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Comparative occupational risk assessment in a CNC machine tool operator position

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Abstract

Law requires from employers to assess occupational risk in workplaces. A well-executed occupational risk assessment promotes the improvement of working conditions and reduces a negative impacts on employees' health and life. Employers by conducting occupational risk assessment not only meet legal requirements but also benefit from it in two ways. They eliminate loss of an enterprise connected with employees' absence, and they also decrease the probability of high compensation pay due to situations that have a destructive influence on the employees' health. However, in order to benefit from such actions, firstly, it is necessary to select a risk assessment method properly, then to apply it and implement preventive measures. The paper presents the results of the occupational risk assessment carried out on the example of a CNC machine operator by means three-stage methods in accordance with the PN-N-18001, PHA and Risc Score. Despite the subjectivity of the assessment, there were differences in the results. Thus, it is advisable to choose a risk assessment method skilfully, for example by comparing several similar methods.

1. Introduction

Occupational risk assessment is a primary prevention and health task in every workplace. This assessment is mainly intended to ensure the safety of employees and to eliminate or partially reduce existing threats by taking appropriate remedies. Employers, by carrying out occupational risk assessments, in their workplaces not only meet legal requirements, but also they benefit in two ways: they eliminate companies' loss related to absence of employees and to the need to pay high compensations in cases that are destructive for employees' health. Therefore, identifying hazards at every workplace is an extremely important part of an appropriate health and safety policy. Correctly estimated likelihood and risk tolerance statement of a particular risk, make employers and workers aware of how important it is to use health and safety regulations in everyday work circumstances and to use appropriate protection measures to prevent or minimize possible consequences of unforeseen dangerous situations. (ULEWICZ R., ŻYWIOŁEK J. 2016, KABER D., ZAHABI M. 2017)

Occupational risk assessment is not a one-time process but a repetitive one. If changes have been made to the organiza-

tion of work, requirements, protective measures using or new equipment or materials have been introduced, a risk assessment process should be repeated. An occupational risk assessment process should also be repeated if it is necessary to reduce the risk after the assessment was carried out, of course, after a prior selection and the application of appropriate safety measures. An occupational risk assessment should be performed by a team of at least two people, and, also, with appropriate knowledge and experience in this area. (KRAUSE M. 2011, WOŻNY A., PACANA A. 2014, NOWICKA-SKOWRON M., ULEWICZ R. 2016)

The methodology of conducting occupational risk assessment includes 4 main steps: collecting information, identification of hazard, occupational risk evaluation and determination of occupational risk admissibility (PN-N 18002:2011).

There are many methods of occupational risk assessment, therefore, subject literature divides the methods of occupational risk assessment. Current division of methods include dividing into inductive and deductive, and quantitative and qualitative methods. It is important to select an adequate method out of such a variety to properly assess occupational risk in a particular workplace. Employees responsible for safety and health, sometimes try to use one risk assessment

methodology for all job positions. It is not the most advantageous solution, as there are various risks in different workplaces (ROMANOWSKA-SŁOMKA I., SŁOMKA A. 2104)

What is more, for example, there are different types of dangers that occur in locations where conventional cutting machines and CNC machines are situated. Hence, it seems advisable to diversify methods of risk assessments according to the risk in different positions and, at the same time, to discover as adequate as possible for a specific position. An attempt to do this is presented in the paper in relation to the position of the operator of numerically controlled machines.

2. Characteristic of the position of CNC machine operator

Machine toll-controlled with a computer (CNC) performs automated processing with CNC computer control. The computer integrated with a system takes over the whole control process as well as the control functions of the machine. This computer supervises all the movements in the machining process, machining parameters and auxiliary operations so as to obtain the product with the de-sired features of shape, dimension and specific surface. These facts affect the specific hazards of this workplace. A CNC machine toll operator should have appropriate qualifications. (RACHIERU N., BELU N., ANGHEL D.C. 2015, YIN C., ET AL. 2013, ZHU X.C., ET AL. 2013, LESTYANSZKA-SKURKOVA K. 2017)

Work at the operator's station is an individual work, typically 8 hours, sometimes shifted. This work requires a long period of focus, both visual and auditory concentration. During work, there may be increased energy expenditure, monotony of activity, monotonous position of the body. It is forbidden to wear loose clothing while working at the operator station. The microclimate of work can most often be assumed to be stable, which is beneficial for the tasks performed. The work should be performed in a closed, heated, well exposed and ventilated room.

Working as a CNC machine operator's connected with the risk of both dangerous and harmful or disruptive factors. Their occurrence is likely to result in an accident at work and it is imperative that an operator must follow the required health and safety measures every day.

Performing work in the operator's CNC machine position is associated with the occurrence of dangerous mechanical factors causing injuries. Examples include moving parts of used machines, falling machine parts or hot surfaces. Hazardous substances also include the dangers of electric shock. The harmful factors occurring during the work in the operator position of CNC machines are, for example, noise and vibration, oil mists or grinding dusts, and temperature and humidity of the air. The onerous factors affecting the operator of a numerically controlled machine tool may include many hours of standing work, stress and physical exertion. Negative effects of such threats entail, but are not limited to, tendons and backbone injuries, limb injuries, but also psychological stress.

3. Risks at the position of CNC machine tool operator

Risks in a particular workstation after being identified should be classified. Danger that was identified in CNC machine tool operator's work-place is presented in the Tab. 1. It was supported with the Polish standard PN-N-18002 and the guidelines of the Polish Labor Inspection (PIP) (GÓRSKA E. 2012., PN-N 18002:2011, WOŹNY A., PACANA A. 2014). Protection measures are omitted in the table since the information is available in the literature.

Table 1. Threats identified at CNC operator position

No	SOURCE	EFFECTS
1	moving parts of used machines	contusions, injuries
2	moving machine elements and objects	pinching, pressing
3	sharp, protruding and rough objects	injuries, cuts, abrasions
4	falling elements of machines	pinching, pressing
5	slippery, uneven surfaces	Injuries caused by slipping, tripping and falling due to technological fluid leakage or substrate inequality
6	situation of the position with respect to the ground	fall from the heights, injuries, contusions
7	hot or cold surfaces corrosive substances	burns
8	electric shock	paralysis
9	hand tolls	cuts, abrasions, contusions, infections due to contamination of small abrasions places and small injuries
10	noise emitted by machine tools, mechanized and hand tools and activities performed in the production hall	Noise, damage or even hearing loss
11	heavy elements moving and lifting	contusions, injuries
12	forced body positions at work	Contusions, injuries, back-bone pain
13	work stress: overtime, night work, employees' conflicts, forced work rate, long monotonous work	stress, psychological trauma
14	exposure to harmful chemicals (oil mist and grinding dust)	infections and respiratory diseases, eye irritation, pollination with dust, grit and curls
15	Low or high temperature on the workstation	cold, chilled body, overheating of the body
16	fire	burns, injuries, poisonings
17	explosion	burns, injuries

4. Occupational risk assessment of CNC machine operator

As a method proposed for occupational risk assessment on a CNC machine operator position, a three-stage method according to PN-N-18002, a Risc Score method and a PHA method were chosen. The methodologies are described in the literature of the subject, for example (GÓRSKA E. 2012, KRAUSE M. 2011, ROMANOWSKA-SŁOMKA I., SŁOMKA A. 2104, WOŹNY A., PACANA A. 2014).

In case of assessment based on the PN-N-18002 standard all risks have been classified into five groups, followed by probability and severity of consequences. Then, using the (WOŹNY A., PACANA A. 2014), the value of a risk and its admissibility in acceptable and unacceptable categories were determined (Tab. 2).

Table 2. Occupational risk assessment of CNC machine operator according to the PN-N-18002 standard

No	Threat	Probability (P)	Effect (S)	Risk	
				Result	Admissibility
1	Contusions	small	medium	1	admissible
2	Injuries	small	medium	1	admissible
3	Burns	small	medium	1	admissible
4	Noise	big	medium	3	impermissible
5	Infections, diseases	small	small	1	admissible
6	Stress	medium	medium	2	admissible
7	Pollination	small	medium	1	admissible

The average value of risk occurring at the CNC machine operator's position, estimated with the PN-N-18002 standard is 1.25. It means that it is defined as small, so the risk is admissible.

Table 3 shows the results of the conducted occupational risk assessment of a CNC machine tool operator using the Risc Score method.

Table 3. Risk assessment of the CNC machine operator with use of the Risk Score method

No	Threat	Probability (P)	Exposure (E)	Effect (S)	Risk (PxExS)	
					Value	Category
1	Contusions	6	6	3	108	Significant
2	Injuries	0,5	3	3	4,5	Acceptable
3	Burns	0,5	2	3	3	Acceptable
4	Noise	10	6	1	60	Small
5	Infections, diseases	0,2	0,5	3	0,3	Acceptable
6	Stress	3	3	3	27	Small
7	Pollination	0,5	1	3	1,5	Acceptable

The average value of the risk in position of CNC operator calculated with use of the Risc Score method is 29.2, that

according to the categories of this method qualifies it as acceptable, in a scale of: very big, big, significant, small and acceptable.

Table 4 presents the occupational risk assessment of CNC machine tool operator, performed with use of the PHA method.

Table 4. Occupational risk assessment of CNC machine tool operator by the PHA method

No	Threat	Probability (P)	Size of damage (S)	Risk	
				Value (PxS)	Category
1	Contusions	4	1	4	permissible
2	Injuries	3	1	3	acceptable
3	Burns	2	2	4	permissible
4	Noise	6	2	12	unacceptable
5	Infections, diseases	1	2	2	acceptable
6	Stress	5	1	5	permissible
7	Pollination	4	2	8	permissible

The average value of risk at the workplace of numerically controlled machine tools, calculated by the PHA method, is 5.4. It is defined as permissible in a scale of acceptable, permissible and unacceptable.

In the next step, the obtained results of the occupational risk assessment were compared and presented in Tab. 5.

Table 5. Comparison of occupational risk assessment.

No	Identified threat	According to the PN-N-18002 standard	Risc Score method	PHA method
1	Contusions	permissible	significant	permissible
2	Injuries	permissible	acceptable	acceptable
3	Burns	permissible	acceptable	permissible
4	Noise	unacceptable	small	unacceptable
5	Infections, diseases	permissible	acceptable	acceptable
6	Stress	permissible	small	permissible
7	Pollination	permissible	acceptable	permissible

The conducted with three methods occupational risk assessment determines the operator's occupational risk as acceptable, but there are differences in the results that may indicate the choice of an adequate risk assessment method.

5. Summary and conclusion

As a result of the occupational risk assessment, it can be observed that, according to all risk assessment methods that were used, the risk of injuries, burns, infections, diseases and pollination is permissible and acceptable. Differences occur

in the case of dangers related to the occurrence of stressful situations. In accordance with the PN-N-18002 standard and with the PHA method a risk is permissible, while the Risc Score method identifies it as small, that indicates the need to periodically controlling the intensification of negative effects. Another difference occurs in case of threat of injuries and contusions. The Risc Score method, as the only one of the analyzed methods, classified these threats as significant, and therefore suggests actions to minimize the impact of this harmful factor. Noise has been classified similarly in each of the three methods analyzed. Nevertheless, it is worth to note that the most radical method for this occupational risk assessment at CNC operator position is the Risc Score method. In spite of the simplifications and assumptions that were made in hereby paper, the Risk Score method can be proposed to assess occupational risk for this workplace.

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数控机床操作员职位的比较职业风险评估

关键词

职业方法
风险评估
数控机床
职业风险

抽象

法律要求雇主评估工作场所的职业风险。执行良好的职业风险评估有助于改善工作条件，减少对员工健康和生活的负面影响。雇主通过职业风险评估不仅符合法律要求，而且从两方面受益。消除与员工缺勤有关的企业的损失，并且由于对员工健康造成破坏性影响的情况，也降低了高薪酬的可能性。但是，为了从这些行动中受益，首先必须适当选择风险评估方法，然后实施并实施预防措施。本文以 PN-N-18001, PHA 和 Risc 分数为依据，采用三阶段方法，对数控机床操作员实例进行职业风险评估的结果。尽管评估的主观性，结果有差异。因此，建议您巧妙地选择风险评估方法，例如通过比较几种类似的方法。
