International Journal of Life Sciences
Available online at http://sciencescholar.us/journal/index.php/ijls
Vol. 2 No. 3, December 2018, pages: 1~12
e-ISSN: 2550-6986, p-ISSN: 2550-6994
https://doi.org/10.29332/ijls.v2n3.196

Occupational Health and Safety Prevention Plan in Water Treatment Plant

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Article history: Received 10 April 2018, Accepted: 30 August 2018, Published: 15 September 2018

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Keywords

El Guarumo;
Occupational risks;
Prevention plan;
Risk assessment;
Santa Ana;

Abstract

The research was carried out at the "El Guarumo" drinking water plant located in Santa Ana, province of Manabí, Ecuador. The objective of the investigation was the proposal of a plan of prevention of occupational risks that allows the management of the labor risks in said plant. The main tools used were: survey, interview, checklist, LEST questionnaire for the diagnosis of the current situation in terms of working conditions, the risk identification matrix and the binary method of risk assessment. The main results obtained were the identification of the risks in their different categories, observing that the critical risk factors are related to the physical overexertion, the uncomfortable postures and the manual lifting of the load. Among the important risks are falling objects, skin contact with toxic substances and mental overwork, closely related to work pressures and job security? It was possible to carry out the proposal of preventive and corrective measures in order to properly manage the risks and contribute to the safety and health of the workers.

Contents

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1. Introduction

The water treatment plant of Guarumo has been in service for 45 years and several cantons have been supplied, including the capital of Manabi, which since 2000 has had its own service, leaving only a small part of the population on the left bank of the river was built by the Manabí Rehabilitation Center (CRM) between 1969-1970 and over time became the province's main source of drinking wáter (INERHI, 1964).

As a research background of this work we have the study conducted by (Real et al, 2014), who made a diagnosis of working conditions and an analysis of the level of compliance with the Legal Technical Requirements Applicable to Safety and Health at Work in the company Aguapen EP, which requires Ecuadorian legislation to know what risk factors workers are exposed to, the author presented in detail the requirements that must be met evaluating the current situation of the company, and , what should be improved to comply with the regulations that It is the main objective of the company.

On the other hand, the work carried out by (SEDAPAL, 2014) provides that the person responsible for occupational safety in the works is the employer, who must define and adopt provisions so that all (workers in the organization are qualified to assume duties and obligations related to the security and health, so that a deficiency in this aspect is due in large part to the irresponsibility of senior managers of organizations. On the other hand, (Morales & Vintimilla, 2014) stated in their work that the proposal of an occupational health and safety plan is made for the control of industrial emergency events, which establishes responsibilities, action measures, norms, forms of action, Identification of the risks in the source of origin and offers information about the subjects that the person must know to work in an efficient and safe way. which should not be documented properly.

It is essential to keep the Safety and Health Regulations updated. Joint Committee. Emergency Plan, carry out periodic inspections within the plant and all the documentation that supports it, as it is not only a requirement to be met in case of an audit by IESS or MRL, but they are necessary safety instruments, which can save the lives of people and the facilities of companies before an event of any nature. Industrial Safety represents one of the most important management tools that adds value not only to the workplace but also improves the quality of work life and work environment in companies. Occupational health and safety plans make it possible to optimize human resources and guarantee a rapid response in case of incidents, accidents or states of emergency. It also helps to avoid environmental pollution and with them strengthens competitiveness and productivity.

The "El Guarumo" potable water treatment plant in the Santa Ana canton does not have an occupational health and safety plan within its facilities; The personnel is vulnerable to the risks existing in the industrial processes and no measures are applied to prevent the occurrence of them, affecting the company in general, so it is necessary to design an occupational health and safety plan that, if implemented Guarantee to improve your current conditions.

This proposal allows compliance with labor legislation, the prevention of occupational risks, as well as a fair and ethical management of human, material and environmental or natural resources, this last aspect allowed society to be favored by having an environmental managed in a responsible way. The direct beneficiaries were the employees of the plant under study, as indirect beneficiaries we have a career in Industrial Engineering and the Technical University of Manabí as an institution that provides constant support to the community. On the other hand, the results of this research, as well as the relevant theoretical information allow us to provide a source of consultation and guidance to future work related to this subject, being important also in the academic and scientific field.

2. Materials and Methods

The research level of this work is Field, defined as the process that, using the scientific method, allows to obtain new knowledge in the field of social and technical reality. A data collection was made for its analysis and interpretation, descriptive research was implemented to get to know the prevailing situations, customs, and attitudes through the exact description of the activities, objects, processes, and people involved in the place of study, this type of research determined how the independent variable (occupational health and safety plan) affects the dependent variable (risks and work environment); in addition to a bibliographic search from sources of official consultations and scientifically endorsed in order to provide a solid foundation and reference referenced in work prior to the research to be carried out.

The use of the LEST method (Diego-Mas et al, 2015), this is a tool used to diagnose the current situation and improve the working conditions of a particular position or a set of positions considered in a globalized manner. To do this, it has an Observation Guide that, by quantifying the information collected to the maximum, guarantees the greatest possible objectivity, so that the results obtained in a specific situation are independent of the person applying the method (Pérez & Guzmán, 2015). It was used in the second phase of the development of the proposal.

3. Results and Discussions

The application of techniques and data collection instruments allowed to find the necessary information for the diagnosis of the problem. The tool was applied to 10 operators of the drinking water treatment plant and one person from the administrative area. These represent 100% of the workers, so it was not necessary to carry out the sample size. The survey was applied to the 10 operators of the drinking water plant, an analysis of the working time of each one was made in the plant, the results are shown in table 1.

Table 1
Years of personnel working in the plant

Time (years)	Frequency
Between one and three years	3
Between seven and ten years	2
Between six months and one year	1
Between four and six years	4
Total	10

Of the total population surveyed, 40% said that they have between 4 and 6 years working in the plant; 30% between 1 and 3 years; to 20% between 7 and 10 years; 10% between 6 months and a year. As it is observed the majority of the population under study has between 4 and 6 years working inside the water treatment plant, this data is necessary because it is necessary to know the time in which the majority of employees have been fulfilling their labor functions in the establishment, so that most have a considerable time in place and may have more knowledge about existing occupational risks.

It was investigated on the functions performed and the risk levels to suffer an accident, obtaining as a result that 60% of the respondents can suffer accidents at work in the position they perform.

Table 2
The probability of having an accident at work in the role it performs

Probability of risk	Percentage (%)
Alto	60
Medio	40

As noted, 60% of workers may be subject to high levels of risk during their job duties at work and 40% may suffer medium levels. The results obtained to establish that according to the operator's object of study, the risk of suffering an accident during their work duties in the plant is high. Therefore, it is necessary to analyze the types of risk and their probability for subsequent evaluation. According to surveys carried out, all workers are at risk of acquiring a disease in Figure 1, percentages are shown by levels, noting that only 10% are not exposed to acquire a work-related illness.

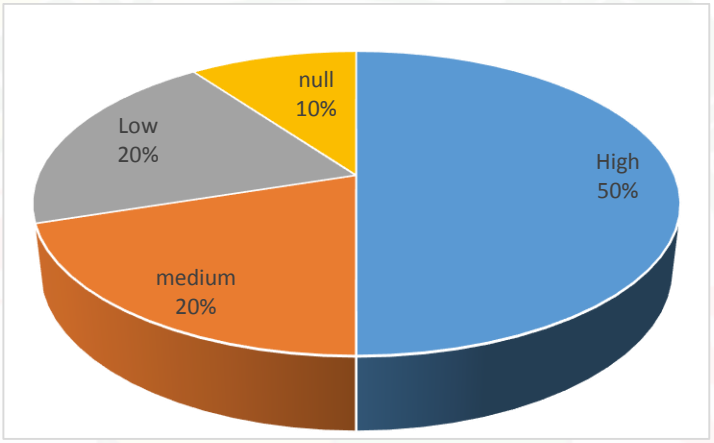

Figure 1. Percentage of acquiring a disease

Half of the population under study considers that the risk of acquiring a disease during the performance of their work duties within the plant is high. Therefore, it is considered that there may be foci or contamination agents in the establishment that may cause some type of pathology in personnel with a probability of biological risks.

In the investigation, the result was that the occupational risk is high due to the chemicals used for water treatment, which are aluminum polychloride and chlorine gas, increasing the chemical risk factors; so they must use the protective equipment, and fundamentally train them to use this protective equipment and mitigate the risks to which they are subjected.

3.1 Ergonomic risks

In relation to ergonomic-type risks, the load of heavy objects is established as the one most likely to represent a risk, with an opinion of 5 workers always responding and 3 saying almost always. At this stage, the factors most likely to be at risk have been determined, so that work conditions must be evaluated through the application of the observation guide technique and the use of a well-founded methodology to define the planning of prevention actions required by the object of study.

To assess the occupational risks and working conditions of the study population, the observation guide technique and the LEST method were used by means of a questionnaire and a series of questions as indicators that refer to 16 variables (numbered from 1 to 16), grouped into 5 information blocks (A, B, C. D and E), related to the job (Pérez & Guzmán, 2015), these results are shown in table 3.

Table 3
Evaluation of work conditions and occupational hazards

A. PHYSICAL ENVIRONMENT	Evaluación (del 0 al 10)	Observaciones
1. Thermal environment		
– The temperature in the workplace	7	
– Level of the effort of the worker when performing a task	5	
– Exposure time to workplace temperatures	8	
– Temperature variation if the worker moves	6	
– Handling of materials (hot or cold) and use of means of protection	6	
2. Noise		
– Global sound level	9	
– Sound level by frequency bands	8	
– Impact noises	5	
3. Lighting	3	
– Level of lighting in the workplace		
– General lighting level	5	
– The degree of contrast between the object to be observed and the background	5	
– Glare	3	
– Type of lighting (artificial, natural)	4	
4. Vibrations		
– Frequency, amplitude, and duration thereof	3	
B. PHYSICAL LOAD		
5. Static load		
– Postures and duration of the same in the development of the task	3	
6. Dynamic load	7	
– Expenditure in Kcal/day		
– Sex	6	
C. MENTAL LOAD		
7. Time constraint		
– (repetitive works)		
– Mode of remuneration (fixed salary, premium)	8	
– Chain work or not		
– Number of breaks during the work day	5	
– The obligation to recover delays or not		
– (non-repetitive jobs)	4	
– The possibility of absenting from the job		
– Possibility to stop the machine	4	

	3 5	
8. Complexity - speed – The average duration of each operation – Duration of each cycle – Number of elections per cycle	 3 6 6	
9. Attention – (Repetitive works) – Level of attention required – Duration and continuity of care – Risks of accidents, frequency, and seriousness thereof – The possibility of rejection of the product – Possibility to talk with colleagues – The possibility of distracting the view and for how long (Non-repetitive work) – Number of machines to be monitored – Average number of signals per machine – Duration of interventions – Number of interventions	 4 4 6 3 3 3 5 5 5 4	
10. Thoroughness – Level of perception of the details – Dimension of objects	 6 6	
D. PSYCHOSOCIAL ASPECTS		
11. Initiative – The possibility of organizing the operator's work – The possibility of controlling the rhythm (self-control) – The possibility of regulating the machine – The possibility of intervening in case of an incident	 4 5 4 6	
12. Status social - Duration of learning - Level of training required for the position	 4 4	
13. Communications – The possibility of talking with colleagues – Possibility of traveling – Number of people nearby	 5 5 4	
14. Cooperation – Types of labor relations (cooperative, functional, hierarchical) – Frequency of relationships	 3 3	
15. Identification in the product – The situation of the worker in the production process	 3	

– Importance of the transformation carried out on the product	3	
E. WORK TIME		
16. Work time – Type of schedule (fixed, shifts, etc.) – Weekly work duration	 5 5	

In order to interpret the results, an evaluation of the 16 evaluated parameters was carried out, for which the values contained in the items of each point were averaged and, thus, by means of a histogram, the occupational risk was shown according to the working conditions.

3.2 Punctuation system

The results of the method are based on obtaining a score for each of the variables studied, therefore, an assessment between 0 and 10 is proposed, which determines the situation of the job or group of jobs in relation to each of the variables according to the criteria shown in table 4.

Table 4
LEST method scoring system

Punctuation system	
0,1,2	Satisfactory situation
3,4,5	Weak discomfort, some improvements could bring more comfort to the worker
6,7	Average discomfort There is a risk of fatigue
8,9	Strong annoyances Fatigue
10	Noxiousness

Source: (Cabezas & Sarabia, 2015).

The graph of Figure 2 shows the 16 categories of work conditions evaluated, so it was possible to determine that noise and dynamic load are the conditions that may present average discomfort among the study population, with lower valuation but in the same range thermal environment and meticulousness were identified, in terms of the weak inconveniences, the parameter of time constraint, complexity, speed, initiative, communications and work time were the most valued, while with lower scores, lighting, vibrations, load were obtained static, attention, social status, cooperation, and product classification. Factors in the range of satisfactory and noxious are not shown.

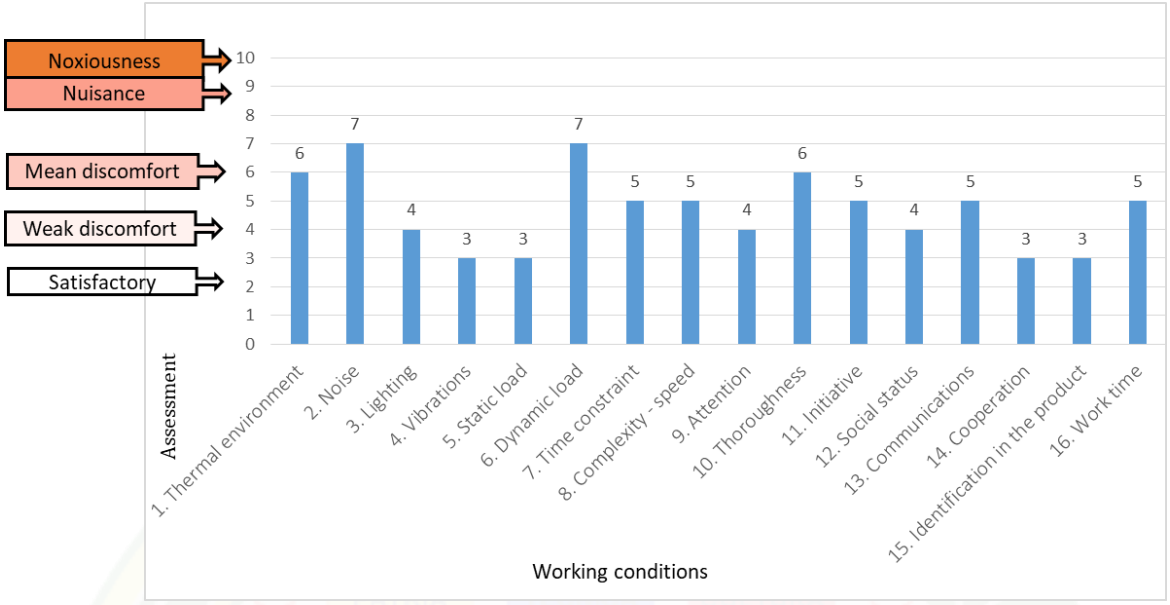

Figure 2. Results of the application of the LEST method in the plant

It is determined that the categories that show higher levels of risks due to the working conditions in place are the physical environment, the physical load, and the mental load, being the noise and the dynamic load the aspects in which more emphasis should be made in the prevention proposal.

3.3 Occupational risk assessment

The occupational risk assessment is carried out using the binary risk assessment method, which considers the probability of occurrence and the severity. Throwing four possible situations: low risk, moderate risk, significant risk, and critical risk. In the case of the probability of occurrence, four situations are taken into account: low, medium and high. In the case of severity, it is considered: slightly harmful (LD), harmful (D) and extremely harmful (ED). Table 5, shows the results obtained from the evaluation. The evaluation is calculated by equation (1).

$$E = P \cdot S \qquad (1)$$

Where:

E⟶Evaluation

P⟶Probability

S⟶Severit

Table 5
Risk assessment in the drinking water plant

Type of risk	Associated hazards	Qualitative		Quantitative		Evaluation	
		Probability	Severity	Probability	Severity	$E = P \cdot S$	Description
Physicists	Fall to the same level	Low	LD	3	4	**12**	**Low risk**
	Falling objects by manipulation.	Low	LD	3	4	**12**	**Low risk**
	Falls of detached objects	Low	D	7	6	**42**	**Important risk**
	Footprints on objects	Half	D	5	6	**30**	Moderate Risk
	Blows with objects and tools	Half	D	6	5	**30**	Moderate Risk
	Exposure to extreme temperatures.	Low	LD	3	4	**12**	**Low risk**
	Thermal contact.	Low	D	3	6	**18**	**Low risk**
Chemicals	Electrical contact.	Low	ED	3	9	**27**	Moderate Risk
	Fire or explosion.	Low	ED	3	9	**27**	Moderate Risk
	Inhalation of gases	Half	ED	4	9	**36**	Moderate Risk
	Ingestion of substances harmful or toxic.	Half	ED	4	8	**32**	Moderate Risk
	Skin contact with toxic substances	Alta	D	7	6	**42**	**Important risk**
Biological	Contact with parasites	Low	LD	3	4	**12**	**Low risk**
	Contact with mushrooms	Low	LD	3	4	**12**	**Low risk**
ergonomic and psychosocial	Work pressure	High	LD	7	4	**28**	Moderate Risk
	Mental overwork	High	D	7	7	**49**	**Important risk**
	Physical exertion	High	D	9	7	**63**	**Critical Risk**
	Work activities with uncomfortable postures	Half	D	9	7	**63**	Critical Risk
	Loading of heavy objects	High	ED	9	9	**81**	Critical Risk

In the first phase of the investigation, an approach was achieved by the managers of the plant and the workers by applying an interview and a survey respectively. In the first case, it allowed knowing the experience of the manager of the plant and the perception of the risks to which the workers are exposed. The results of the employee survey allowed to identify the occupational risks that are latent in their work, being the basis for the application of other tools

The risk analysis made it possible to develop the proposal of the strategies for the Management of the non-tolerable risks in the "Guarumo" drinking water treatment plant, offering in each risk the description, the causes, the preventive measures, the date of compliance and the responsible

4. Conclusion

The application of the LEST method on the working conditions to which the workers of the plant are exposed, allowed to know that the plant with a score of 7/10 presents as an unfavorable condition the noise and the dynamic physical load; also with a score of 6/10 is the thermal environment, and the meticulousness in the work. Through the binary method, the assessment of the existing occupational hazards in the drinking water plant was carried out, identifying the critical risks in the plant, corresponding to the ergonomic and psychosocial risk, related to the physical overexertion, the uncomfortable postures, and a load of heavy objects; as important risks are recognized fallen objects, contact on the skin with toxic substances, and mental over-work.

Acknowledgments
The authors would like to thank the editor of the International Journal of Life Sciences for their support, valuable time, and advice.

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