

RISK ANALYSIS AT WORK IN MANUFACTURING ORGANIZATION

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Abstract

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Risk is virtually present everywhere around us. Nowadays, there is an increasing focus on safety at work; therefore, the organizations that want to be successful in the market try to eliminate risk factors to a minimum to avoid or prevent the health hazard of employees, damages to property or the environment. The work is focused on the risk assessment of a selected device, which is the most risky workplace according to the organization where the research was conducted. In the practical part, we became familiar with the equipment for welding and a thorough analysis of the current state of safety by a complex method was done. Consequently, corrective actions to reduce risk to an acceptable level were proposed. After that, we reassessed the risks of complex method, and the point method was used to verify the effectiveness of proposed remedial measures.

Keywords: risk assessment, health and safety, risk management, level of safety

INTRODUCTION

If you cannot manage the risk, you cannot control it. If it is not possible to control, you cannot manage it. This means that you play a game of chance and you hope you will have the luck (Merna *et al.*, 2007; Savov, 2013; Korenková, 2012).

The safety assessment of machinery and equipment, but also a variety of work activities and the environment is currently a very live issue (Prístavka *et al.*, 2014; Kielbasa *et al.*, 2013; Kadná, 2011). Risk management is based on the assumption of discovery of risk factors sources affecting the risk analysis and risk assessment (Pačaiová *et al.*, 2003; Kowalski, 2012). Occupational safety deals with the risks arising from work activities that are caused by machinery and equipment, or result from the working environment or working conditions (Kadnár *et al.*, 2007; AVEN, 2009). For risk analysis and risk management, it is necessary to use a defined term, which can be expressed precisely (Backskos, 2013; Marhavalis, 2011).

The adoption of the principle of risk assessment represents the implementation of systematic

solutions to the health and safety protection of workers that will bring lower accident rates, morbidity, and increased quality and productivity at work to companies (Višnovský *et al.*, 2014; Sinay, 1997). In an ideal world, a good assessment should always lead to an effective reduction of risk (Merna *et al.*, 2007).

To achieve the risk management, it is important to know the source of danger and the probabilistic nature of hazard consequences. Identification, analysis and risk assessment serve that purpose (Hrubec *et al.*, 2011; Koudelka *et al.*, 2006). It should be emphasized that risk identification is the most important and time-consuming phase of the risk analysis (Prístavka *et al.*, 2009; Hnilica *et al.*, 2009). In estimating the risk, it is determined whether it is necessary to further reduce the risk or whether security was already reached (Prístavka *et al.*, 2013; Pačaiová *et al.*, 2010; Korenková, 2008).

The goal of this work is to increase the level of safety at the workplace of an engineering organization, which is the most risky workplace according to organization's documents. In our case, the risk will be assessed by the complex

method of risk assessment at the workplace, and subsequently, the point method will be used to verify the effectiveness of corrective measures.

The main goal of occupational risk assessment is the health and safety protection of employees. Risk assessment helps to minimize the potential threat to workers or the environment due to work activity.

The goal of ergonomic solutions of relations in the man-machine-environment system is to create working conditions that contribute not only to increased productivity but also to preserving the health of people, i.e. to their physical, mental and social satisfaction.

MATERIAL AND METHODS

Based on the specified goals of work, the basic methodology will be described in this chapter and the work procedures for risk assessment of the welding aggregate will be introduced.

The list of foreseeable hazards will be defined, and the work activities of workers at this facility will be described. By chosen complex methods the final value of risk at the workplace will be calculated. Consequently, corrective measures for elimination or reduction of the risk to an acceptable level will be proposed, and finally, their effectiveness will be verified by the complex method and by the point method.

Most methods present the risk assessment as a procedure consisting of the following steps:

- *hazard identification* – in the selected assessed system, we need to identify features, characteristics, and those aspects that are a potential cause of harm, injury, health hazards or other negative impact. Several standards or guides present the list of risks and hazards that may be a good help, for example Government Regulation no. 395/2006 on providing of personal protective equipment (PPE) and Overview of risk according to the EC manual 'RISK ASSESSMENT';
- *selection of system assessed* – the first step of a systematic risk assessment is the selection of the system assessed, which the welding unit is, its parameters and places where serious injury or other adverse event can occur;
- *threat identification* – following the identified hazards, we can determine how they can cause injury, damage or other negative phenomenon. We can derive one or more threats from one hazard;
- *assessment (calculation of risk)* – the expression of the resulting value of risk depends on the valuation methodology used. If we rely on the definition of risk according to the point method, then in comparison with the classic definition of risk, the extended definition of risk in terms of the probability and severity of consequences of any potential adverse event and the impact of the level of health and safety is used;
- *assessing of compliance with requirements of laws and regulations* – we compare whether the welding unit,

its technology, space, etc. meet the requirements of applicable safety regulations and standards;

- *measures for reduction or elimination of risk* – in the last step, if during the assessment of safety of the system there is shown that the risk has a higher value than the value of acceptable risk, it is necessary to propose measures for reducing the risk or removing it completely. Thus, we can also use standard procedures and principles that allow a systematic approach when designing measures [e.g. STN EN ISO 12100 (83 3001) Safety of machinery. General principles for design. Assessment and risk reduction].

RESULTS

A production hall with dimensions of approximately 58×50×10m is available. It is a steel building with a tin roof, the walls are of sandwich structure, and the floor is partly made of concrete and partly of steel panels. Production facilities are with no acoustic modifications – from the acoustic point of view, the surfaces of external walls, ceiling and floor are sound-reflective, which adversely affects the reverberation time. The quality management system ISO 9001 (2008) is successfully implemented in the company, and it also disposes of several certificates of product conformity.

The welding unit (Fig. 1) welds the grids and it is used for the production of reinforced networks from structural steel.



1: Welding unit

The conveying rollers pull the longitudinal wires of coils through all the lines of straightening equipment to the line of welding. The grooved conveying rollers pull the cross wire from the coils through the point switches, straightening and control switches to the welding line. The conveying rollers are powered by a hydraulic motor through the gear, which is controlled by a servo valve.

The operator of the welding unit performs the following activities:

- preparing and considering the transverse and longitudinal wire;

- stretching the longitudinal wires through all the straightening devices to the welding line and stretching the cross wires through the straightening device and conveyors;
- checking the accuracy of welded mat dimensions at certain intervals;
- additionally setting the straightening device and if necessary mainly when changing the diameter of the wire;
- cleaning the welding line at regular intervals.

Risk Assessment with Complex Method

To a specific risk that exists in the working process and is a function of various parameters of system's elements, we have assigned the point values according to the values obtained from in-house documents (the documents analysed the development of individual factors for the previous period by assessing whether the requirements of binding regulations, standards and procedures of the complex method are satisfied). They complete the assessment of the resulting risk.

Individual point values were determined experimentally, by an expert estimate according to the fact how different factors affect the resulting risk.

When assessing the risk with the complex method, we work with three main factors, namely:

- assessment of the risk caused by machinery or equipment – factor M, the final assessment of the factor device:

$$M = S \times EX \times Wa \times Ve, \quad (1)$$

$$M = 10 \times 1.3 \times 1 \times 1 = 13;$$

- assessment of the working environment influence, environment – factor U, the final assessment of the factor environment:

$$U = U_a + U_b + U_c, \quad (2)$$

$$U = 0.7 + 0.3 + 0.3 = 1.3;$$

- human impact, a competence of person to handle risk – factor P, the final assessment of the factor person:

$$P = Q + \Phi + O, \quad (3)$$

$$P = 8 + 2 + 4 = 14.$$

After determining the values of individual factors, the resulting risk value is calculated according to the following equation:

$$R = M \times U - P \times (M/30), \quad (4)$$

$$R = 13 \times 1.3 - 14 \times (13/30) = 16.9 - 6.1 = 10.8,$$

where

R.....risk,

Mdevice,

Uenvironment, and

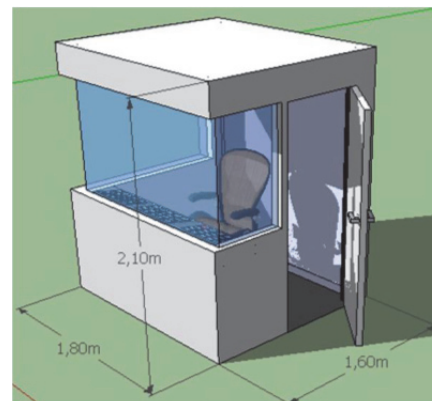
Pperson.

The resulting value of the welding aggregate risk was 10.8. This numerical value informed us that the risk at the workplace should be seen as unacceptable. Practice has shown that the risk of damage (changes) to the hearing of employees originates after prolonged exposure to noise with the noise level above 80 dB.

As we stated in the risk assessment process, the next step results in the fact that we need to propose measures to reduce the risk to an acceptable level, or to completely eliminate it. The goal of proposed remedial measures is to reduce the risk at the workplace to an acceptable level and to increase the safety at the workplace. Following the hazards and threats that may occur at the workplace as well as the activities that workers perform during their workload, we completed the list of personal protective equipment for the welding unit with eye protection. Then, we defined the specific PPE and indicated the individual strengths of selected PPE in comparison with those currently used at the workplace.

According to the abovementioned facts, it is necessary to keep all the technological processes as well as to use the proposed personal protective equipment. It is essential that all employees are informed about training and risk assessment results as well as about measures to be adopted and implemented, with an emphasis on measures that have to be respected by themselves.

It is also important to ensure the implementation of regular professional inspections and testing of electrical equipment of the machine. However, by adopting proposed remedial measures, it is not possible to consider the risk at the workplace as acceptable because the measured value of the normalized noise exposure level LR, AEX, 8 h for the nominal time interval of 8 hours exceeds the permissible 85 dB at the workplace during work, and it reaches up to 99.3 dB. Therefore, one of the best options to reduce this undesirable risk is to locate an acoustically isolated room with a control panel inside the room on the current position of the control panel, with a view and with



2: Designed acoustically isolated room

the possibility to visually check the entire system operation.

The graphical design of the acoustically isolated room with dimensions (H × W × D) 2 100×1 800×1 600 mm is shown in Fig. 2. The floor, walls and ceiling are acoustically isolated by the special sound insulation WOLF made of a three-layer laminated cardboard, which is filled with fine quartz sand. This design allows an efficient sound isolation of all frequency spectra. Considering that the measured value of the standard level of noise exposure LR, AEX, 8h for the nominal time period of 8 hours at the workplace reached 99.3 dB in service, by using the insulation WOLF, the worker would be placed in the acoustically isolated room where the normalized level of noise exposure would not exceed the permissible noise exposure of 85 dB. By applying this proposed measure, it would

be possible to reduce the undesirable risk of noise at the workplace of welding unit.

Risk Assessment After Accepting the Corrective Measures

After suggesting corrective measures, we have reassessed the risks at the workplace by the complex method, and the effectiveness of these corrective measures on reduction of risk was verified by the point method.

Resulting risks at the given workplace can be considered as acceptable because the resulting risk value calculated according to the equation of complex method is 8.3. From this follows that the proposed corrective measures fulfilled their purpose, reduced the risk at the given workplace to an acceptable level, and removed the unwanted risk in the form of noise by placing the graphical representation of sound isolation room.

CONCLUSION

The goal of this work was to assess the risk for the most dangerous job in the manufacturing organization. The selected department belongs to the danger because of constant noise during the working activities of the facility and owing to the fact that production facilities are with no acoustic modifications and surfaces of exterior walls, the ceiling and floor are sound-reflective, which negatively affects the reverberation time.

Therefore, it is highly important to be particular about caution and to avoid accidental unexpected risks, and other necessity is operating the equipment only by trained personnel. Regular training of OSH may serve as prevention.

The risk arising from noise negatively affects not only the performance of workers on the device but also the overall climate environment in which the employee is located. There are several solutions to reduce or eliminate this unwanted risk. One of the best options is to build an acoustically isolated room, from which a worker using the control panel could see not only individual steps of the device but he could also operate without exerting a negative risk – noise. The staff would leave this proposed acoustically isolated room only in case of cleaning of the device or failure when the effect of noise would not be in such an extensive time as it is in the current situation.

By usage of proposed PPE, the safety of operators at the workplace should be increased to a certain extent and this safety should improve working conditions that contribute not only to increase of productivity but also to preservation of the health of persons, i.e. to their physical, mental and social satisfaction.

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