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IDENTYFICATION AND ASSESSMENT OF OCCUPATIONAL HAZARDS IN THE WORKING ENVIRONMENT OF THE LASER CUTTER OPERATOR

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Abstract: The purpose of this article was to identify occupational hazards at the laser cutter operator's workplace and to assess occupational risk. The article also indicates the basic requirements for the analyzed workplace. Research methods included: observation of the workplace (using a checklist), interviews with the employer, selected employees and a health and safety specialist, as well as analysis of the company's internal documents. The occupational risk assessment carried out at work using the Risk Score method showed that there are many different risk factors for accidents or diseases related to the work performed at the position of the laser cutter operator. However, thanks to the preventive measures applied, they are in the analyzed workplace at an acceptable (acceptable) level.

Keywords: occupational exposure of employees, work environment, occupational risk assessment, laser cutter operator, occupational health and safety (OHS)

1. INTRODUCTION

The basic way to prevent accidents and related diseases with the work performed is reliable identification of risk factors and carrying out occupational risk assessment (Papadopoulos at al., 2010). The effectiveness of the occupational health and safety policy implemented in the workplace depends on the quality of this assessment (Pacana, 2017; Peeters and Peng, 2015; Seifi Azad Mard et al., 2017). According to the definition contained in the Ordinance (Journal of Laws of 2003, No. 169, item 165, with amendments), occupational risk is the probability of occurrence of adverse events related to the work performed, and in particular the occurrence of adverse health effects of the employee as a result of exposure to occupational hazards occurring in the work environment or due to the way work is performed.

In view of the above, the process of occupational risk assessment should be understood as continuous and systematic monitoring of working conditions aimed at identifying current and potential occupational hazards that may be the cause of an accident, injury, deterioration of the employee's health or occupational disease. The

work environment study process also makes it possible to identify the necessary preventive measures to limit or eliminate the adverse impact of work environment factors on employees (Arimbi et al., 2018; Dolegowski and Janczala, 2008; Ejdys et al., 2008; Niciejewska and Klimecka-Tatar, 2018; Wieczorek and Zukowski, 2014).
For the purposes of occupational risk assessment, a careful assessment should be carried outand a comprehensive assessment of the workplace in terms of (Krause, 2017; Wieczorek and Zukowski, 2014):

- dangerous, harmful and troublesome factors occurring in the workplace;
- potentially accidental events;
- health and safety at work both in the workplace and in the entire workplace;
- ergonomic conditions in the workplace.

The purpose of this article is:

- identification of occupational hazards at the workplace of the laser cutter operator on the basis of observation of the workplace, analysis of source materials of the company and the author's knowledge;
- conducting occupational risk assessment for a selected job using the Risk Score method and determining the overall level of occupational risk, including preventive measures used to ensure an acceptable level of occupational risk.

2. METHODOLOGY OF RESEARCH – RISK SCORE METHOD

The Risk Score method is a qualitative, indicator method for assessing occupational risk, which takes into account the following parameters (Pietrzak, 2002):
– possible consequences of the event, losses caused by the incident (S value);
– exposure to the hazard (E value);
– probability of occurrence of the incident (P value).
The risk value R describes the expression:

$$R = S * E * P \quad (1)$$

The criteria for estimating individual risk assessment parameters are described in Tables 1 – 3, while the criteria for assessing risk value are presented in Table 4.

Table 1
Assessment of potential effects of the hazard - S (Risk Score)

Value S	Type of effects	Description of losses	
		human	material
100	A major disaster	Many fatalities	Over 30 million PLN
40	A disaster	Several fatalities	From 10 to 30 million PLN
15	Very big	Fatal Victim	From 1 to 10 million PLN
7	Big	Severe bodily injury	From 30 thousand up to PLN 1 million
3	Medium	Absenteeism at work	From 3 to 30 thousand PLN
1	small	First aid	Below 3 thousand PLN

Source: (Pietrzak, 2002)

Table 2
Assessment of exposure to the hazard - E (Risk Score)

Value E	Description of exposure
10	Constant
6	Common (everyday)
3	Occasional (once a week)
2	Occasional (once a month)
1	Minimal (several times a year)
0,5	Insignificant (once a year)

Source: (Pietrzak, 2002)

Table 3
Assessment of probability of occurrence of the hazard - P (Risk Score)

Value P	Description of probability	Chance[%]
10	Very likely	50
6	Quite possible	10
3	Not likely, but possible	1
1	Only sporadically possible	10^{-1}
0,5	Conceivable	10^{-2}
0,2	Virtually impossible	10^{-3}
0,1	Only theoretically possible	10^{-4}

Source: (Pietrzak, 2002)

Table 4
Interpretation of the risk level indicator - R (Risk Score)

Value R	Risk category	Risk acceptability	Necessary actions
R < 20	Very small	Acceptable	Control recommended
20 ≤ R < 70	Small		Control needed
70 ≤ R < 200	Medium		I need improvement
200 ≤ R < 400	Big	Unacceptable	Immediate improvement needed
R ≥ 400	Very big		It is advisable to stop work

Source: (Pietrzak, 2002)

3. RESULTS

The work of the laser cutter operator consists in performing activities related to cutting a wide range of materials, such as (Internal materials of the examined enterprise): steel (e.g. carbon, alloy, construction, quality, tool, wear-resistant, galvanized),

stainless steel (e.g. stainless, heat-resistant, acid-resistant), non-ferrous metals and their alloys (e.g. aluminum, copper, titanium, brass), stone (granite, marble, conglomerate, sandstone), ceramics, gum, plastics, glass, wood-based, wood-like panels and other. The operator's stand is located in a production hall with the following dimensions: 30 m; width - 12 m; height - 9 m. The building is heated by central heating installation and meets the requirements for minimum temperatures at physical work stations. The workplace is illuminated by daylight through trained wall surfaces and in the ceiling. Fluorescent lamps are additional lighting. The floor is even, non-slip, dust-free and without thresholds between rooms. Employees have access to full hygiene and sanitary facilities. Escape routes have been designated on the company's premises and marked with appropriate pictograms. Occupational risk assessment at the position of the laser cutter operator was carried out using the Risk Score method. Based on the developed hazard identification card, the workplace was analyzed in terms of actual and possible (potential) hazardous, harmful and onerous factors. Parallel with the identification of hazards an initial assessment of their potential effects and the time of exposure of the employee (exposure) was conducted, taking into account the ones used preventive measures (technical, organizational and human) in the plant. Next, as part of own research, individual risk parameters and their total value were estimated for each threat, taking into account the criteria described in tables 1 – 4.
Tables 5 – 6 present the results of measuring occupational risk assessment at the position of the laser cutter operator.

Table 5
Hazards identification as a laser cutter operator

Hazard symbol	Name of hazard	Source of hazard	Effects of hazard
TH-1	Capture by moving machine parts	Moving machine parts	Injuries, injuries, limb amputations, death
TH -2	A sharp impact and fixed elements	Sharp protruding parts of machines, devices and workpieces	Bruises, bumps, skin abrasions, cuts, cut limb woundsand heads
TH-3	Damp by the machine	Machines moving around the production hall	Severe injuries, sprainsand fractures of the limbs, crushing, head and spine injuries, concussion, internal organ injuries, disability, death
TH-4	Crush by the machine	Machines moving around the production hall	Severe injuries, sprainsand limb fractures, crushing head and spine injuries, concussion, internal organ injuries, disability, death
TH-5	Hit by falling objects	Storage items on racks, fall of moved material	Bruises, bumps, cuts, head injuries, concussion, disability, death
TH-6	Fall at the same level	Spilled fluids (water, oils, greases), cables, left behind tools and materials in the wrong place, general	Bruises, bumps, skin abrasions, cuts, sprains and fractures of the limbs, head injury

Hazard symbol	Name of hazard	Source of hazard	Effects of hazard
		disorder, obstructed communication routes, improper footwear worn by the employee	
TH-7	Fall to a lower level	Using the stairs, using the ladder	Bruises, bumps, skin abrasions, cuts, sprains and fractures of the limbs, head injuriesand spine, internal organ injuries, disability, death
TH-8	Noise	and landings	Fatigue, headache, problemswith concentration, malaise, damage to the hearing organ
TH-9	Electromagnetic radiation	Electromagnetic radiation generated by the cutting plotter screen or control computer	Nervous system diseases, skin redness, itchy rash, cancer
TH-10	Laser radiation	Laser radiation generated by the laser	Damage to the retina of the eye, thermal damage to the skin, erythema
TH-11	Electric shock	Faulty electrical installation, use of faulty devices and power tools	Burns, paralysis, disorders of the organs of the nervous, respiratory, circulatory systems, loss of consciousness, death
TH-12	Changing weather conditions	Unloading or loading of materials, objects outside the production hall	Colds, flu, pneumonia
TH-13	Fire	Fire, arson, short circuit, improper storage of flammable materials, non-compliance with smoking bans	Body burns, soaking, disability, death, disaster
TH-14	Thermal burns	Hot workpiece parts	Irritationand skin burns
TH-15	Allergies, allergies	Means used to maintain laser machine tools (e.g. oil, grease, liquids for cooling workpieces)	Allergies, irritation of the mucous membranes of the eyes, throat, larynx, headache, malaise, intoxication
TH-16	Dynamic load on musculoskeletal system organs	Manual transport of materials, workpieces and waste, performing cleaning works	Muscle and joint pains, tendonitis, spinal degeneration, limb cramps
TH-17	Static load on musculoskeletal system organs	Embedding materials on the template, entering data into the control computer, supervising the cutting process	Pain, musculoskeletal system diseases, flat feet, varicose veins, spinal curvatures
TH-18	Eye load	Work that requires accuracy,	Visual impairment, pain,

Hazard symbol	Name of hazard	Source of hazard	Effects of hazard
		poor lighting	burning, tearing, conjunctivitis
TH-19	Load on the nervous system	Employee interpersonal relations	Somatic symptoms (e.g. headache, internal organs), depression, problemswith concentration, dizziness, stomach upset, coronary artery disease

Source: Own study based on own research

Table 6
Occupational risk assessment card as a laser cutter operator

Hazard symbol	Preventive actions	Size of risk				Risk category
		S	E	P	Risk	
TH-1	Designation of a zone for moving machine elements, motion sensors	15	6	0.2	18 [VS]	AcceptableControl recommended
TH -2	Use of personal protection (clothing, gloves, footwear), caution	3	6	3	54 [S]	Acceptable Control needed
TH-3	Designation of machine movement zones, marking communication passages, compliance with the principles of safe machine operation, compliance with the prohibition to stay in the danger zone, caution	15	6	0.5	45 [S]	Acceptable Control needed
TH-4	Designation of machine movement zones, marking communication passages, compliance with the principles of safe machine operation, compliance with the prohibition to stay in the danger zone, caution	15	6	0.5	45 [S]	Acceptable Control needed
TH-5	Maintaining order and arrangement in the workplace, arranging materials and objects in a stable manner, securing the material (load) being handled, caution	15	6	0.5	45 [S]	Acceptable Control needed
TH-6	Keeping the workplace clean and tidy, paying attention to spilled liquids (water, oils, greases), proper cable laying, not setting communication routes, transport routes without thresholds between rooms, the use of shoes with non-slip soles, the use of mats and non-slip floor coverings, caution	7	6	1	42 [S]	Acceptable Control needed

Hazard symbol	Preventive actions	Size of risk				Risk category
		S	E	P	Risk	
TH-7	Maintaining order and work environment, using a functional ladder and platforms, marking platforms and any unevenness, caution	15	6	0.5	45 [S]	Acceptable Control needed
TH-8	The use of personal protection (hearing protectors, if the NDN exceeds 85 dB (A)), the use of efficient machinery and equipment, and repair (or replacement) and maintenance of this equipment, which generates excessive noise, switching off unnecessary noise generating devices, conducting periodic checks and measurements of noise values	7	6	0.5	21 [S]	Acceptable Control needed
TH-9	The use of monitors with reduced emissions of electromagnetic radiation, the use of anti-static liners, the appropriate position of the monitor, the use of breaks in working with the computer	7	6	0.2	8.4 [BM]	AcceptableControl recommended
TH-10	Protection, covers, safety locks that prevent the machine from starting, the use of personal protective equipment, checking the technical condition of the laser machine, caution	7	6	0.2	8.4 [VS]	AcceptableControl recommended
TH-11	Compliance with the rules for the safe operation of machinery, equipment and power tools, using only efficient equipment and tools powered by electricity, switching off devices in the event of faulty cables, sockets, etc., carrying out repairs and maintenance of electrical installations and power tools by authorized employees, conducting periodic inspections and measurements of electrical installation parameters, effective protection against electric shock, caution	15	6	0.5	45 [S]	Acceptable Control needed
TH-12	Adapting clothing to the weather conditions outside (protection against excessive cooling or overheating)	3	3	3	27 [S]	Acceptable Control needed

Hazard symbol	Preventive actions	Size of risk				Risk category
		S	E	P	Risk	
TH-13	Ensuring efficient fire protection measures (fire extinguishers, sensors, etc.), the use of shields, starting the laser when there is material in its path, compliance with fire protection rules, marking of areas at risk of fire, compliance with related rules with operation and storage of flammable substances, strict compliance with the smoking ban, caution	40	3	0.5	60 [S]	Acceptable Control needed
TH-14	Use of personal protection (if required), use of special tools for removing workpieces, caution	1	6	3	18 [VS]	AcceptableControl recommended
TH-15	Ensuring adequate ventilation in the production hall, using only known ones and approved substances, proceeding in accordance with the material safety data sheets, every leak cleaning, caution	7	3	1	21 [S]	Acceptable Control needed
TH-16	Compliance with the rules for manual transport (lifting standards, lifting technique), avoiding manual lifting of objects, ensuring the correct organization of transport work, the employee adopting the correct body posture, caution	3	6	1	18 [VS]	AcceptableControl recommended
TH-17	The employee adopting the correct body posture, providing breaks at work for rest or rotation of employees (in the case of constant or frequent exposure), performing relaxation exercises, exercising caution	3	6	1	18 [VS]	AcceptableControl recommended
TH-18	The use of appropriate lighting, cleaning and maintenance of lighting fittings, ongoing replacement of used light bulbs and fluorescent lamps, correct orientation of the light source, correct positioning of the workplace, use of breaks in work and care for proper eye hygiene	3	6	0.5	9 [VS]	AcceptableControl recommended
TH-19	Responding to conflict situations, active rest, anti-mobbing procedure	7	3	1	21 [S]	Acceptable Control needed

Source: Own study based on own research

The occupational risk assessment carried out at work showed that there are many different hazards at the position of the laser cutter operator. Based on the analysis of the data contained in Table 4, it can be concluded that the most severe effects associated with the loss of human health or life, as well as material losses will be the result of such events as: fire, being caught by moving machine parts, being hit or crushed by the machine, hit by falling objects, falling to a lower level, electric shock.
In turn, considering the exposure to the threat, in the author's opinion, most threats are characterized by frequent (daily) exposure. Occasional exposure may relate to such risk factors as: fire, changing weather conditions or stress on the nervous system.
Considering the next risk assessment parameter, which is the probability of occurrence of a specific threat, the highest level (i.e. practically possible) was estimated for the following threats: impact against sharp and stationary elements, changing weather conditions, thermal burns. In turn, the lowest probability of hazard occurrence was estimated for related events captured by moving machine parts, electromagnetic and laser radiation.

4. CONCLUSION

Based on the literature analysis and own research, the following conclusions and final statements can be formulated:

1. Occupational risk assessment is a measure of the level of safety in the workplace. Its primary goal is to ensure the safety and protection of both business assets as well as people's health and life.
2. Occupational risk assessment should be carried out for each workplace (and more broadly the place of work) taking into account all hazardous or harmful factors occurring or likely to occur in the work environment, as well as individual predispositions of employees (including pregnant and breastfeeding women), juvenile, disabled or elderly employees or employees with no experience).
3. The basis for conducting occupational risk assessment is the identification of threats, which requires the collection of a range of information regarding both the workplace and the workplace, as well as the requirements for employees and the scope of their activities. The source of this information can be: observation of the workplace (using a checklist), interviews with the employer and employees, analysis of company documents (disease record, accident documentation, measurements of harmful factors, workplace instructions, instructions of machinery and equipment manufacturers, safety data sheets) or specialized literature.
4. Workplace analysis allowed to indicate the basic tasks and activities performed by the laser cutter operator, which include: preparation of the workstation, setting parameters of the cutting process, supervising the operation of the laser machine tool, transporting materials to the workstation or their storage places, conducting machine inspections and their maintenance, detection of irregularities in the operation of the machine tool and removal of minor defects, maintaining cleanliness at the workplace.
5. Work as a laser cutter operator involves exposure of the employee to the occurrence of many risk factors for an accident or illness related to the work performed. However, the occupational risk assessment showed that due to the

preventive measures applied they are in the analyzed workplace at an acceptable (acceptable) level. It is also worth emphasizing that so far no accidents at work have been reported in the workplace.

6. Maintaining the acceptable level of identified occupational hazards requires systematic control of technical and organizational security measures applied, as well as employee education and their caution in special situations. Because the lack or disregard of the preventive measures indicated in the risk assessment card will increase the likelihood of a work-related accident or illness and, consequently, increase the risk category, even to an unacceptable level.

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