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SUMMARY OF CHOSEN LEGISLATION USED IN AUTOMATED OPERATION

Urgency of the research. *In the field of automation currently exists a lot of standards and directives deals with this area, and frequent mistakes and errors occur during implementation of automated workplaces (especially with robotic arm).*

Target setting. *Purpose of article is to give an overview and brief summary of chosen legislation that is most used during of implementation of such systems.*

Actual scientific researches and issues analysis. *Several books and articles were published during past of years, but a lot of them contain general and complex information, only few of them were focused on limited area, such automated workplaces.*

Uninvestigated parts of general matters defining. *Despite to lot of information from this area, still is missed clear idea for automated workplace implementation.*

The research objective. *The point of article is showing the most important legislative for automated workplace designing with safety requirements.*

The statement of basic materials. *For success realization of automated solution (obviously with robotic arm) is needed evaluation and assessment of risk that can occur there, with regards to the persons around workplace.*

Conclusions. *The results published in this article increase the correct installation of such automated workplaces, together with industrial robots. In addition, presented legislative helps persons for better understanding of material flow creation in these types of workplaces, where major role is realized via industrial robot. Our proposed solution can be considered as relevant base for introducing such workplaces into the "INDUSTRY 4.0" concept.*

Keywords: *directives and standards; risk assessment; safety guards.*

Fig.: 4. References: 9.

Introduction. The legislation that have impact to the automated operation lead producers to the ambition for creation of new impulses with aim of effectively of manufacturing, assembly or welding processes. New information is still coming with added values from SMEs practical testing in Slovakia and also from abroad. These companies depends on being to more competitive at labour market, increases their production capacities, productivity and push impact to the effectiveness. Without automation, robotics and digitalisation are impossible in present, and mainly in future to be competitive with qualified employees. Actual trends point out to the missing knowledge of many workers, how correctly implemented legislative important. It is still more difficult and many SMEs pay for it through outsourcing from external companies that deal especially with this issue [1]. Another aspect lay in problem with manual work. Manual work is on declining; in companies grow up automation systems on each level. Operators with sufficient qualification for operation, maintenance of such systems are deficiency. The correct way how to solve these problems could be in education and implementation of innovative technologies to the companies. Workers must be interested in and including into these new areas [2]. Several researches are focused on trends, implementation of automated workplaces (including robotic arms) for whole purposes.

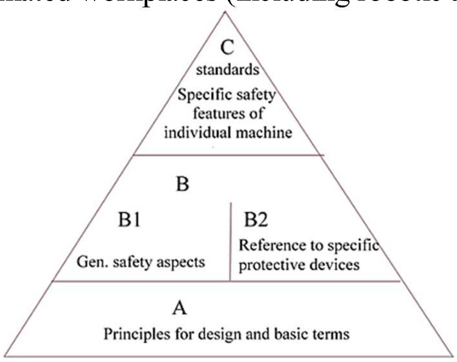

Fig. 1. Safety legislation during operation at automated workplace with industrial robot

The safety legislation focused on basic determination of security requirements has followed structure, Fig. 1.

– A-standards: It provides determination of basic issues for projecting and designing of such automated workplaces that could be applicable for all machines. This includes standards EN ISO 14121, EN ISO 121002, IEC 61508.

– B-standards: Focused on one special chosen safety factor or type of security equipment that can be used during automated workplaces implementation. Deals with safety requirements or equipment, which can be used for which machine, industrial robot and so on. It is divided into B1 – individual safety aspects (safety distances, temperature, noise, requirements to control system etc…) and B2 – deals with two handled control or contactless protection devices. It includes standards like: EN ISO 13849, EN 62061, EN 60204-1, IEC 61496-1, EN 349 or EN 1088.

– C-standards: Deals with special safety machine norms. It determines safety requirements for individual machine, robot or equipment. Also includes requirements for specialized machines. Obviously it is focused on special conditions (radioactive, dust, clean etc…) and on atypical solutions of machines. This includes EN 692 or EN ISO 10218 (for industrial robots).

Risk assessment, EN ISO 12 100. Risk assessment is considered as systematically approach that leads to verification, if exists some kind of danger directly at automated workplace. In the same time, safety actions are considered, if they are sufficient for people protection, Fig. 2. It also serves as standard base to increasing of quality and effective actions [3]. Currently, several types of methods for risk assessment is available for automated workplaces, most often is point method. This method has several modifications regarding to the evaluated person. Each of them can create his own methodology for risk assessment depending on the specific issues at automated workplace and activities on it [4].

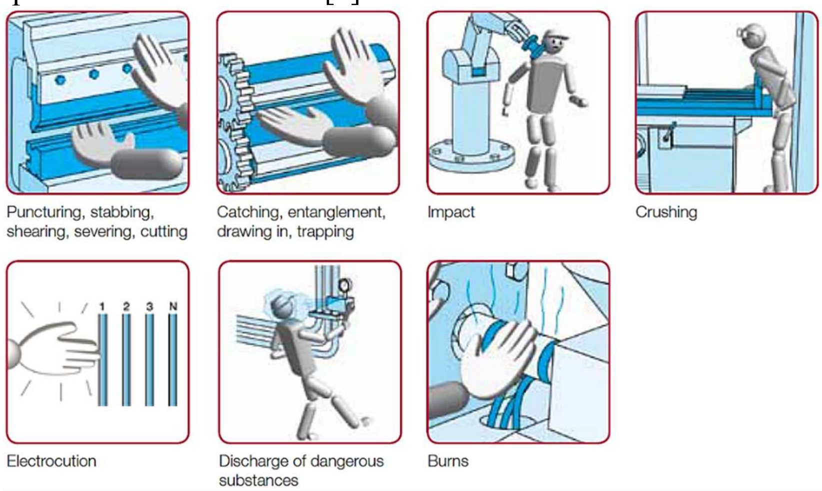

Fig. 2. Example of possible risk at automated workplace

Basically, we could say a statement that process for risk has a same form – including following steps:

– Selection of assessed area at automated workplace,

Assessed part could be a machine, industrial robot, belt conveyor or another part of automated workplace equipment. Accurate determination of assessed part show us, where could be a potential of danger.

– Hazard identification,

After selection of assessed part is necessary property identification and aspects that could be potential source for creation of danger, health problems or diseases as negative state.

– Danger identification,

If hazard were determined, next step consist of setting how injury can be realized via this chosen part, as product of negative state. So, we must determine the way and direction of negative effect to the persons, environment, values etc. From one potential danger could be divided more dangers.

– Requirements fulfilment of actual legislation,

In praxes, directly these issues are not filled and law respecting could significantly influence for risk parameters. In this step is necessary to compare if chosen part of automated workplace, work envelope, technology fulfil requirements regarding to the laws, technical documentation, provider guides, etc.

– Risk assessment (calculation),

From definition of risk, we can consider that probability for creation of potential dangerous situation is depended at importance of consequences of potential negative situation. We can state that risk is a function two basic parameters: probability (p) and consequence (c).

– Assessment of safety at automated workplace,

During assessment of safety is necessary to make expertize, it means, how is the probability for danger creation. This process consists of injuries probability if exists any potential, from statistical numbers of reliability and from qualify estimation of specialist

– Actions lead to risk decreasing or removing.

Accident consequences are mean as level or importance of potential, damage. During this process we start from importance of damage – dead, heavy, another type, illness from working. The second aspect consists of damage range – only one person, more persons, and equipment damages.

Risk minimisation, EN ISO 13 849-1.

Risk minimisation is obviously considered as complex, hard and difficult procedure, Fig. 3. This is a very often reason of SME companies that have an influence on its insufficient realisation at automated workplaces (including robotic arms). Risk minimisation must be regularly considered e.g. by standard employee with normal thinking mind. In case employee is realized this procedure, it is better because of his knowledge of specific automated workplace, where he spent eight hours per day. It is better than another person via outsourcing companies [5]. For securely identification of hazards caused at automated workplace can be used also a universal control list for danger situations. It is necessary to start directly at reality from automated workplace, individual working areas and machine, industrial robot or another equipment work flow. Person can consider if individual hazard potentially at high or low degree of dangerous situations is.

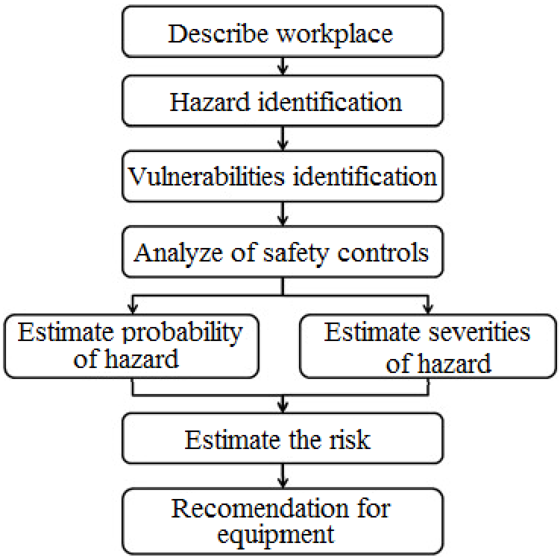

Fig. 3. Risk minimisation

After risk minimisation can be agreed several recommendations:

– Do not leave any automated workplace without supervision,

– Do not leave any automated workplace equipment turned on, if there is possibility of human approaching (except operators and instructed persons),

– Do not move under the robotic arm with end effector,

– Do not overtake any moving equipment at automated workplace,

– Do not help to robotic arm with its payload,

– Ways for moving equipment must be clear, soft an straight due to loose of stability or work piece falling from it,

– Regularly controlling of each equipment at automate workplace with documentation,

– Overloading of any equipment at automated workplace,

– Manipulation with any equipment at automated workplace must be realized only by instructed persons.

Risk minimisation can be evaluated through this method that consists of individual activities at automated workplace (including industrial robots). These points are taken into account from activities generally realized at these types of workplaces. Each activity is considered by its most important parameters (speed, acceleration etc...) and then is possible to identify hazards from them [6]. After that is evaluate probability of its creation and also possible reasons, if they will be created as negative event. Later, we can determine the value of risk, activities for its decreasing or removing.

Safety guard switches, EN ISO 14 119.

The purpose of safety guard switches are prohibiting to machine, robot etc. between uncontrolled start in case of potential risk exists for operators (opened machine part, paused robotic arm etc.). Switches serve for reliable detection of machine, robot or another equipment status together with movement detection some of its parts [7]. It is not depended on sensing of position, end positions of machine, robot or equipment specific part, not even based on security zones. For implementation to the automated workplace with robotic arm are contactless positioning switches good choices in difficult conditions, Fig. 4. Their advantage consists of:

– Modularity for deployment into the various workplace types, big flexibility and low expenditures,

– Several combinations due to many physical principles with end parts,

– Variants for extreme environment implementation, corrosive protection,

– Quick diagnostic based on LED diodes,

Programming of these switches contains complete and modular units that can be assembled into specific variants based on application. One million connecting and disconnecting operations are guaranteed together with 1500 possible configurations [8].

Fig. 4. Safety guards at automated workplace

Blocking barriers - serves as protective security equipment to protect persons (at one hand) and also machines or equipment (due to its expensiveness i.e.) at automated solutions. Various types of barriers are used or its specific arrangement at such workplaces for accessing close into the equipment (like robots, conveyors etc.) working envelope resp. workspace. These protective sources are designed in such way that protects people and their human parts before reaching of potential dangerous area. Any contact between them and machine, robot etc. prohibited, especially during its automatic mode. Blocking barriers serves for separation of machines, manipulating AGVs or robotized areas from the operators and other persons [9]. In addition, it can create a safety zones around areas which are potentially dangerous for people.

Requirements for blocking barriers:

Whole automated workplace (including robotic arm) must be stopped, directly after barrier opening. The starting of automated workplace is allowing after barrier closing and confirmation from operator, regarding to the required procedure. Based on blocking barriers types, we can recognize:

– Blocking barriers that are connected directly with security separation equipment without fusing. They allow to each equipment cannot be at working, while blocking barrier is opened. After closing of barrier, equipment must be set into the manual mode (required also for robotic arm) and allowed by operator.

– Blocking barriers that are connected directly with security separation equipment with fusing. They allow to each equipment cannot be at working, also after blocking barrier closing. Equipment is locked until risk is at the workplace (person near the robotic arm i.e.). It is possible via special mechanical switches that are used for sensing of protecting shields position inside the workplace and also at specific machines. Switch can be turned by positive or negative signal, if is used only one switch, positive signal is preferred.

Conclusions. Risk is practically everywhere and during whole our life, often it uncover our health quality and productivity in SME companies. Each year there are many employees that are injured during their work flow, lot of them lead to work inability, stress factors or overloading for human psychics or another human diseases based on long time working. These type of accidents and diseases are not difficult only for SME companies owners, but also for employee's family and state health system and have a big influence to the productivity of companies.

Various types of risk are also created during "INDUSTRY 4.0" implementation, where automation is (in few steps) decreasing availability for lower workers qualification skills. Assessment of risk is still needed and is base for successfully control of safety requirements and health protection that is the key for decreasing of person's illness and occupational injuries. In case of its correct assessment can be considered as a good source for safety and good health at automated workplaces, and also – in general, is necessary to avoid of all possible risk at workplaces.

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ОГЛЯД ВИБІРКОВОГО ЗАКОНОДАВСТВА, ЩО ВИКОРИСТОВУЄТЬСЯ В АВТОМАТИЗАЦІЇ ОПЕРАЦІЙ

***Актуальність теми дослідження**. У сфері автоматизації нині існує безліч стандартів і директив, однак виникають часті помилки і збої під час впровадження автоматизованих робочих місць (особливо у роботизованого маніпулятора).*

***Постановка проблеми**. Мета статті – огляд і короткий виклад окремих законів, які найбільш часто використовується при впровадженні автоматизованих систем.*

***Аналіз останніх досліджень і публікацій**. За останні роки було опубліковано кілька книг і статей, але більшість з них містять загальну і складну інформацію, і лише деякі орієнтовані на вузьку область, а саме – автоматизовані робочі місця.*

***Виділення недосліджених частин загальної проблеми**. Незважаючи на велику кількість інформації в цій галузі, відсутній чіткий план впровадження автоматизації на робочому місці.*

***Постановка завдання.** У статті наведено найбільш важливий принцип проектування автоматизованих робочих місць відповідно до вимог безпеки.*

***Виклад основного матеріалу**. Для успіху реалізації принципу автоматизації (за допомогою роботизованого маніпулятора) необхідна оцінка та виявлення ризику, який може статися з особами, які працюють на робочому місці.*

***Висновки відповідно до статті.** Результати, опубліковані в цій статті, забезпечують більш правильну установку таких автоматизованих робочих місць разом із промисловими роботами. Крім того, представлені принципи допомагають людям краще зрозуміти процес виробництва на таких типах робочих місць, де важливу роль відіграє промисловий робот. Запропоноване рішення можна розглядати, як актуальну базу для впровадження робочих місць у концепцію «INDUSTRY 4.0».*

***Ключові слова:** директиви та стандарти; оцінка ризику; захисні пристрої.*

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