b>Action</b>       |
|------------------------|------------------|---------------------|
| <b>Excludable</b>      | R < 20           | No action is needed |
| <b>Low risk</b>        | 20 <= R < 70     | Please note         |

|                       |                    |                              |
|-----------------------|--------------------|------------------------------|
| <i>Medium risk</i>    | $70 \leq R < 200$  | Improvement needed           |
| <i>High risk</i>      | $200 \leq R < 400$ | Immediate improvement needed |
| <i>Very high risk</i> | $R \geq 400$       | Consider stopping work       |

The acceptable risk level includes categories 1 and 2. Starting from category 3, there is an unacceptable risk, according to the Risk Score method, which requires action to be taken to reduce it to an acceptable level [7].

## CONCLUSION

This paper presents three methods of occupational risk assessment at the workplace which are popular in Poland. In order to ensure safe and hygienic working conditions, a comprehensive risk assessment should be carried out at every workplace. The established risk assessment team is free to choose the assessment method. It is important that everyone involved in the risk assessment has the necessary information and skills to carry out the risk assessment properly [8].

## LITERARY ACTIVITY

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