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STRUCTURAL OPTIMIZATION OF OCCUPATIONAL RISK ASSESSMENT IN ROMANIA: CASE STUDY FOR THE ACTIVITIES CARRIED OUT WITHIN A HYDROTECHNICAL CONSTRUCTION

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Abstract: *After 18 years since the legislative changes in the field of safety and health at work introduced the obligation to assess occupational risks at all workplaces, we note that the indigenous method of the National Research and Development Institute for Labor Protection in Bucharest was quasi-generalized in applicability. Starting from this practical reality, this paper aims to offer a more synthetic and pragmatic version of the application of the method for more complex jobs/activities, in which several socio-professional categories of workers are involved, by structural optimization of the procedure for the implementation of the specific stages and tools, in order to increase the effectiveness of the assessment of occupational injury and illness risks. This finality is achieved through a case study applied to a construction activity carried out within an important hydro-technical project. The main advantages of the approach proposed by the authors are summarized.*

Keywords: *risk assessment optimization, socio-professional category, hydro-technical construction, effectiveness, prevention and protection plan*.

1. Introduction

In the context of harmonization of national legislation with the European community regulations risk assessment has become in Romania too the angular stone of the approach in the field of safety and health at work [1, 2, 3, 4]. The starting point for the optimization of work accidents and professional diseases prevention in a working system is the risk assessment of that system [5]. Whether it's a job, a workshop or an enterprise, such an analysis allows prioritizing risks according to their size and efficient allocation of resources to prioritiy measures [6, 7]. Risk assessment involves the identification of all the risk factors within the analyzed system and the quantification of their size based on the combination of two parameters: the severity and frequency of maximum possible consequent impact on the human body, thus producing partial risk levels for each risk factor, namely the global levels of risk for the entire analyzed system [8, 9, 10]. In order to facilitate meeting the employers ' legal obligations in the field of risk assessment of occupational illness and injury there have been developed and are currently in use a relatively large number of methods [11, 12, 13, 14, 15]. From the multitude of methods used internationally and nationally for the assessment of injury and occupational illness risk, most often used in Romania is the method of assessing risk of accident and occupational illness, issued by I.N.C.D.P. M. Bucharest, approved by the Ministry of Labor and Social Security in the year 1993, re-approved in 1996, published in 1998 and was republished in 2002 and applied on a large scale in many industries and activities [16].

The method developed by I.N.C.D.P.M. Bucharest belongs to the category of analytical semi-quantitative methods and consists essentially in the identification of all the risk factors in the analyzed systems with the aid of a preset checklist and quantifying risk dimension for each risk factor, based on the

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combination of severity and frequency of the maximum foreseeable consequence. The overall level of risk on the job is determined as the weighted average of the partial risk levels. Application of the method is completed with two documents that have been created for every workplace: the risk assessment card and the proposed measures card [17].

Already a significant period of time passed over since the appeal to the I.N.C.D.P.M. method, and - at European and worldwide level - to other methods of the same type, the self-nominated as "quantification tools", takes place on a large scale in the field of safety and health at work, for prioritizing their own risks of a trade, profession or working system. Currently, more and more industry experts critique the limitations and disadvantages of this class of methods, considering them to be incomplete, unreliable, with a pronounced character of subjectivity [18, 19]. Other specialists are shading their opinions, proposing that such methods should be applied only as supplementary or informative tools [20]. In order for the application of the INCDPM occupational risk assessment method, as an established method in Romania for the assessment of occupational injury and disease risks, to lead to the most relevant results, the first condition is that the system to be analyzed is a well-defined workplace under the aspect of its purpose and elements. In this way, the number and type of potential interrelationships to be investigated and implicitly the risk factors to be considered are limited [21].

Another particularly important condition is the existence of a complex and multidisciplinary assessment team, which includes occupational safety specialists, designers, technologists, ergonomists, doctors specialized in occupational medicine, etc., corresponding to the varied nature of the elements of work systems, but also of risk factors [22]. The team leader should be the occupational safety specialist, whose main role will be to harmonize the points of view of the other evaluators, in the sense of subordinating and integrating the criteria used by each of them to the goal pursued by the analysis: the evaluation of occupational safety. [23]. The practical application of the INCDPM Bucharest risk assessment method in the work system is sufficiently laborious, as the amount of information that must be taken into account in the case of monitoring several workplaces, to justify the use of modern techniques for autonomous data processing.

The use of the computer is possible due to certain features of the method, respectively:

- staged work procedure;
- the existence of an algorithm for calculating the risk level;
- the type of links between the variables taken into account when determining the level of risk.

The automatic calculation technique can be applied both to the actual assessment of risks and to their computerized management within the unit.

a. During the evaluation itself, the use of the computer is recommended in two ways:
   - creation of data banks regarding: lifetime of technical equipment; operating time; the number of exposed persons; exposure time; the statistics of work accidents and occupational diseases produced and their use to more accurately determine the probability classes;
   - automatic calculation of partial risk levels and global risk level per workplace, activity sector, enterprise.
b. Computerized risk management requires the creation of complete and permanently updatable data banks, including the data from the risk and measures sheets for all evaluated workplaces in the unit. In this way, at every moment it is possible to know and correct according to the last assessment the exact situation of the existing risks, their size (risk levels), the measures that must be taken, those that have been taken, the responsibilities and competences for those are the measures.

2. Material and method

2.1. Brief description of the company under review

Hidroconstructia S.A. has its origins in the "General Directorate of Bicaz Hydropower Plant" established in 1950 as the sole builder of the hydropower investment in Bicaz. In 1961, the construction unit was moved with its headquarters in Bucharest under the name "Intreprinderea de Constructii Hidroenergetice" (I.C.H.), transformed over time into "Trustul de Constructii Hidroenergetice Bucuresti" (T.C.H.), then "Trustul Antrepriza Generala de Constructii Hidroenergetice Bucuresti" (T.A.G.C.H.) to become a commercial company under the name Hidroconstructia S.A. in 1990 by GD 1104. The company has as its main field of activity the execution of hydropower and hydro-technical construction works on the surface and underground.

From the establishment until now, the complexity of hydropower facilities has required the approach of the entire range of construction works, being performed in addition to specific hydropower works, civil and industrial works, roads and bridges, building works, land improvement works, quarrying and ballasts, equipment repairs, metal constructions, prefabricated reinforced concrete, etc., as follows:

- 172 dams, of which 144 are in concrete with heights up to 168 m;
- 182 hydropower plants, with an installed power of up to 1050 MW/plant;
- 881.8 km of water supply galleries, with diameters up to 7.50 m;
- 189 km of diversion and escape channels at hydropower plants;
- 516.4 million cubic meters of excavations in alluvium;
- 80.8 million cubic meters of rock excavations;
- 494.84 million cubic meters of ballast fillings;
- 45.89 million cubic meters of rock fillings;
- 42.66 million cubic meters of surface and underground concrete;
- 27.4 million square meters of wall at the dykes;
- 5.7 million square meters of sealing walls;
- 1753.2 km surface injections;
- 36.8 km veil injections;
- 612.4 km of filling and consolidation injections;
- 567 km of highways, national roads, county roads and other road rehabilitation;
- 126 bridges totaling 7115.8 m in length;
- 30 closures of waste depots;
- 14 waste sorting / composting stations;
- 8 water tartar and water purification stations;
- 1564 km of pipes for water supply and sewage;
- 350,639.5 square meters of civil and industrial constructions.

In parallel with the works in the country, the company tackled works of hydro-technical constructions, bridges, tunnels, etc. abroad (in Germany, Belgium, Bulgaria, Jordan, Iraq, Algeria, Iran, etc.). Hidroconstructia SA was organized to carry out construction activities in the country and abroad, according to its object of activity, which is carried out through a number of 9 Branches and Assembly Construction Units. In addition to the main activity, the Company also performs other secondary activities:

- vehicle transport with materials, goods and passengers;
- water supplies;
- civil and industrial constructions;
- roads and bridges;
- landscaping of watercourses;
- slag and ash deposits, etc.

Paroseni construction site had as its activity the hydro-technical development of the Baleia stream in order to supply water to Paroseni thermal power plant and the construction of the Equilibrium Castle and the Forced Pipeline (Bumbesti Pressure Node) from the Hydropower Development of the Jiu River.

2.2. Structural and functional analysis of the assessed workplace

Bumbeşti pressure node is an integral part of the hydropower development of the Jiu River on Livezeni - Bumbeşti sector. It is located in the perimeter of the town of Bumbeşti, about 800 m downstream from the confluence of the Sadu and Jiu rivers, on the left slope (the lower terrace of the Jiu River) and includes the following objectives:

The hydroelectric power station is the second power station (downstream), on the Jiu River and will be an above-ground construction (relative to the upstream power station which will be of underground construction). Access to the plant is on the right bank of the Jiu River, after the existing bridge over the Jiu, of the road that leads to Valea Porcului, from the bridge upstream, on a road of approx. 1300 m. The power plant will be a category B construction of importance and class II of anti-seismic protection. The plant will house three groups (turbine/generator) with an installed flow rate of 3 x 12 mc/sec and a gross drop of 154 m. The infrastructure of the plant will be a tank-type construction made of reinforced concrete with dimensions, in plan, of 15.50 x 31.00 m and a maximum height of 13.50 m of which 5.00 m below the level of the turbine axis.

The superstructure of the plant will be a hall type with reinforced concrete frames. The height of the superstructure of the plant will be 11.50 m in the engine room area. The resistance structure consists of pillars, crossbars and perimeter beams to support the closures, as well as a metal frame consisting of wedges, beams and pops to support the covering of sheet metal panels. Figure 1 shows the location of the future plant.

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Fig. 1. The location of the future hydroelectric plant

Dumitra - Bumbeşti adduction gallery will ensure the transit of the installed flow of 36 m3 /s, between C.H.E. Dumitra and Bumbeşti pressure node, with a length of 12.75 km.

The forced pipeline will be located on the slope (figure 2) between the valve house and the power plant distributor and will be a metal pipe type construction mounted on reinforced concrete supports and massive anchors. The metal pipe will have an internal diameter varying from 3.00 m at the top to 2.80 m at the connection with the power plant distributor and a length of 262.2 m. Next to the pipe will be located the pedestrian access staircase that will connect between the plant platform and the valve house. Figure 2 shows the location of the forced pipeline.

Fig. 2. Location of the forced pipeline

The valve house will be located on the platform at the height of 419.60 m at the point where the adduction gallery emerges and has the role of ensuring the stoppage of the water flow between the gallery and the plant in the event of an accident.

The Equilibrium Castle will be located at an elevation of 454.60 m and will connect, vertically, with the adduction gallery at a distance of 25 m from the place where the gallery emerges (surface), having the role of avoiding ″batter hits″ in turbines. The construction will have a useful diameter of 12 m on the underground side at a height of 30 m. The above-ground construction will be in the form of a truncated cone (with the large base down) with a useful diameter of 17 m at an outer diameter between 17.6 m and 17.8 m. Figure 3 shows the place where the equilibrium castle will be located.

Fig. 3. Original location of the equilibrium castle

3. Results and discussion

3.1. Safety and health at work risk assessment for the activities carried out at the "Equilibrium Castle" workplace within the C.H.E. Bumbeşti. The work process

The main phases of execution for the realization of the Equilibrium Castle are:

a) Deforestation and cleaning of roots and other plant debris.

In the first phase, the existing trees from the expropriated perimeter will be felled, this stage containing the following main operations:

- clearing the land in the direction of felling the trees;
- cutting down trees;
- manual removal of stumps;
- clearing the land of trees and weeds.

b) Excavation of the well and evacuation of waste.

Excavation is carried out using the classic methods, namely by drilling and demolishing with explosives. The evacuation of the material resulting from demolition with explosives is done with the excavator on the first 3 m from the ground surface, after that is done with screed to a depth of 13 m. After the excavation of the 16 m, an evacuation well with a diameter of 1.2 m will be drilled. The evacuation well will be executed by drilling several holes with a diameter of 59 mm up to the ceiling of the gallery, after which the demolition will be done with explosives, and the material resulting from the demolition will fall by gravity into the gallery. The tailings brought to the surface and the ones that fell into the gallery will be loaded with the autoloader into dump trucks and transported to the tailings dump.

c) Stages/phases of execution.

- Plotting the axis of the well;
- Excavation of a ring at a depth of 6 m with a diameter of 14 m;
- Supporting the ring with net, anchors and concrete;
- Formwork and concreting of the ring (at a useful diameter of 13.2 m).
- Excavation of the next ring (10 m deep at an excavation diameter of 13.2 m). After every 2 m of excavation, support will be made with anchors, netting and shotcrete;

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- After excavating and supporting the 10m, the drainage well will be executed with a diameter of 1.2m by drilling several 59 mm holes, the length of these holes will be 14m (up to the ceiling of the gallery).
- After the execution of the drilling, the demolition will be done with explosives;
- After the execution of the evacuation well, 2m rings will be made, with a diameter of 13.2m, by means of punching and mechanized dumping of the material on the well and temporary support with anchors, net and shotcrete;
- At the end of the excavations, formwork and upward concreting of the well will be carried out;
- After the completion of the well, the actual construction of the castle will be carried out, work that will be carried out by upward concreting.

3.2. Equipment

The following work equipment is used for clearing, excavation, temporary protection, formwork and concreting works:

- Excavator S 1203;
- 60-ton RDK crane;
- Bulldozer-excavator
- Compressor XA 175;
- Drilling machine SG-150;
- Front loader;
- Perforators VK 23;
- Raba 16 t dump truck;
- MIXOCRET shotcrete pump;
- Compressed air hoses;
- Compressed air container 12 mc;
- Pneumatic rotary hammers;
- Winches;
- Fixed bridges;
- Mobile bridge;
- Auxiliary installations (electrical, air, traction cables, etc.)
- Dynamite (Lambrex, Austrogen);
- Blasting initiation means
- Hand tools (shovels, pickaxes, trowels, hoe, hammer, etc.);
- Scaffolding and support scaffolding.

3.3. Workers, the human factor

During the execution of the work, "Bumbeşti Pressure Node - Equilibrium Castle", the work process is carried out with the participation of the following workers:

- Servicemen of earthmoving machinery (Du);
- Concrete workers (B) - licensed internally and as shotcrete workers;
- Shot firer (A) – externally authorized;
- Drillers (Si);
- Welders (S) – internally authorized;
- Compressor operator (C) – internally authorized;
- Crane operator (Ma) – authorized ISCIR;
- Miner (Mi) ;
- Mechanical locksmith (Lm);
- Mechanics (M);
- Carpenter (D);
- Unskilled workers (Lnc);
- Technical-operational staff (TO);
- Electricians (E).

All workers are medically checked. Depending on the specifics of the job, workers are authorized internally/externally.

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3.4. Working task

The activity carried out for each job is as follows:

- ✓ **Servicemen of earthmoving machinery (Du):** performs the following operations: machine operation (excavation, loading in dump trucks, pushing or leveling), fueling the machines with fuels and lubricants, small repairs, when they do not have a work front for the machine, performs unqualified category operations ordered by the head of the work point.
- ✓ **Concrete workers (B):** performs the shoveling and vibration of concrete, directs the concrete mixers when going backwards, ties / directs / unloads the concrete pouring bucket, performs the obtaining of the concrete spray mixture and when applying it with the help of the MIXOCRET pump, stretches the wire mesh on the ring supports, cuts it to the dimensions necessary and fix it with plates and nuts to the previously mounted anchors. Performs operations of cleaning dust holes by blowing with compressed air, performs concreting of anchors by manually filling boreholes with cement mortar.
- ✓ **Shot firer (A):** ensures the manual and specially prepared and authorized vehicle transport of explosive materials from the explosive storage to the blasting site, handles the explosive materials, ensures the withdrawal of workers and machines from the front, provides security, controls the drilled holes, primes the explosive and inserts the primer into the hole , makes the connections to the firing circuit, drills the holes, triggers the explosion, checks the front after firing to make sure there are no misses. Performs other tasks given by the workplace manager (e.g. bleeding, perforation).
- ✓ **Drillers (Si):** drill the anchor holes with the pneumatic rotary drill, install the pneumatic drill on the working position, clean the place for drilling and disassemble the drilling rig at the end of the work, install the air hose and fix it in the drill, check the good operation of the drill. After the drilling, clean the holes from dust by blowing with compressed air. It helps to fix the anchors. Performs other activities ordered by the workplace manager.
- ✓ **Welders (S):** prepares and checks the welding machine before starting work, cuts / welds the metal subassemblies that require this operation, participates in the handling of the materials needed for the metal constructions, checks the quality of the welds. Performs other activities ordered by the head of the work point.
- ✓ **Crane operators (Ma):** performs the loading / unloading of materials, the evacuation of tailings in the well, the daily inspection and maintenance of the crane, performs small repairs. If the crane is not being used, it also performs other activities ordered by the head of the work point.
- ✓ **Miners (Mi):** performs drilling, reaming operations, assembles the wire mesh, drives anchors, loads / unloads materials manually or with the help of lifting mechanisms, helps the fireman to transport and handle explosive materials, to load the front.
- ✓ **Unskilled workers (Lnec)**: performs operations specific to the unqualified category, manual digging, manual loading / unloading of materials, dredging, felling trees, manual clearing, removing roots, clearing the land of trees and weeds, helps other workers.
- ✓ **Mechanical locksmith (Lm):** carries out the assembly of metal constructions, mounts metal formwork, displays metal elements embedded in concrete required for fastening by welding. Performs other activities ordered by the head of the work point.
- ✓ **Mechanics (M):** have the task of keeping earthmoving machinery and mechanical work equipment in working condition, under conditions of intensive exploitation, carry out technical inspections according to the inspection program, are responsible for the method of carrying out repairs by checking the equipment when empty and under load, and have the purpose maintaining the state of operation in normal parameters and in safe exploitation conditions. Performs other activities ordered by the head of the work point.
- ✓ **Carpenters (D):** supplies the workplace with the necessary materials, tools and devices, manually or mechanically processes the wooden material, measures, traces, carves, chisels, plans, drills, nails, screws and bolts, executes wooden formwork and wooden platforms, dismantles the elements with a temporary character and recovers the used materials.
- ✓ **Compressor operator (C):** ensures the functioning of the compressor in order to produce compressed air under intensive operating conditions and under safe operating conditions.
- ✓ **Technical-operational staff (TO):** ensures the fulfillment of the technical and organizational conditions during the activity, coordinates the production process, checks the execution of the operations and the compliance with the tasks and responsibilities of subordinate workers. Ensures the work point with appropriate materials, equipment and qualified workforce, ensures the

distribution of the quantities to be executed on workstations and executors, supervises the development of the activity throughout the work schedule, establishes responsibilities and duties for subordinate workers.

- ✓ **Electrician (E):** executes the connection of electrical work equipment to low-voltage electrical panels; maintains and fixes malfunctions in electrical installations (cables, panels, lighting); maintains electrical safety of all electrical installations.

3.5. Work environment

The set of works that are executed for A.H.E. of the Jiu River on Livezeni – Bumbeşti sector, respectively C.H.E. Bumbeşti – Pressure node – Equilibrium castle – Excavations of temporary protections, concrete formwork is located, partly in the open air, on the surface work platform, partly underground. Workers are subject to natural environmental factors, such as the presence of atmospheric currents and air humidity that vary according to atmospheric conditions and seasons. The lighting during the activity is natural and artificial, on the work platform and only artificial on the well route, the works being carried out in three shifts.

The personal protective equipment that the workers are equipped with consists of: protective helmet, coveralls, boots with metallic domes, raincoat or waterproof suit, boots with metallic domes, protective glasses, external earplugs, dust masks, welding masks, welding apron and leggings, welding goggles, protective gloves, padded clothes. In accordance with the stages of the risk analysis specific to the applied INCDPM method and using the specific tools, the assessment of the risks of occupational injury and illness was carried out for the categories of work positions mentioned and described previously, the results obtained being centralized in table 1.

Table 1. Synthesis of the risk assessment results for the investigated workplaces

Jobs/tasks : Servicemen of earthmoving machinery (Du); Concrete workers (B); Shot firer (A); Drillers (Si); Welders (S); Compressor operator (C); Crane operator (Ma); Miner (Mi) ; Mechanical locksmith (Lm); Mechanics (M); Carpenter (D); Unskilled workers (Lnc); Technical-operational staff (TO); Electricians (E).																									
The concrete form of manifestation of the risk factors (description, parameters)		**Severity / Likelihood**												**Risk level**											
		Du	**B**	**A**	**Si**	**S**	**C**	**Ma**	**Mi**	**Ln**	**Lm**	**Me**	**D**	**Du**	**B**	**A**	**Si**	**S**	**C**	**Ma**	**Mi**	**N**	**Lm**	**M**	**D**
WORKER	1. Wrong maneuvers performed by the crane operator when handling loads.	7/1	7/1	7/1	7/1	7/1	-	-	7/1	7/2	7/2	7/1	7/1	3	3	3	3	3	-	-	3	**4**	**4**	3	3
	2. Commands/maneuvers given/performed by the fireman and/or workers who help transport, handle and load the front.	-	-	7/3	-	-	-	-	7/3	-	-	-	-	-	-	**5**	-	-	-	-	**5**	-	-	-	-
	3. Wrong maneuvers performed by machine operators, drivers at the work point .	7/1	7/1	7/1	7/1	7/1	7/1	-	7/1	7/1	7/1	7/1	7/1	3	3	3	3	3	3	-	3	3	3	3	3
	4. Wrong maneuvers performed by the electrician during interventions in electrical installations.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5. Wrong positioning of workers during tree felling, clearing and root removal operations.	-	-	-	-	-	-	-	7/1	7/1	-	-	-	-	-	-	-	-	-	-	3	3	-	-	-
	6. Wrong maneuvers/positions with/or of the oxygen/acetylene tubes.	-	-	-	-	7/1	-	-	-	7/1	7/1	7/1	-	-	-	-	-	3	-	-	3	3	3	3	-
	7. Wrong positioning of workers during the transport and manual handling of masses.	2/3	2/2	2/2	2/3	2/2	2/2	-	2/3	2/4	2/3	2/3	2/3	2	2	2	2	2	2	-	2	2	2	2	2
	8. Wrong positioning of material/sterile loads in dump trucks.	-	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/2	7/1	7/1	-	3	3	3	3	3	3	3	3	**4**	3	3

	9. Wrong positioning of the load tie in relation to the crane's range of action .	-	7/1	-	7/1	7/1	-	-	7/1	7/2	7/1	7/1	7/1	-	3	-	3	3	-	-	3	4	3	3	3
	10. Wrong positioning of workers in public transport when traveling from home to work or vice versa.	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2	2	2	2	2	2	2	2	2	2	2	2
	11. Wrong fixing of the loads in the crane hook, of the air hose in the perforator.	-	7/1	-	7/1	7/1	-	-	7/1	7/2	7/1	7/2	7/1	-	3	-	3	3	-	-	3	4	3	4	3
	12. Wrong positioning of EMs/workers when loading materials/sterile.	-	7/1	7/1	7/1	7/1	-	-	7/1	7/1	7/1	7/1	7/1	-	3	3	3	3	-	-	3	3	3	3	3
	13. Wrong positioning of the workers when directing the EMs when going backwards or when performing other maneuvers.	-	7/1	7/1	7/1	7/1	-	-	7/1	7/1	7/1	7/1	7/1	-	3	3	3	3	-	-	3	3	3	3	3
	14. Wrong maneuvers performed with the car, personal property or the property of the Branch when traveling from home to work and vice versa or when traveling in the interest of work	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	3	3	3	3	3	3	3	3	3	3	3	3
	15. Wrong positioning of the EMs and/or the workers in relation to the existing risks (on the edge of the well, within the range of action of the mobile EMs/crane).	7/2	7/2	7/1	7/2	7/1	7/1	7/1	7/2	7/3	7/1	7/1	7/1	4	4	3	**4**	3	3	3	4	5	3	3	3
	16. Improper fixing/wrong assembly of the means of collective protection.	-	7/1	-	7/2	7/1	-	-	7/1	7/1	7/1	-	7/3	-	3	-	4	3	-	-	3	3	3	-	5
	17. Wrong fixing of the tool when performing the perforation operations.	-	-	-	4/2	-	-	-	4/1	4/1	-	-	-	-	-	-	3	-	-	-	2	2	-	-	-
	18. Incorrect use or non-use of protective means and/or PPE.	7/1	7/2	7/3	7/2	7/1	7/1	7/1	7/2	7/2	7/1	7/1	7/2	3	4	5	4	3	3	3	4	4	3	3	4
	19. Non-synchronization of operations when working in a team (workers, work equipment, overlapping works).	-	7/1	7/2	7/1	7/1	-	-	7/2	7/2	7/1	7/1	7/2	-	3	4	3	3	-	-	4	4	3	3	4
	20. Non-synchronization of operations in the handling, transport and loading of the front with explosives.	-	-	7/2	-	-	-	-	7/2	-	-	-	-	-	-	4	-	-	-	-	4	-	-	-	-
	51. Failure to perform the PRAM checks on time (by the due dates)..	-	7/1	-	7/1	7/1	-	7/1	7/1	7/1	7/1	7/1	7/1	-	3	-	3	3	-	3	3	3	3	3	3
	52. Non-verification on time (at the due dates) of the EMs that fall under the incidence of ISCIR.	-	7/1	-	7/1	7/1	-	7/1	7/1	7/1	7/1	7/1	7/1	-	3	-	3	3	-	3	3	3	3	3	3
	53. Inadequate distribution of work tasks among workers in relation to their training.	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	3	3	3	3	3	3	3	3	3	3	3	3
	54. Inadequate identification and signaling of risks.	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	3	3	3	3	3	3	3	3	3	3	3	3

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	55. Inadequate work methods when fueling EMs.	2/3	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
	56. Inadequate work methods for the transport and manual handling of materials.	-	2/3	2/2	2/3	2/2	-	-	2/4	2/4	2/3	2/3	2/4	-	2	2	2	2	-	-	2	2	2	2	2
	57. Carrying out work at height on ladders, improvised scaffolding.	-	7/1	7/1	7/2	7/1	-	-	7/2	7/1	7/2	7/1	7/2	-	3	3	**4**	3	-	-	**4**	3	**4**	3	**4**
	58. High effort when handling heavy materials.	-	2/2	2/2	2/3	2/2	-	-	2/3	2/4	2/3	2/3	2/3	-	2	2	2	2	-	-	2	2	2	2	2
	59. Forced working positions when leveling walls, driving anchors or during blasting operations.	-	2/5	2/4	2/4	-	-	-	2/5	2/5	-	-	-	-	3	2	2	-	-	-	3	3	-	-	-
	60. Neuro-psychic stress when handling and using explosive materials.	-	-	2/3	-	-	-	-	2/4	-	-	-	-	-	-	2	-	-	-	-	2	-	-	-	-
	61. Difficult decisions in a short time when a serious and imminent danger occurs.	7/1	7/1	7/2	7/1	7/1	-	7/1	7/2	7/1	7/1	7/1	7/1	3	3	**4**	3	3	-	3	**4**	3	3	3	3
EQUIPMENTS	62. Clinging hands/arms to moving machine parts.	4/2	-	-	4/3	-	-	4/1	4/3	4/2	4/1	4/1	4/1	3	-	-	**4**	-	-	2	**4**	3	2	2	2
	63. Not commanded/uncontrolled movements under the effect of gravity of the kibble, mobile bridge, mobile EMs not secured with auxiliary brake.	-	7/1	7/1	7/1	7/1	-	-	7/1	7/1	7/1	7/1	7/1	-	3	3	3	3	-	-	3	3	3	3	3
	64. Rolling, free fall (under the effect of gravity) of boulders, fallen material or trees.	7/1	7/1	7/1	7/2	7/1	7/1	-	7/2	7/2	7/1	7/1	7/1	3	3	3	**4**	3	3	-	**4**	**4**	3	3	3
	65. Overturning of EMs (excavator, loader, bulldozer) when working in overload or due to non-compliance with the safety distances from the edge of the slopes, the edge of the well.	7/1	-	-	-	-	-	7/1	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-	-	-
	66. The free fall of loads from the crane hook due to the use of improper connection means and/or the lack of safety from the hook.	-	7/1	7/1	7/1	7/1	-	-	7/1	7/1	7/1	7/1	7/1	-	3	3	3	3	-	-	3	3	3	3	3
	67. Falling of material (sterile) from the overloaded or unevenly loaded dump trucks.	-	7/1	7/1	7/1	7/1	7/1	-	7/1	7/1	7/1	7/1	-	-	3	3	3	3	3	-	3	3	3	3	-
	68. Free fall or throwing of materials and tools from scaffolding, ladders, landings.	-	7/1	7/1	7/1	7/1	-	-	7/2	7/2	7/1	7/1	7/1	-	3	3	3	3	-	-	**4**	**4**	3	3	3
	69. Damage to the walls of the well due to their geo-morphological structures or improper sealing.	-	7/1	7/1	7/1	7/1	-	-	7/2	7/2	7/1	7/1	7/1	-	3	3	3	3	-	-	**4**	**4**	3	3	3
	70. Ejection of pieces/and or particles from drilling operations, hammering, shot peening, manual demolition.	-	4/3	-	4/3	4/2	-	-	4/3	4/3	4/2	4/2	4/1	-	**4**	-	**4**	3	-	-	**4**	**4**	3	3	2

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	71. Deviation from the normal trajectory of EMs (dump trucks, earthmoving machines) due to technical faults.	7/1	7/1	7/1	7/1	7/1	-	-	-	7/1	7/1	7/1	7/1	3	3	3	3	3	-	-	-	3	3	3	3
	72. Balancing the loads in the crane's ring.	-	2/2	-	2/2	2/2	-	-	2/3	2/3	2/3	2/3	2/3	-	2	-	2	2	-	-	2	2	2	2	2
	73. Recoil during perforation operations with the manual perforator or sudden braking of EMs in motion.	2/2	2/2	2/3	2/3	-	-	-	2/4	2/4	-	-	-	2	2	2	2	-	-	-	2	2	-	-	-
	74. Jets of air or oil when pressure hoses break or when they are connected improperly.	2/3	2/2	2/2	2/3	-	-	2/2	2/4	2/4	2/2	2/2	-	2	2	2	2	-	-	2	2	2	2	2	-
	75. Uncontrolled explosions during the liquidation operations of open holes (unexploded).	-	-	7/1	-	-	-	-	7/1	-	-	-	-	-	-	3	-	-	-	-	3	-	-	-	-
	76. Stinging, cutting, abrasion when working with materials and/or tools with sharp edges or abrasive surfaces.	-	2/2	2/2	2/4	2/4	-	-	2/5	2/5	2/5	2/4	2/4	-	2	2	2	2	-	-	3	3	3	2	2
	84.. Colds due to air currents or low temperatures	2/3	2/4	2/4	2/4	2/3	2/4	2/3	2/4	2/4	2/4	2/4	2/4	2	2	2	2	2	2	2	2	2	2	2	2
	85. Sunstroke due to high temperatures.	2/4	2/4	2/4	2/4	2/4	2/4	2/3	2/4	2/4	2/4	2/4	2/4	2	2	2	2	2	2	2	2	2	2	2	2
	86. Noise due to the operation of thermal engines when running under load or pneumatic hammers / perforators / vibrators.	2/3	2/3	-	2/4	-	2/3	2/3	2/4	2/4	-	-	-	2	2	-	2	-	2	2	2	2	-	-	-
WORKING ENVIRONMENT	87. Food poisoning due to the consumption of water from a bacteriologically unverified water source and / or serving the meal in poor hygiene conditions.	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	3	3	3	3	3	3	3	3	3	3	3	3
	88. Pneumoconiogenic dusts resulting from drilling or demolition operations with explosives.	-	3/2	3/3	3/4	-	-	-	3/4	3/4	3/2	-	-	-	2	3	**4**	-	-	-	3	3	2	-	-
	89. Wild animals/venomous snakes (wild animal bites wolves, bears, wild boar or venomous snakes).	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	3	3	3	3	3	3	3	3	3	3	3	3
	90. Natural calamities: lightning, wind, hail, landslides, earthquakes, floods.	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	7/1	3	3	3	3	3	3	3	3	3	3	3	3

3.7. Risk level (N_r) calculation on jobs/workplaces at "EQUILIBRIUM CASTLE"

The risk level is calculated with the formula:

$$Nr = \frac{\sum_{i=1}^{n} r_i x R_i}{\sum_{i=1}^{n} r_i}$$

1. Servicemen of earthmoving machinery (Du); Nr = $\frac{\sum_{i=1}^{41} r_i x R_i}{\sum_{i=1}^{41} r_i} = \frac{1(4x4)+28(3x3)+12(2x2)}{(1x4)+(28x3)+(12x2)} = \frac{316}{112} = 2{,}82$

41 factors

2. Concrete workers (B) Nr = $\frac{\sum_{i=1}^{68} r_i x R_i}{\sum_{i=1}^{68} r_i} = \frac{4(4x4)+50(3x3)+14(2x2)}{(4x4)+(50x3)+(14x2)} = \frac{570}{194} = 2{,}94$

68 factors

3. Shot firer (A) Nr = $\frac{\sum_{i=1}^{61} r_i x R_i}{\sum_{i=1}^{61} r_i} = \frac{2(5x5)+6(4x4)+38(3x3)+15(2x2)}{(2x5)+(6x4)+(30x3)+(15x2)} = \frac{548}{154} = 3{,}56$

61 factors

4. Driller Si) Nr = $\frac{\sum_{i=1}^{69} r_i x R_i}{\sum_{i=1}^{69} r_i} = \frac{8(4x4)+46(3x3)+15(2x2)}{(8x4)+(46x3)+(15x2)} = \frac{602}{200} = 3{,}01$

69 factors

5. Welder (S) Nr = $\frac{\sum_{i=1}^{55} r_i x R_i}{\sum_{i=1}^{55} r_i} = \frac{47(3x3)+8(2x2)}{(47x3)+(8x2)} = \frac{455}{157} = 2{,}90$

55 factors

6. Compressor operator (C) Nr = $\frac{\sum_{i=1}^{33} r_i x R_i}{\sum_{i=1}^{33} r_i} = \frac{27(3x3)+6(2x2)}{(27x3)+(6x2)} = \frac{267}{93} = 2{,}88$

33 factors

7. Crane operator (Ma) Nr = $\frac{\sum_{i=1}^{35} r_i x R_i}{\sum_{i=1}^{35} r_i} = \frac{28(3x3)+7(2x2)}{(28x3)+(7x2)} = \frac{280}{98} = 2{,}86$

35 factors

8. Miner (Mi) Nr = $\frac{\sum_{i=1}^{77} r_i x R_i}{\sum_{i=1}^{77} r_i} = \frac{(5x5)+16(4x4)+44(3x3)+16(2x2)}{5+(16x4)+(44x3)+(16x2)} = \frac{741}{233} = 3{,}18$

77 factors

9. Unskilled worker (Ln) Nr = $\frac{\sum_{i=1}^{72} r_i x R_i}{\sum_{i=1}^{72} r_i} = \frac{1(5x5)+13(4x4)+46(3x3)+12(2x2)}{(1x5)+(13x4)+(46x3)+(12x2)} = \frac{695}{219} = 3{,}17$

72 factors

10. Mechanical locksmith (Lm) Nr = $\frac{\sum_{i=1}^{665} r_i x R_i}{\sum_{i=1}^{65} r_i} = \frac{3(4x4)+50(3x3)+12(2x2)}{(3x4)+(50x3)+(12x2)} = \frac{546}{186} = 2{,}94$

65 factors

11. Mechanic (M) Nr = $\frac{\sum_{i=1}^{62} r_i x R_i}{\sum_{i=1}^{62} r_i} = \frac{(4x4)+48(3x3)+13(2x2)}{4+(48x3)+(13x2)} = \frac{500}{174} = 2{,}87$

62 factors

12. Carpenter (D) Nr = $\frac{\sum_{i=1}^{61} r_i x R_i}{\sum_{i=1}^{61} r_i} = \frac{(5x5)+5(4x4)+44(3x3)+11(2x2)}{5+(5x4)+(44x3)+(11x2)} = \frac{545}{179} = 3{,}04$

61 factors

13. Technical-operational staff (TO) Nr = $\frac{\sum_{i=1}^{46} r_i x R_i}{\sum_{i=1}^{46} r_i} = \frac{(4x4)+40(3x3)+5(2x2)}{4+(40x3)+(5x2)} = \frac{545}{134} = 2{,}96$

46 factors

14. Electrician (E) Nr = $\frac{\sum_{i=1}^{55} r_i x R_i}{\sum_{i=1}^{55} r_i} = \frac{(5x5)+3(4x4)+42(3x3)+9(2x2)}{5+(3x4)+(42x3)+(9x2)} = \frac{487}{161} = 3{,}02$

55 factors

The safety level (N_s) per job / workplace is identified on the scale of risk / safety levels, in descending order depending on the relationship of inverse proportionality with the risk levels, resulting in the values shown in figure 4.

1. Shot firer (A)	Nr.(N) = 3.56	→	Nsp = 3.44
2. Miner (Mi)	Nr.(Ms) = 3.18	→	Nsp = 3.82
3. Unskilled worker	Nr.(Ln) = 3.17	→	Nsp = 3.83
4. Carpenter (D)	Nr.(D) = 3.04	→	Nsp = 3.96
5. Electrician (E)	Nr.(E) = 3.02	→	Nsp = 3.98
6. Driller (Si)	Nr.(S) = 3.01	→	Nsp = 3.99
7. Technical-operational staff (TO)	Nr.(S) = 2.96	→	Nsp = 4.04
8. Concrete worker (B)	Nr.(B) = 2.95	→	Nsp =4.05
9. Mechanical locksmith (Lm)	Nr.(Lm) = 2.94	→	Nsp = 4.06
10. Welder (S)	Nr. (S) =2.90	→	Nsp = 4.10
11. Compressor operator (C)	Nr.(C) = 2.88	→	Nsp =4.12
12. Mechanic (M)	Nr.(M) = 2.87	→	Nsp = 4.13
13. Crane operator (Ma)	Nr.(Ma) = 2.86	→	Nsp = 4.14
14. Earthmoving machinist (Du);	Nr. (Du) =2.82	→	Nsp = 4.18

Fig. 4. Centralizer of the correspondence of the risk/security levels obtained for the workstations analyzed in the case study

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Overall safety level (Ng)

It is calculated with the formula: $$Ng = \frac{\sum_{p=1}^{n} rpxNsp}{\sum_{p=1}^{n} rp}$$

$$Ng=\frac{\sum_{p=1}^{16} rpxNsp}{\sum_{p=1}^{16} rp}$$

where : r_p = rankf of the job/workplace " p " ;
n = number of analyzed jobs/workplaces ;
N_{sp} = average safety level / job " p "

$$\frac{14(4,18)^2+13(4,14)^2+12(4,13)^2+11(4,12)^2+10(4,10)^2+9(4,06)^2 +8(4,05)^2+7(4,04)^2+6(3,99)^2+5(3,98)^2+4(3,96)^2+3(3,83)^2+2(3,82)^2}{(14x4,18)+(13x4,14)+(12x4,13)+(11x4,12)+(10x4,10)+(9x4,06) +(8x4,05)+(7x4,04)+(6x3,99)+(5x3,98)+(4x3,96)+(3x3,83)+(2x3,82)}$$

$$+\frac{(3,44)^2}{(3,44)}=\frac{1689,49}{427,72}=3,95$$

Ng = 3.95

From the risk/safety level framing scale, it follows that a safety level of 3.95 results in a risk level of 3.05

Global risk level at the workplace (Equilibrium Castle) **Nr=3.05**

Figures 5 and 6 graphically represent the average risk levels calculated for each element of the work system and - respectively - the percentage weight of the distribution of risk factors on the analyzed system elements.

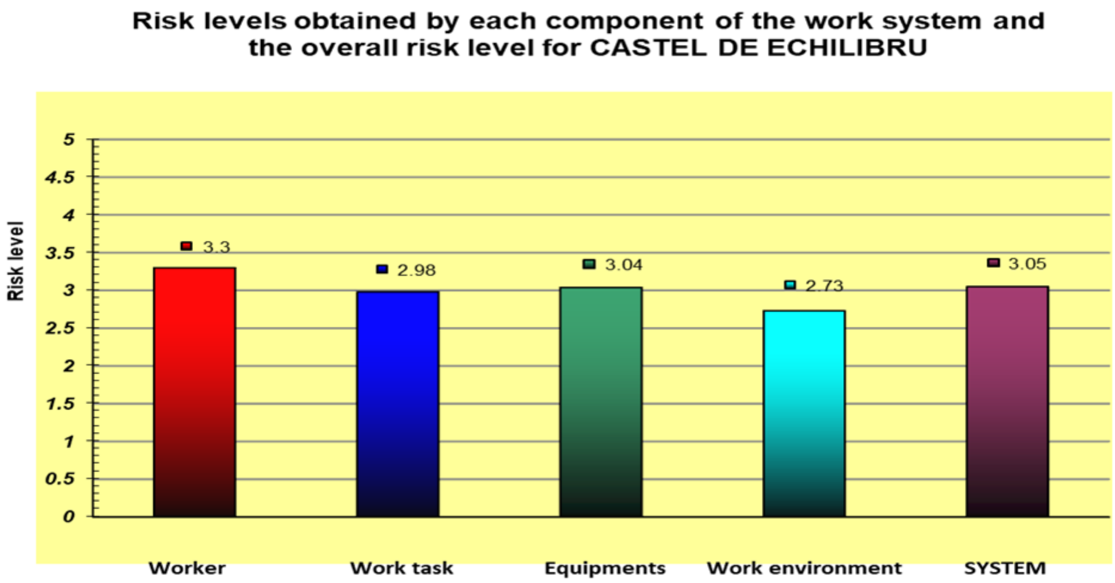

Fig. 5. Risk assessment results structured by the elements of the studied system

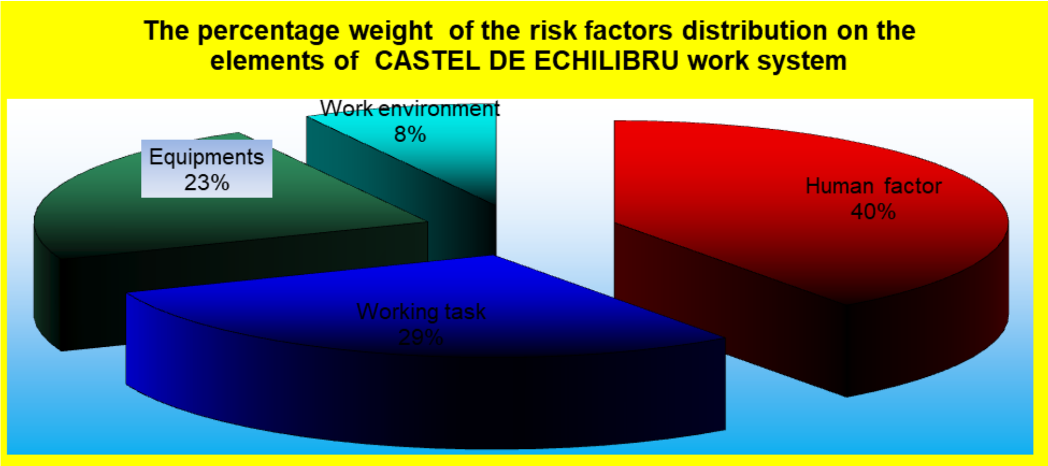

Fig. 6. Distribution of risk factors on the elements of the work system

Based on the risk assessment, appropriate risk minimization measures were established and implemented, selectively presented in the Prevention and Protection Plan summarized in table 2.

Table 2. Selective extract from the Prevention and Protection Plan

No	Assessed risks	Technical measures	Organizational measures	Other measures	Actions in order to achieve the measure	The person responsible for carrying out the measure
0	**1**	**2**	**3**	**5**	**6**	**7**
1.	Wrong positioning of EMs and/or workers in relation to the existing risks (on the edge of the slopes/well, within the range of action of mobile EMs/cranes) or failure to comply with the specification of risk signaling panels.	Identification of risks in accordance with the assessment carried out and their signaling. Only approved warning/signaling panels shall be used.	Daily organization of operations, so that the execution of some operations so that a work formation does not generate risks for other workers (other work formations).	The signaling panels will be mounted in visible places and will be protected against the weather.	Retraining workers regarding the meaning of the signboards and the consequences of not respecting their meaning.	Shift leader
2.	Commands/maneuvers given/performed by the fireman and/or workers helping to transport, handle and load the front or inappropriate work methods for transporting and handling explosives, loading the front and/or liquidating the holes.	The use of approved/authorized work equipment for the transport of explosive materials.	Nomination of workers in the Blasting Disposition who help in the transport and handling of explosive materials and their training.	It is forbidden to shoot the fogged holes. The place where the explosion is ignited, where workers and work equipment were withdrawn, will be strictly observed.	Compliance with Blasting Regulations.	Shot firer
					Training of workers and verification of knowledge acquisition.	Shift leader
					Compliance with the provisions of the OSH instructions.	Workers.
					Respecting the meanings of the sign boards.	
					Authorization of blasting shot firers	Shift leader

5.	Wrong fixing of the loads in the crane hook, of the air hose in the perforator and/or wrong positioning of the load binder in relation to the reach of the crane.	Use only the means of tying the loads that have the identification label with their number and maximum load. Use only approved collars when connecting hoses.	The training, authorization and reauthorization of workers nominated as task binders and signalers.	Prohibition of workers' access within the crane's range of action. Acoustic signaling of maneuvers performed with the lifting equipment.	Securing the work point with verified and labeled fasteners and standardized collars of different sizes.	Shift leader OHS officer
6.	Wrong commands/maneuvers performed by the crane operator when handling the loads or wrong signals given by the load binder/signalist to the crane operator.	Display of the signaling code on the hood of the crane and the list of authorized load binders in the crane cabin.	Identification of signalmen by application of the "LOAD BINDER" symbol on the protective helmet.	The crane's operator participation in the regular weekly trainings.	Carrying out a trial maneuver, before lifting loads. Correct application of the signaling code. Training of load binders and cranes. Verification of the acquisition of OSH knowledge	Shift leader Load binder
7.	Non-synchronization of operations when working in a team (workers, work equipment, overlapping works).	The application of the technology given by the specifications and the use of the work equipment indicated by the designer.	The organization of the workplace, in order to avoid, as much as possible, the execution of mechanized works at the same time as manual ones.	It is forbidden to carry out overlapping works when cleaning/tidying the walls of the well and protection with netting and shotcrete.	Training of workers regarding execution technology (technological order of operations).	Shift leader
					Respecting the sequence of operations.	Workers
8.	Non-synchronization of operations in the handling, transport and loading of the front with explosives.	Use only approved work equipment for the transport and handling of explosive materials.	The operations of transport, handling and loading of the front will be carried out only under the supervision of the fireman.	It is forbidden to carry out other activities during the loading of the front.	Training of the fireman and the workers who help with the transport, handling and loading of the front.	Shift leader
27.	Bursting of the walls/collapse of the well due to its geomorphological structure.	Compliance with the project and specifications.	The use, for the provisional support, only of the materials provided by the technical documentation of the works.	If changes in the rock structure are found, the designer and the geologist will be called to give the technical solutions.	Checking, after each blast and whenever necessary, the condition of the walls.	Shift leader

28.	Failure to check the front after shooting, failure to check EMs and EIP periodically and before use, failure to ensure equipment against uncontrolled movement or starting by untrained or unauthorized workers, failure to check collective protection means or the presence/absence of voltage before interventions in electrical installations .	Interventions in the electrical installations will only be carried out after checking the lack of voltage and blocking the switching devices in the open position. Every day, before starting work, each worker will check the EM_ or EIP_ in the endowment, bringing to the attention of the head of the work point any deficiency found.	The daily establishment of work tasks for each individual worker or for groups of workers, so that everyone knows what they have to do. After each shooting operation, the head of the work point and the fireman will check the work front and only after they will find that everything is in order will they admit workers to the front.	When leaving temporarily or at the end of the work schedule, machine attendants will secure them against uncontrolled movement with the auxiliary brake or by locking the wheels, and for starting them by untrained and/or unauthorized workers, they will take/remove the keys from the cash or disconnect them from to the electrical network.	Daily establishment of work tasks. Compliance with the provisions received. Any deficiency will be brought to the attention of the head of the work point. Checking, daily, before the start of work, of the EMs	Shift leader Workers
30.	Non-compliance with work technologies, workplace discipline, firing regulations and/or own OSH instructions.	Ensuring the technical documentation and own OSH instructions.	Display of work and OHS instructions on/on work equipment.	Carrying out controls in the field regarding compliance with work technologies.	Training workers regarding applied technologies.	Shift leader
31.	Failure to carry out on time (at the due dates) the PRAM checks or the EMs that fall under the ISCIR incidence.	Re-inventory of all work equipment and PPE that must be periodically checked.	Drawing up the verification charts, in accordance with the deadlines (periods) given by the manufacturers/legislation in force.	Decommissioning those that do not meet OSH requirements.	Adherence to the verification charts.	Mechanization service.
41.	Natural calamities: lightning, wind, hail, landslides, earthquakes, floods.	Ensuring a stock of materials and tools, at the work point, for emergency situations.	Drawing up the intervention plan in case of emergency situations.	Performing periodic simulations.	Training of workers on how to alarm, intervene and first aid.	Work point leader.

4. Conclusions and proposals

4.1. Conclusions

After completing the evaluation, an analysis was carried out on the components of the work system (human factor, workload, equipment, work environment) regarding:

- Weight of partial risk factors ≥ 4;
- The level of risk on each component of the work system compared to the global level;
- Percentage share of the risk factors assessed on the system components.

1. *The share of risk factors with partial level ≥ 4 of the total risk factors identified and evaluated and the share of risk factors with partial level ≥ 4 on each component of the evaluated work system;*

1.1. The share of partial risk factors ≥ 4 relative to the total number of factors is 30 %.

1.2. The weight of partial risk factors ≥ 4 on each component of the system is:

- Human factor 35%;
- Workload 25 %;
- Equipment 27%;
- Work environment 13%.

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2. *The level of risk on each component of the work system is:*

- Nr (Ex) = 3,30 ;
- Nr (Sm) = 2,98 ;
- Nr (Mp) = 3,04 ;
- Nr (Mm) = 2,73.

3. *The weight of the assessed risk factors on the system components is:*

- Human factor 40 %;
- Workload 29 %;
- Equipment 23 %;
- Work environment 8 %.

It is noted that risks have been identified that can generate accidents with serious, irreversible consequences, i.e. disability or death, so it follows that the "Equilibrium Castle" workplace is classified as an area with ***high and specific risk of injury***.

Following the analysis, the following were found:

- out of the total of 90 risk factors, the factors that act on the human factor component have the largest weight, respectively 36 factors, of which 13 factors are with risk level ≥ 4, followed by factors that act on the workload component with 26 factors of which 7 factors with risk level ≥ 4, respectively equipment with 21 factors of which 6 factors are with risk level ≥ 4 and 7 factors acting on the work environment component with one factor with risk level ≥ 4.
- calculated in percentages, it is observed that the share of factors with risk level ≥ 4, of the total evaluated factors, represents 30%, and the share of risk factors on the components of the work system from the total of identified risk factors is held by the "*human factor*" with 40%, followed by the "*work load*" with 29%, the "*equipment*" with 23%, respectively the "*work environment*" with 8%.

From the interpretation of the results (the analysis carried out) it appears that the human factor (workers), through the wrong actions, the performance of operations not foreseen by the work load or through their omissions, generate the most risks both in terms of weight and level, followed by the work load, the equipment, respectively the work environment. In order to reduce the level of risk and increase the safety level, it is necessary to act mainly for:

- awareness raising of workers through training;
- supervising the performance of the activities by competent technical staff;
- identification of risks and appropriate signaling;
- compliance with work technologies and own safety and health instructions;
- exploitation of equipment in safe conditions;
- use of explosive materials (transport, handling, use) only by authorized and trained personnel;
- priority implementation of the measures ordered to eliminate risks with partial level ≥ 4 regardless of the composition of the work system;
- carrying out all the measures set out in the Prevention and Protection Plan.
- the allocation of financial resources in order to carry out the measures at the due dates.

4.2. Proposals

Considering the advantage of using the automatic calculation technique in the application of the method and the computerized management of risks and based on the professional experience in the field of risk assessment, it is proposed to modify (improve) the form (sheet) of risk assessment, in the sense that all jobs (workstations) that are necessary in the course of the work process to be evaluated in a single evaluation sheet. This has a number of advantages, but it also has some limitations, namely:

Advantages:

1. Identification, based on the "*Identification List*", of all existing or potentially existing risks from the workplace (work point) subject to evaluation, only once;
2. As is known, both job-specific risks and workplace-specific risks operate at a certain workplace. In addition, the equipment also introduce different risk factors, depending on the work environment (underground/surface, frost/heat, etc.). So through the centralized assessment, on the same sheet, it is unlikely to "miss" certain risks;

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3. Ease of carrying out evaluations (it starts from the identified risk and analyzes whether that risk can affect the workers and to what extent, after which, depending on the time the workers spends in the presence of the respective risk, the forecasts that the evaluator does them depending on the state of mind of the workers, the degree of wear and tear of the work equipment, the probability of occurrence of the events - according to the statistics, the maximum foreseeable consequence is analyzed and the respective risk is quantified;
4. Saving paper and reducing the level of formalism that can affect the finality of the process of safety and health at work real improvement;
5. The ease of applying the method to similar/comparable work places (jobs).

Limitations:
1. It is not possible to evaluate a large number of jobs on the same form (from experience we found that, under good technical editing conditions, a maximum of 14 jobs can be evaluated)
2. Over a number of 3-4 jobs, one can only work on A3 page format.
3. Higher level of experience is required for the risk assessor and – in general – all the members who are part of the evaluation team (evaluators, technical staff, representative workers, occupational medicine doctors, etc.).

Consequently, we propose to analyze this change and to take it into account in order to facilitate the more effective and goal-oriented risk assessment.

Paradoxically, one of the most important advantages of the method are, at the same time a disadvantage: it is a risk assessment expressed numerically. Of course, a numerical approach allows establishing priorities for action, but will not be able to take into account aspects relating to the arrangement of the workplace and human behavior, such as, for example, those associated with ergonomic and psychosocial risks. However, the method has many advantages such as, for example, accessibility, ease of application and can be used to introduce to employees the basics of probability, frequency and gravity, in a qualitative manner. As a result, the method can be an ideal tool to raise awareness of personnel.

As long users do not neglect certain elements, the method retains its purpose and reason for being. First, this method is very useful for monitoring the implementation of preventive measures. On the other hand, it is (or should be) a participatory method and so an educational one. Applied within the framework of a working group, the method can be a valuable tool, since it is not complicated and allow some reflections regarding the elementary components of the risks.

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