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OCCUPATIONAL SAFETY ASSESSMENT AT THE CUTTING PROCESSES

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ABSTRACT: The article is aimed at the proposal of measures for the elimination of harmful factors arising from the cutting operation processes.. Analysis of the current occupational safety and health (OSH) has been made at a particular turning and drilling workplace, where in addition to objective methods. The questionnaire method was used to identify the subjective perception of the safety on workplace. The aim was to propose measures leading to occupational safety and health improvement.
KEYWORDS: Occupational safety and health, drilling, turning, boring, personal protective equipment

❖ INTRODUCTION

The Slovak legislation on occupational safety and health (Act no. 124/2006, Section 6 "General duties of employer" paragraph 1) point c), defines one of the essential duties of the employer is "to identify hazards and threats, to assess risks and elaborate a written document on risk assessment for all working operations and processes performed by employees." The results of risk assessment presented in the article may serve to employers dealing with cutting as a gross framework for developing their own risks analysis in specific workplaces.

Even in the advanced plants with up-to-date technologies the existence of hazards and the resulting threats can not be excluded, thereby impairing the level of occupational safety and health. Therefore it is necessary to pay attention to the risk reduction or its absolute elimination. Experience shows that even the willingness of management is to ensure optimal safety, it is necessary to take into account the existence of the unreliable human factor. [2], [6]

While cutting the risk of injury or health damage is high, considering the fact that the machining operations are exercised by high speed instruments and during the manufacturing process pollutants can be emitted. [3] The risk evaluation was lead in order to determine the factors of working environment, which may adversely affect the health of workers, reduce safety and cause damage to health and property. [2]

❖ THE STATE OF ART OF THE OCCUPATIONAL SAFETY AT THE WORKPLACE

Hazards identification and risk assessment was carried out in the company, which production activity is focused on metal cutting processes - turning, milling, drilling, bending, grinding as well as metal shaping and finishing - cutting, stamping, welding, metalwork and assembly, and products surface treatment (painting and varnishing). Technological equipment assigned for cutting processes used in the company is horizontal boring machines, metal-working lathes, and radial drilling machines, milling and grinding machines. Equipment used in the company is considerably outdated therefore presenting a significant source of noise and other negative factors at work.

In the workplace, a combined lighting - neon lamps and daylight is used. In the direct environment of the equipment this light source is supplemented with halogen lighting. The flooring of the production hall is made of concrete. In certain places, especially in lathes and drills environment, the floor is polluted by oil emulsion, somehow blended with metal chips (Fig. 1).

Chips are removed by sweeping after each work-shift. Nevertheless, some amount of chips remains on the floor. Type of chips depends on the machined material - long and short cylindrical chips, helical or spiral and half-screw chips are generated. Swept chips are stored in separate pallets by the material type. When pallets are filled by chips, they are collected and transported to scrap yard for material re-use.

Figure 1. Flooring polluted with chips and dust

Oil emulsion is re-used. Unusable oil is stored in casks in a factory building. In the hall, the dust concentration is measured regularly. During operation, its concentration is often increased. Ventilation should be used more effectively, particularly in the paint spraying room, where the concentration of odorous substances is increased. The company plans to install a hydro cyclone for aerosols elimination. In the hall, three radial fans and filters in the pipelines are installed.

Since heavy constructions are sprayed directly in the hall, the visibility of safety markings on the floor is impaired.

The predominant risk factors in the production hall appear to be noise, dust, vibration and presence of chemical pollutants.

Before the risk assessment there is need to determine whether they met the requirements of mandatory rules and standards, and whether existing measures are adequate. It is based on an assumption that as the system meets the safety provisions of the legislative, regulations, guidelines, technical standards and whether the equipment, technology and working space shall meet the requirements of applicable standards, technical documentation and manufacturer's instructions. [4] In this assessed case, it is necessary to mention that the used machines and technical equipment is very outdated, even in maintaining order. However, protective equipment is missing, which is a serious deficiency, and can be the source of the accidents and health injuries.

Employer has to ensure that the requirements of the amended Act no. 124/2006 on the occupational safety and health, amended Act no. 311/2001 Labor Code, and Government Regulation No. 392/2006 on the minimum health and safety requirements at equipment usage are executed on its workplace.

Company employees are regularly involved in training and are instructed on safe working practices. Nevertheless, some employees violate the obligations on health and safety, mainly not using the personal protective equipment, or disabling the protective equipment. In the hall, it is necessary to follow the smoking ban carefully, moreover, in view of the fact that dangerous substances - cutting fluids are stored in the hall.

❖ RISK ASSESSMENT AT CUTTING PROCESS – RISK ASSESSMENT AT TURNING PROCESS

The cutting process has been assessed - the risks were assessed separately for turning, drilling and boring, milling and grinding.

Machining is based on the removal of material from the semi-product, which results is the work piece with the required dimensions accuracy and surface quality to ensure its functionality and durability in applied machinery equipment [6].

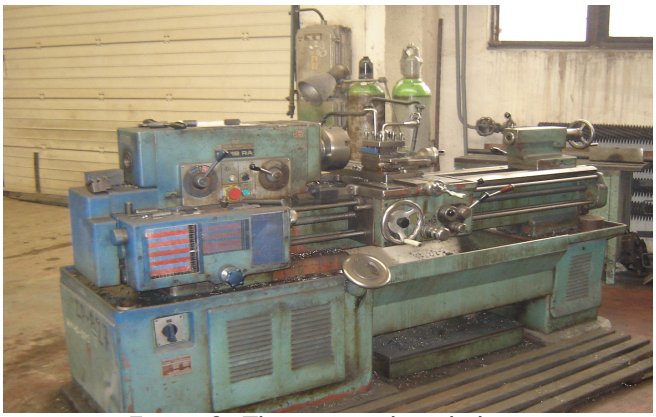

Figure 2. The assessed workplace with turning machine

Cutting speeds in turning depend on the type of machining and cutting material and other factors. For different work piece materials are in the range from 5m.min^{-1} to 1000m.min^{-1}. Cutting depths at turning are in range from few tenth mm to several mm [6]. The turning is to be taken at the current 45A and three-phase alternating voltage with zero drivers of 380V. Temperature, arising from the cutting reaches up to 1000°C and has an adverse effect on tool wear, machining accuracy and the quality of tooled area. The assessed workplace of turning is on the Fig. 2.

❖ DETERMINATION OF THE HAZARDS AND RISKS

Hazards at turning have been identified according to standard STN EN ISO 14 121. The risks were evaluated by failure modes and effects analysis (FMEA method) a semi quantitative method based on an estimation of the likelihood of emergency and the severity of its consequences [1], [5]. The results of the evaluation are briefly listed in Table 1. The evaluation revealed that the risks are higher than acceptable risk, thus Table 1 contains also proposed measures for risks reduction or elimination.

Table 1. Threats, assessed risks and proposed measures at turning process

THREAT	RISK RATE	MEASURES
Organizational weaknesses		
Faults in trainings	*Undesirable*	*Staff retraining and testing of acquired knowledge*
Improper use of PPE	*Undesirable*	*More frequent control of PPE use*
Workplace layout		
Slip and fall of personnel caused by floor pollution and unevenness, or by parts scattered on the floor	*Undesirable*	*Maintaining order in the workplace - frequent clearing the chips and cleaning the floor*
Ergonomics		
Unilateral workload, repeated working operations, forced positions (e. g. standing)	*Undesirable*	*More frequent breaks*
Inconvenient climatic conditions - air quality and humidity	*Moderate*	*Regular ventilation, or if necessary the use of advanced air conditioning*
Mechanical hazards		
Uncontrolled moving or swinging parts	*Moderate*	*Not leaving the key in the chuck hole*
Sharp edges, corners, rough surfaces	*Undesirable*	*Caution*
Uncontrollably moving and falling parts	*Unacceptable*	*Personal protective equipment*
Electricity		
Dangerous transition currents (touching the conductive parts which are under tension in the emergency case)	*Unacceptable*	*Restricted manipulation by unauthorized persons; regular checks of machinery*
Harmful substances		
Harmful effects of the vapors and aerosols while breathing	*Unacceptable*	*Regular ventilation; Use of proper exhaust system; more frequent exchange of used oil emulsions*
Skin damage by cooling and lubricating agents	*Undesirable*	*Lathes cleaning after each shift, eventually even during the change, control of the proper use of protective gloves*
Fire and explosion threat		
Fire hazard of solids, liquids and gases	*Moderate*	*Flammable substances removal from the lathes vicinity; having adequate manual fire extinguishers, place and wear unpolluted with flammable substances*
Physical factors		
Noise	*Unacceptable*	*Use of hearing protection; more frequent breaks*
Contact with the hot surface/ medium	*Unacceptable*	*Use of undamaged and dry gloves, increased attention*
Psychical strain		
Overloading, stress, time limits	*Moderate*	*Increased attention*
Responsibilities, qualification, operation chains, supply chains	*Moderate*	*Work management*
Working times management - shift work, overtimes	*Undesirable*	*More frequent breaks, better time management*
Other strains		
Workers overestimating their own abilities	*Undesirable*	*More frequent inspections; staff retraining*

Risk analysis in turning technology revealed that in the process, following shortcomings occur frequently: disuse of personal protective equipment, distractibility at work and lack of order and cleanliness in the workplace. Lathe has to be equipped with protective equipment to avoid the chips outflow.

❖ RISK ASSESSMENT AT DRILLING AND BORING PROCESS

The term drilling is meant drilling holes in the full construction material; boring means enlarging the drilled holes. During drilling process the friction occurs and material is heated, therefore it needs to be cooled by rapeseed or drilling oil. [2], [3]

Figure 3. Horizontal boring machine HVF 160

Selection of the drilling eventually boring technology shall be based on the shape and dimensions requirements, according to the characteristics of the specific parts, with regard to the requirement of quality and performance. [6] In the assessed workplace, radial drilling machines and horizontal boring machines are in use (Fig. 3)

❖ DETERMINATION OF THE HAZARDS AND RISKS

Drilling and boring pose the threats and risks, as indicated in Table 2. Sixteen out of 17 risks are as serious, that measures have to be taken to reduce or eliminate the risk.

Table 2. Threats, risks and the proposed measures at drilling and boring

THREAT	*RISK RATE*	*MEASURES*
Organizational weaknesses		
Faults in training	*Moderate*	*Staff retraining and testing of acquired knowledge*
Incorrect working instructions	*Moderate*	*More effective work organization and management*
Improper use of personal protective equipment	*Unacceptable*	*More frequent controls of PPE use*
Workplace layout		
Slip and fall of personnel caused by floor pollution and unevenness, or by parts scattered on the floor	*Moderate*	*Maintaining order in the workplace - frequent cleaning the metal chips and the floor*
Ergonomics		
Unilateral workload, repeated working operations, forced positions (e. g. standing)	*Moderate*	*More frequent breaks, safety breaks with activity change*
Uneven workplace lighting	*Moderate*	*Ensuring even lighting at workplace*
Air quality	*Moderate*	*Regular ventilation, or if necessary the use of advanced air conditioning*
Mechanical threats		
Uncontrolled moving or swinging parts	*Undesirable*	*Caution at work, using protective wear and footwear, elimination of drill breaks by its correct sharpening and proper fixation of drilled component; using protective goggles or transparent shield*
Electricity		
Dangerous transient currents	*Undesirable*	*Interdiction of handling by unauthorized persons; regular monitoring of machine status; using of dry rubber gloves*
Harmful substances		
Skin damage by cooling and lubricating agents	*Moderate*	*Use of protective gloves, regular machinery maintenance*
Fire and explosion hazard		
Fire hazard of solid, liquid and gaseous substances	*Moderate*	*Removal of flammable materials from machinery proximity, clothing unpolluted with flammables*
Specific physical effects		
Noise	*Undesirable*	*Using of hearing protection*
Vibrations	*Undesirable*	*Proper components fixation, more frequent safety breaks*
Contact with hot media - hot surfaces	*Undesirable*	*Drill cooling, use of protective gloves*
Psychical strain		
Overloading or under loading of staff capacity, time pressure	*Moderate*	*Better work management*
Working hours organization - work shifts overtimes	*Moderate*	*Proper working time management, safety breaks, increased caution while working overtimes*
Other factors		
Irresponsibility, bad cooperation	*Acceptable*	*Without need of measures implementation*

Drilling and boring requires attention in terms of safety, in particular for the correct operation of drills. Very often they are refracted in case they are blunt, or if drilling at low cutting speeds, if trays are obstructed with chips, if cut parts are not fixed properly, etc. [3] Drilling machines have to be equipped with protective guards; it is unacceptable to remove chips with bare hands or by blowing. To prevent injury or accident, system damage, loss of production, and financial losses in the process of drilling and boring it is necessary to eliminate risks by proposed measures (listed in Table 2).

❖ MEASURES ENHANCING THE HEALTH AND SAFETY AT CUTTING WORKPLACE

Proposed measures for reduction or elimination of harmful factors in turning process are summarized in Tables 1 and 2. In any case, it is necessary to give priority to collective over individual action. The measures are related in particular to the increase of cleanliness of machine tools and their surroundings. There is need to apply welding screens to separate welding area from machine tools sufficiently. Collective action can be followed by individual measures. Regular inspection of personal

protective equipment use and its proper use is inevitable. The protective clothing and footwear, gloves, goggles and face shields are required.

To ensure the cleanliness of the floor around cutting machines, portable industrial vacuum cleaners can be used. Their advantage is that in addition to metal chips, vacuum cleaner is able to clean the floor and machines surroundings from the emulsion. Solid and liquid substances shall be evacuated and collected into a container. Collected liquid (emulsion) may be re-used in most cases.

Running the HVAC equipment should not cause a deterioration of working environment in terms of noise, vibration or emissions of polluted air. To reduce the noise arising HVAC equipment operation, pipes should be lead through walls, floors and ceilings.

❖ CONCLUSIONS

The article summarizes the results of risk assessment at turning, drilling and boring processes by FMEA method. It highlights the risks that may arise from material cutting, and the design of technical equipment, which helps to eliminate the presence of harmful factors in the process of turning. Based on the direct observation and experience it can be noted that the major threats are caused predominantly by personal protective equipment misuse, lack of facilities maintenance, and last but not least by the use of obsolete machinery and equipment. For this reason it is necessary to give greater emphasis to the control of workers, workplaces, and compliance with general legal rules and guidelines for occupational health and safety. Although each intervention in the form of new or advanced equipment is costly, there is nothing to offset the health of employees.

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