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ROBOT-BASED SAFETY CONCEPT OF AN AUTOMOTIVE PRODUCTION FACILITY

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Abstract: *This article gives the results of a safety concept implementation for a gearboxes assembly station. The legislative framework was synthesized, both at national and at European level. Based on it's implementation, the conditions to ensure employees safety at work are at highest standards. Next, a description of the equipment, presenting its operation and work process was carried out. The implemented safety functions were described in detail, referring to their mode of action, as well as their subsequent checks that are part of the maintenance plan, in order to ensure preventive maintenance and thus, the operation in quality and safety conditions.*

Keywords: *safety concept, automotive, gearbox, assembly station, emergency stop, robot range, safety standards.*

1. INTRODUCTION

The Montaj LLC company was founded in 2010, having as its field of activity the assembly of gearboxes for passenger cars. The company is an international supplier for the automotive industry. The basic principles of the company are represented by the continuous improvement of customer satisfaction, production facilities and processes at the highest standards, qualified, motivated and responsible employees, the implementation of processes in a way that is as safe as possible in terms of the health and safety of employees, environmental protection and sustainability [1, 2]. In addition to fulfilling the objectives related to the company's business, social responsibility is not neglected either, the company being actively involved in various social projects, at city and county level. The company is certified in terms of occupational health and safety and environmental protection, according to ISO 45001:2018 and ISO 14001:2015 standards, respectively.

The production of gearboxes is carried out in a production hall, spread over an area of 7 hectares. The production lines include automatic stations, semi-automatic stations and manual stations. They were built, in compliance with the highest standards, and in accordance with all the regulations in force, in order to achieve a complete and qualitative production capacity, and to protect the safety and health of employees. The main process implemented by the company, to ensure the safety of its employees from the point of view of the safety of work equipment, is represented by the participation of the safety engineer in the entire process of purchasing production lines, starting with the design of the lines, and ending with their acceptance process in production. Within the company, a number of 1500 employees are active, in the directly and indirectly productive departments and the administrative personnel departments. They continuously benefit from qualification, training and training programs, being the most important resource of the company.

A special emphasis is placed on the component of health and safety at work, the basic principle that guides the company being that, healthy employees and satisfied with the workplace conditions, have the greatest contribution to qualitative development and productivity growth [3].

By understanding the fact that employees are the most important resource of the company,

attention is particularly focused on improving their satisfaction, by motivating, stimulating and empowering them, by ensuring that all equipment and the working environment are in accordance with the legislation, applicable regulations and policies and by constantly making efforts to achieve the goal of "zero accidents and zero occupational diseases" [4].

2. APPLICABLE LEGISLATIVE FRAMEWORK AND PRINCIPLES OF SAFETY INTEGRATION INTO MACHINES DESIGN AND CONSTRUCTION

At the time of construction of a work equipment, its manufacturer is directly responsible for compliance with the European Union regulations, in the field of Machinery Safety, national legislation, and regulations specific to the field in which the equipment will be used. Due to the multiple requirements in this field, the existence of a safety concept in accordance with the above is required.

Legislation and standards applicable in the field of machinery safety include:

A. Normative acts:

• G.D. no. 1146/2006 regarding the minimum safety and health requirements for the use of work equipment by workers [5];

• G.D. no. 1029/2008 regarding the conditions for placing machinery on the market ("Machinery" Directive, amended and supplemented by G.D. no. 517/2011) [6].

B. Standards:

• Romanian standards that adopt the harmonized European standards relating to machines:

- SR EN ISO 12100: 2011: Machinery safety. General design principles - Risk assessment and risk reduction [7];

• relevant standards regarding terms and definitions in the field of machine safety:

- SR ISO 45001: 2018 - Occupational health and safety management systems. Requirements and guidelines for use [8].

• harmonized technical standards:

- Safety of machinery - Minimum clearances to prevent crushing of body parts EN 349:1993 +A1:2008 [9];
- Continuous transport equipment and systems - Safety and EMC - Requirements for mechanical devices transporting unit loads EN 619:2002+A1:2010;
- Machinery safety - Protective devices - General requirements for the design and construction of fixed and mobile protective devices EN 953:1997 +A1:2009 [10];
- Safety of machinery - Human physical performance - Part 2: Manual handling in relation to machinery and machinery parts EN 1005-2:2003 +A1:2008;
- Safety of machinery - Human physical performance - Part 4: Assessment of working positions and movements in relation to machinery EN 1005-4:2005 +A1:2008;
- Fluid engineering - General rules and safety requirements for systems and their components (ISO 4414:2010) EN ISO 4414:2010;
- Robots and robotic devices - Safety requirements for industrial robots - Part 1: Robot (ISO 10218-1:2011) EN ISO 10218-1:2011;
- Robots and robotic devices - Safety requirements for industrial robots - Part 2: Robotic systems and integration (ISO 10218- 2:2011) EN ISO 10218-2:2011;
- Safety of machinery - Integrated manufacturing systems - Basic requirements (ISO 11161:2007) EN ISO 11161:2007 (A1:2010);
- Acoustics - Noise emitted by machinery and equipment - Determination of emissions - Sound pressure levels at a workstation and other specified positions (ISO 11202:2010) EN ISO 11202:2010;
- Machinery safety - Basic concepts - Risk assessment and mitigation (ISO 12100:2010) EN ISO 12100:2010 [11];
- Safety of machinery - Safety parts of control systems - Part 1: General principles (ISO 13849-1:2006) EN ISO 13849-1:2008 (AC:2009);
- Safety of machinery - Safety parts of control systems - Part 2: Validation (ISO 13849-2:2012) EN ISO 13849-2:2012;

- Safety of machinery - Emergency stop - General design principles (ISO 13850:2006) EN ISO 13850:2008;
- Safety of machinery - Placement of protective equipment according to the approach speeds of body parts (ISO 13855:2010) EN ISO 13855:2010;
- Safety of machinery - Safety clearances to prevent upper and lower limb danger zones (ISO 13857:2008) EN ISO 13857:2008;
- Safety of machinery — Locking devices associated with protectors - Principles of design and selection (ISO 14119:2013) EN ISO 14119:2013;
- Safety of machinery - Electrical equipment of machines - Part 1: General requirements IEC 60204-1:2005 (adapted) EN 60204-1:2006 (AC:2010).

When selecting the most appropriate solutions, the manufacturer or his authorized representative must apply the following principles, in the indicated order [12]:

- to eliminate or reduce risks as much as possible (design machines with intrinsic safety);
- to adopt the necessary protective measures for the risks that could not be eliminated;
- to inform users about the remaining (residual) risks.

When designing and constructing machines and drawing up instructions, the manufacturer or his authorized representative must take into account not only the normal use of the machines, but also foreseeable misuses and take into account the constraints to which the operator is subjected, as a result of the necessary or foreseeable use of personal protective equipment.

3. DESCRIPTION OF WORK EQUIPMENT – GEARBOX ASSEMBLY STATION

3.1 General requirements regarding the analyzed work system's operation

The work equipment is a component part of a gearbox production line, in the automotive field. The work equipment is an automatic station for mounting blade subassemblies, as a component part of a gearbox. For the purpose of selling and using work equipment, according to the Machinery Directive, 2006/42/CE, and H.G. no. 1029 of September 3, 2008, which takes over the directive in Romanian legislation, without the preparation of the CE Declaration of Conformity and the application of the CE marking, no equipment can be put on the market or put into operation, legally. Thus, the equipment manufacturer must ensure the following [13]:

- Satisfying the essential requirements of Safety and Health at Work;
- Ensuring the availability of the equipment's technical file, provided for in Annex 7 of the Machinery Directive, 2006/42/EC;
- Providing the necessary instructions;
- Application of specific conformity assessment procedures;
- Drawing up the EC declaration of conformity, according to Annex 2, letter A, point 1;
- Applying the CE mark, according to art. 16 of the directive.
- In addition to the safety instructions related to the work equipment, the safety, accident prevention and environmental protection regulations valid for the machine's field of activity must be observed

3.2 Work areas and workstations

Figure 1 shows the working areas of the analyzed work equipment. These areas are presented as follows:

Zone 1 – the zone where the subassembly packages are brought and assembled by the 2 robots.

Zone 2, zone 3, zone 4 – zones where the operator manually inserts subassembly packages. With the help of a measuring probe, the station checks the lifting height of the sub-assembly packages. The camera positioned inside each of the 3 zones verifies the type and positioning of the subassemblies. The robots move to the pick-up areas and their grippers pick up the placed packages. They are transferred to the rotary table in zone 1, being at the same time rotated into the correct position for assembly.

Zone 5 – Robot 1, this being programmed to ensure the collection of subassemblies packages from zone 2 and zone 3.

Zone 6 – Robot 2, which is programmed to ensure the pickup of subassembly packages from zone 4.

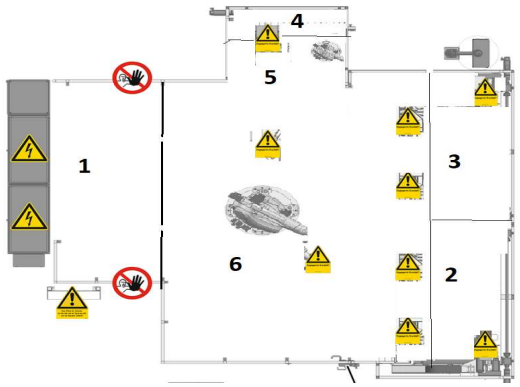

Fig. 1. The working areas of the equipment

During the work process, the operator must ensure the necessary packages of subassemblies, which he will insert manually in the areas intended for them: zone 2, zone 3 and zone 4. Robot 1, will take the package of subassemblies from zone 2, will transfer it and place on the conveyor belt in zone 1. Afterwards, robot 2 will take the package of subassemblies from zone 4, and will transfer and place it on the conveyor belt in zone 1, mounting it above the package already transferred from zone 2. Robot 1, it will then move to area 3, from where it will pick up, transfer and place the package of subassemblies on the conveyor belt. It will be mounted above the package of subassemblies in zone 4.

When taking over the packages of subassemblies, the robots will detect, by scanning, the fact that they do not correspond to the codes already entered in the station, they will automatically generate automatically an error at the station's main panel, an error that will confirm to the operator that he will have to intervene manually to replace the package of subassemblies with the corresponding one. Signaling devices are installed; the malfunctions that have occurred are displayed in the form of a clear text on the main control panel and an optical display of malfunctions, with the help of a traffic light:

- green – proper operation;
- yellow – station error;
- red – station/station component off.

The operator's workstations are located at the station:

1) In front of the main control panel of the station - in this workplace, the operator can make all the necessary settings regarding the entire station. Also, the station's start, stop, or stationary commands can be accessed from the main control panel;
2) In the working area of the station, if it is stopped - to remedy any errors or irregularities that may have occurred;
3) In the areas of manual introduction of subassembly packages – for the introduction of subassembly packages, the jobs are temporary, the operator being in the respective areas, only when the need to complete the subassembly packages arises.

4. SAFETY CONCEPT OF THE GEARBOX ASSEMBLY STATION

4.1 Safety areas of work equipment

The work equipment has a well-defined safety concept, being divided into 6 safety zones, figure 2, being determined following the risk assessment.

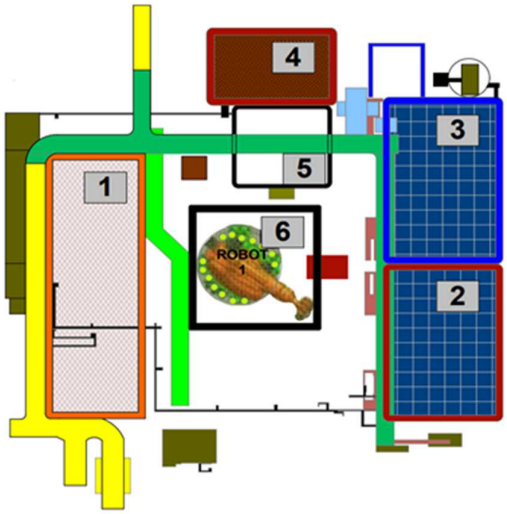

Fig. 2. Safety areas of work equipment

- Zone 1 – subassemblies assembly area;
- Zone 2 – loading zone of the first package of subassemblies;
- Zone 3 – loading zone of the second package of subassemblies;
- Zone 4 – loading zone of the third package of subassemblies;

- Zone 5 – the zone of the robot that takes package 1 and package 2 of subassemblies;
- Zone 6 - the zone of the robot that takes the package 3 of subassemblies.

Risk assessment is followed, whenever necessary, by risk reduction measures. In accordance with the requirements of the SR EN ISO 12100: 2011 standard, the risk assessment includes:

a) risk analysis:

- establishing the limits of the machine;
- hazard identification;
- risk estimation;

b) risk evaluation.

Aspects that must be taken into account in the risk estimation process (adjustment after SR EN ISO 12100: 2011):

- exposed persons;
- type, frequency and duration of exposure;
- the link between exposure and effects;
- human factors;
- the applicability of preventive measures;
- the possibility of neutralizing or evading preventive measures;
- the ability to maintain preventive measures;
- information for use.

When establishing the concept of an equipment and putting it into operation, according to SR EN ISO 12100: 2011 and the Machinery Directive 2006/42/EC, the following aspects must be taken into account:

i. technical equipment documentation and occupational safety requirements;
ii. safety measures against mechanical risks;
iii. measures against falling from height;
iv. measures against the risk of slipping, falling from the same level;
v. preventive measures against physical risks;
vi. fire and explosion protection measures;
vii. ergonomic measures;
viii. protective measures against chemical risks;
ix. protective measures against electrical hazards, [14, 15];
x. protective measures against thermal risks;
xi. protective measures on control and safety devices;
xii. proper implementation of the necessary conditions at the workplace

4.2 Protective devices implemented following risk assessment

As a general means of protection implemented in the safety concept of work equipment, it is the fencing of work areas with Makrolon polycarbonate panels. His purpose is to prevent physical access to the working area of the equipment. Makrolon polycarbonate is extremely robust, transparent and, at the same time, resistant to impact, even at low temperatures. It also has high stability.

The mounting dimensions of these panels are established based on the actions taken by the work equipment, the determined safety zones, and the distances from the risk zones. In the case of robot areas, the protective fence has been designed according to the robots' range and their software limits.

The panels are mounted with safety screws, which can only be removed with the help of special tools, by authorized personnel. In order to ensure the safety of operators and other workers participating in the work process, the safety devices that act on all the work equipment are the emergency stops.

The emergency stop button (ESB) is a safety device, which, when pressed, stops the entire work equipment to which it is connected. After pressing the emergency stop, the work equipment can only be restarted after the circuit has been reset and the error that caused it to be pressed has been cleared and corrected. The emergency stops are connected in series with the control circuit of the equipment.

Pressing it will switch all actuators, valves and outputs to a safe state, with compressed air cut off. All movements with potential risk that occur in a safety zone surrounded by an emergency stop will be stopped safely.

The color standard of emergency stop buttons is represented by a yellow background, on which a red mushroom-shaped device is connected. The work equipment is equipped with 5 emergency buttons, according to the diagram in figure 3.

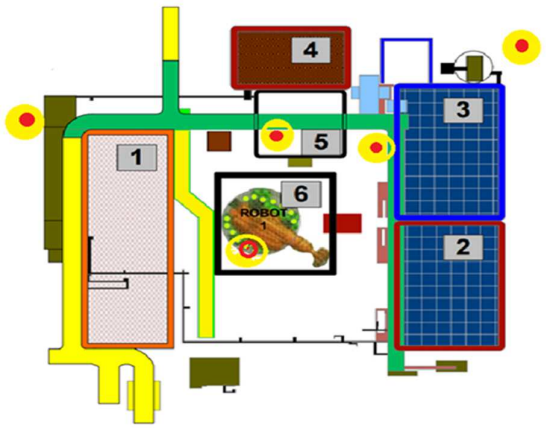

Fig. 3. Positioning of emergency stop devices

ESB 1– the main control panel of the equipment;
ESB 2– the secondary control panel of the equipment;
ESB 3 – inside zone 5;
ESB 4 – robot console 1;
ESB 5– robot console 2;
Areas 2, 3 and 4 – loading areas of subassembly packages.

The loading areas of the subassembly packages are each divided into 2 areas. In the first area, the operator introduces the packages of subassemblies, and in the second area, the robots take them, for their transfer to the assembly area.

In order to ensure the protection of the operator, the loading areas of the subassembly packages are provided with 2 types of safety devices, namely:

- interlocking devices at the operator's access protection doors for introducing packages into the station;
- photoelectric barriers, at the demarcation between the area of manual introduction of packages and the area of their collection by robots.

The loading areas of the sub-assemblies are provided with safety doors, which have connected Euchner CES-AR-C01 interlocking devices [16].

The safety switches of the CES AR manufacturing series are interlocking devices without protective interlock (construction type 4). The device meets the requirements of EN IEC 60947-5-3. Unicode-rated devices have a high encoding step, and Multicode-rated devices have a lower encoding step. Together with a movable protective device with a separating role and the control device, this safety component prevents the execution of a dangerous machine function while the protective device is open. If the guard opens during a hazardous machine function, a stop command is triggered. This means:

a) Connection commands that trigger a dangerous function of the machine can only become active when the protective device is closed;

b) Opening the protective device triggers a shutdown command;

c) The closing of a protective device must not produce an automatic start of a dangerous function of the machine. A separate startup command must be performed for this purpose.

As general safety measures, and to protect against errors, the following have been implemented:

- The operating voltage UB is ensured against polarity reversal.
- The safety outputs are secured against short circuits.
- The switch detects short circuits between safety outputs.
- By protecting the cable on the route, a short circuit between the cable conductors can be excluded.

The demarcation between the areas for manual introduction of subassemblies packages and the areas for pick-up by robots is done with the help of photoelectric barriers, type Sick, figure 4.

Fig. 4. Sick photoelectric barriers [17]

Optical safety barriers provide safe, low-cost to install and configure solutions for almost any access protection application in areas with potential injury hazards. This type of safety components are electrosensitive protective devices consisting of a transmitter (sender) and a receiver (receiver) or a transmitter/receiver

(sender/receiver) on the active side and reflective mirrors on the passive side. If one or more rays of the protective field are interrupted, the optical barriers give a stop signal to interrupt the condition with potential danger of injury to the machine or industrial plant [18].

Both the optical components of the barriers and the electronic components are encapsulated in weatherproof aluminum housings. The lengths of the protection fields (the minimum distances between the receiver and the receiver while maintaining the protection function) are between 0.5 m and 70 m. Within them, there is a 7-segment LED indicator that is useful both for alignment and when installing, configuring and diagnosing the safety system, indicating its status (configuration/installation errors, correct/incorrect alignment, etc). Before putting into operation for the first time an installation protected by a safety photoelectric barrier, the installation must be checked and authorized for operation by a qualified person [19].

At the time of refueling, the operator will operate the "Request Button" of the loading zones. The photoelectric barrier engages to ensure that the robots will not move into the loading areas and the safety door's Euchner safety switch opens, allowing operator access to open the door safely. The zones are filled by the operator with the subassembly packages, up to the maximum level (indicated by a marker). Load units are inserted, after which the operator closes the safety door. The Euchner interlock system closes and the photoelectric barrier is disconnected, allowing the robots to pick up the subassembly packages. The positioning of the safety devices is diagrammatically represented in figure 5.

4.3 Procedure for checking protective devices

The emergency stops must be checked before commissioning and subsequently at a certain frequency according to the maintenance plan. The safe restart of the work equipment must be done only from the main control panel, without the need for other interventions. ***The photoelectric barriers*** will be checked before commissioning, by specialized and authorized personnel in this regard.

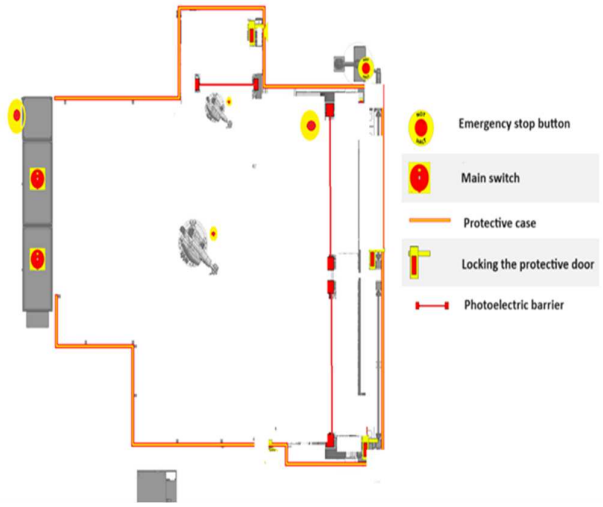

Fig. 5. Positioning of safety devices

In this sense, the photoelectric barriers will be checked, with calibrated measuring devices, which will measure the reaction speed of the barriers, as well as their reaction time. The accepted deviation will be taken into account, and the general protection equation will be calculated. In order to ensure proper functionality, the barriers will be checked daily by the operators, before the start of the activity. The barrier is equipped with a wand for verification, which is attached to the work equipment in close proximity to the barrier. In order to verify the photoelectric barrier, the verification wand will be passed manually through the area to be secured. It will be considered that the proper operation is proven by stopping the secured area and it will be taken into account that, during the verification, the OSSD-LED will continuously light up red. After the need to reboot the system is confirmed, the OSSD-LED will light green.

The EUCHNER interlocks connected to the safety doors can be checked by opening the doors. At that moment, the secured area will stop working, and the device's LED will light up red. On the main control panel, the protective door opening message will appear. When the protective door is closed, the LED of the Euchner device will glow yellow, and after confirming the need to restart the secured area, by pressing a confirmation button, the LED of the device will light up green.

5. ROBOT SAFETY AND DEACTIVATION MATRIX. THE SAFEROBOT CONCEPT

Safety zone 5 and zone 6 are represented by the robots that take the packages of subassemblies and transfer them to zone 1, where they assemble them. Robot safety concepts must be defined taking into account the workplaces in which the operators work and the length of time they are stationed in those areas. Thus, there are the following job categories, figure 6:

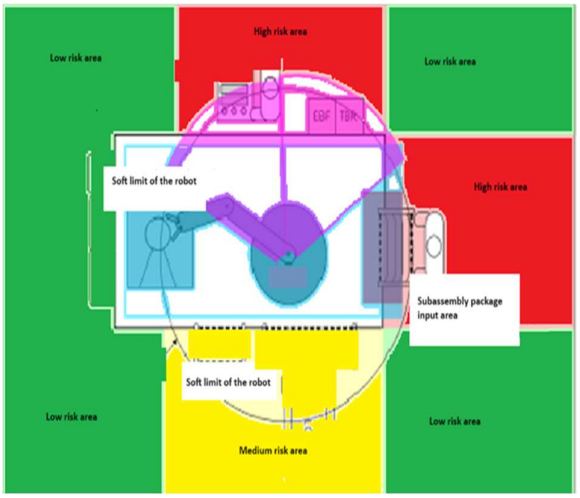

Fig. 6. Robot 2 range limits and risk areas

The ***deactivation matrix*** represents all the safety devices of a work equipment, and the method of their operation on it. The deactivation matrix can thus be considered a summary of the entire safety concept planned for an installation. Through it, you can easily check the equipment, from the point of view of safety at work, and the functionality of the technical means of protection implemented. Within the automatic station for the assembly of blade packages, the installation of safety devices was planned and carried out in such a way as to protect both the personnel working at the station and the auxiliary personnel located near it. According to the 6 defined safety zones, they were installed:

- 3 safety doors, with Euchner devices attached to them, at each zone for manual introduction of subassembly packages;
- 3 photoelectric barriers, installed at the delimitation of the areas for manual introduction of packages, and the areas for their collection by the two robots;
- 5 emergency stops, two of which are installed on the robot consoles.

For each of the 3 areas of manual introduction of subassembly packages, opening the protective door and thus activating the Euchner device, results in the immediate stoppage of the operation of all electrical, mechanical and hydraulic components of the respective areas, no further movement being possible, until closing the doors and confirming the resumption of the process, by the operator pressing the confirmation button. Photoelectric barriers are installed at the border between the areas of manual introduction of subassembly packages and the area of their pick-up by robots. After the packages are inserted, the rotary table on which they are inserted rotates 180o, thus enabling the robots to pick them up. Interrupting the photoelectric barriers results in an instant stop of the rotary tables and robots. Their purpose is to prevent any human access to the range of the robots in the situation where, due to improper use, there is a confirmation of deactivation of the Euchner device, while a person is still behind the protective door. Table 1 shows schematically the method of operating the safety devices on the equipment, at the time of their operation:

Table 1

The action mode of the safety devices on the equipment, at the time of their operation.

Work area	Safety door subassembly station 1 with Euchner device	Subassembly station photoelectric barrier 1	Safety door subassembly station 2 with Euchner device	Subassembly station photoelectric barrier 2	Safety door subassembly station 3 with Euchner device	Subassembly station photoelectric barrier 3	Main panel emergency stop	Emergency stop secondary panel	Robot 1 console emergency stop	Robot 2 console emergency stop	Emergency stop zone 5
Zone 1							X	X			X
Zone 2	X	X					X	X			X
Zone 3			X	X			X	X			X
Zone 4					X	X	X	X			X
Zone 5						X	X	X	X	X	X
Zone 6		X		X			X	X	X	X	X

Area is turned off

Area is not turned off

6. CONCLUSION

Before putting work equipment into use, its concept must be thought through from the planning stage. In this sense, the main sources of risk to which the operating personnel are subject

must be defined and understood. Identifying these risks is the first step in protecting employees at work. Among the most common risks are those of a mechanical, electrical, physical, chemical and ergonomic nature. After the risk assessment, the measures necessary to be implemented will be established, ranking them according to the directives and standards in force, regarding health and safety at work. Initially, technical protection measures will be implemented, aimed at ensuring the safe operation of the work equipment. Following a reassessment of the risks, in the event of residual risks, the implementation of protective measures of an organizational nature will be implemented, for example: safety signage, provision of individual protective equipment and staff training in the related work processes and safety rules. Within the safety concept, the safety areas of the equipment were first identified. Based on a risk assessment, the protective devices to be implemented have been identified in order to ensure the implementation of the basic principles of the Machinery Directive. The description of the safety concept of the robots and the determination of their range of action, depending on the workstations of the operators, as well as the safety measures implemented to prevent risks.

Afterwards, the machine deactivation matrix was presented, which summarizes the entire safety concept, from the point of view of the technical measures applied to it. The safety zones of the station, all the protective devices installed on the station, as well as their mode of action are presented in the matrix. Thus, according to the 6 defined safety zones, there were installed: 3 safety doors, with Euchner devices attached to them, at each zone for manual introduction of subassembly packages; 3 photoelectric barriers, installed at the delimitation of the areas for manual introduction of packages and the areas for their collection by the two robots; 5 emergency stops, two of which are installed on the robot consoles. The deactivation matrix shows the parts of the equipment that stop during the activation of the devices, presented by color: red signifying the stopped area, and green the area that continues its functionality, not representing a risk to the working personnel.

As a result of the reassessment of risks, following the application of technical protection measures, a series of residual risks resulted. These have been presented, along with proposed safeguards, to eliminate or reduce their effect on personnel.

7. REFERENCES

[1] Moraru, R.I., Băbuţ, G.B. *Principles and guidelines regarding the risk management implementation: The new ISO 31000:2009 standard*, Quality - Access to Success, 11 (4): 50-59, 2010

[2] Appiah-Kubi, E., Dura, C. C., Niță, D., Drigă, I., Preda, A., & Baltador, L. A., *The effect of digitalization on sustainability reporting: The role ofsustainability competence, green knowledge integration, andstakeholder pressure,* Business Strategy and the Environment,1–21, 2024, https://doi.org/10.1002/bse

[3] Moraru, R.I., Păun, A.P., Dura, C.C., Dinulescu, R., Potcovaru, A-M. *Analysis of the drivers of Occupational Health and Safety performance disclosures by Romanian companies*, Economic Computation and Economic Cybernetics Studies and Research, Issue 3, pp. 197 –214, 2020

[4] Eckermann, E., *World History of the Automobile*, Society of Automotive Engineers, 2001

[5] Government of Romania, GD 1146/2006 regarding the minimum safety and health requirements for the use of work equipment by workers, Official Gazette of Romania, No. 815, 2006

[6] Government of Romania, GD 1029/2008 regarding the conditions for introducing machinery to the market, Official Gazette of Romania, Part 1, No. 674 of September 30, 2008

[7] ASRO, *SR EN ISO 12100:2011, Machinery safety. General design principles. Risk assessment and risk reduction,* Romanian Standardization Association (ASRO), Bucharest, 2011

[8] ASRO, *SR ISO 45001:2018, Occupational health and safety management systems. Requirements and guidelines for use,* Romanian Standardization Association (ASRO), Bucharest, 2018
[9] ASRO, *SR EN ISO 13857:2008- Machinery safety. Safety distances to prevent the penetration of upper and lower limbs into dangerous areas,* Romanian Standardization Association (ASRO), Bucharest, 2011
[10] ASRO, *SR EN ISO 13855:2010 - Machinery safety. Positioning of the means of protection in relation to the approach speed of the body parts, Romanian Standardization Association (ASRO), Bucharest*, 2011
[11] ASRO, *SR EN ISO 14119:2014 - Machinery safety. Interlocking devices associated with protectors. Design and choice principles,* Romanian Standardization Association (ASRO), Bucharest, 2011
[12] Băbuț G.B, *Machinery safety*, Universitas Publishing House, Petroşani, 2016
[13] European Council, *Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on technical equipment and amending Directive 95/16/EC*, 2006
[14] Government of Romania, *GD 971/2006 regarding the minimum requirements for safety and/or health signage at the workplace*, Official Gazette of Romania, No. 683, 2006
[15] INCDPM "Alexandru Darabont" Bucharest, *Safety and Health at Work Guide regarding Safety and Health signaling at the workplace*, 2013
[16] Euchner, Instructions for use, (Translation of the original instructions for use), 2098039-19-07/19.
[17] Sick, Instructions for use, 8020152/YT79/2016-03-14
[18] * * *, www. Electromatic.ro, Optical barrier|electrosensitive protective devices (electromatic.ro)
[19] * * *, www. Electronica – azi.ro, SICK M 4000 Safety light barriers – Electronics-Today

Conceptul de siguranță centrat pe robot al unei facilități de producție automotive

Acest articol oferă rezultatele implementării unui concept de siguranță pentru o stație de asamblare a cutiilor de viteze. A fost sintetizat cadrul legislativ, atât la nivel național, cât și la nivel european. Pe baza implementării sale, condițiile pentru asigurarea siguranței angajaților la locul de muncă sunt la cele mai înalte standarde. În continuare, a fost realizată o descriere a echipamentului, prezentând funcționarea și procesul de lucru al acestuia. Au fost descrise în detaliu funcțiile de siguranță implementate, făcând referire la modul lor de acțiune, precum și verificările ulterioare ale acestora care fac parte din planul de mentenanță, pentru a asigura întreținerea preventivă și astfel, funcționarea în condiții de calitate și siguranță.

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