CHEMICAL ENGINEERING TRANSACTIONS
VOL. 91, 2022
A publication of AIDIC
The Italian Association of Chemical Engineering
Online at www.cetjournal.it
Guest Editors: Valerio Cozzani, Bruno Fabiano, Genserik Reniers

ISBN 978-88-95608-89-1; **ISSN** 2283-9216
DOI: 10.3303/CET2291054

Reduction of the Rate of Accidents at Work through the Implementation of an Occupational Safety and Health Management System (OSHS) in the Industrial Electromechanical Industry

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Accidents at work in industry are very important factors that must be addressed. They often occur because of lack of a Safety and Health at Work management system (OSHS). The electromechanical industry requires the observance of different safety procedures because as it is a risky activity many equipment and mechanical tools are employed and operators must comply with established protocols so that regrettable accidents do not happen. The research aimed to reduce the rate of occupational accidents of employees of an industrial electromechanical company through the implementation of an OSHS at work. There were identified the probable causes of accidents at work during 10 weeks. The proposed implemented system took into consideration the following 5 phases: policy, scope, planning, implementation and verification. As a result of the implementation, there was a reduction in occupational accidents of about 87.5% (from 8 accidents to just 1). It confirms the need to manage risky activities safely in manufacturing companies in order to have regularity in the production processes and guarantee the health of workers

1. Introduction

Responsible companies base their activities on a good performance of their employees and, for the achievement of their objectives; one important aspect is the well-being of their workers. Accidents at work derive in delays in production activities representing social, human and economic costs for the organization (ILO, s. f.). The metal industry because of the nature of their activities has a considerable rate of accidents at work for the failure to implement a management system for safety and health at work (OSHS). In Peru, in September 2021, it was reported to the Ministry of Labor 11 fatal accidents, 2 184 accidents at work, 62 dangerous incidents and 8 occupational diseases (MTPE, 2021). According to a study carried out by the World Health Organization (WHO) and the International Labor Organization (ILO), work-related diseases and injuries caused 1.9 million deaths between 2000 and 2016; the main factors were: exposure to long working hours and workplace exposure to air pollution, asthmagens, carcinogens, ergonomics risks, and noise (Diaz Dumont et al., 2020). Many companies support the implementation of Safety and Health at Work management systems (OSHS) because of legal, economic reasons and the benefits of a good image (Gadea García, 2016). It also contributes to the corporate image enhancement as a socially responsible company that seeks sustainable human development of the quality of life of their workers. (López, 2016). On the other hand OHSH systems are implemented in many different industries (Montano Angie et al., 2020).

2. Methodology

The research consisted of an evaluation of the way as occupational safety and health activities were managed in the industrial electromechanic area of a company. For the evaluation, there were registered the number accidents at work occurred in 10 weeks. In a second phase, after the implementation of an (OSHS) system, the same evaluation was carried out in order to analyze the improvement.

Paper Received: 9 January 2022; Revised: 12 April 2022; Accepted: 5 May 2022
Please cite this article as: Prince Grandez J., López Padilla R.D.P., Benites-Alfaro E., 2022, Reduction of the Rate of Accidents at Work Through the Implementation of a Occupational Safety and Health Management System in the Industrial Electromechanical Industry., Chemical Engineering Transactions, 91, 319-324 DOI:10.3303/CET2291054

2.1 Indicators:

Occupational Health: It was evaluated by the occupational medical examinations index (IEO), Eq(1) was used.

$$IEO = \frac{\text{Number of occupational medical examinations performed} \ * \ 100}{\text{Number of occupational medical examinations scheduled in 10 weeks}} \quad \text{Eq(1)}$$

- **Planning**: index IIPER for the hazard identification and risk assessment), Eq(2) was used

$$IIPER = \frac{\text{IPER N°made} * 100}{\text{IPER N°programmed in 10 weeks}} \quad \text{Eq(2)}$$

- **Implementation and decision-making**: The index was training in the company Eq(3) was used.

$$x = \frac{\text{Hours of effective training} * 100}{\text{Total training hours programmed in 10 weeks}} \quad \text{Eq(3)}$$

- **Monitoring**: It was evaluated by the index of inspections made (IM), Eq(4) was used.

$$IM = \frac{\text{Numbers of inspections} * 100}{\text{Number of inspections performance programmed in 10 weeks}} \quad \text{Eq(4)}$$

- **The Audit:** index of audits performed (IA) was determined, Eq(5) was used..

$$IA = \frac{\text{Number of audit made} * 100}{\text{Number of planned audits by HODELPE in 10 weeks}} \quad \text{Eq(5)}$$

2.2 In assessing accidents at work, the following were taken into account:

Temporary disability accidents: expressed as the number of accidents after 10 weeks of evaluation. Measured by the accident frequency (AF) index, Eq(6) was used.

$$AF = \frac{\text{Number of registered accidents} * 100}{\text{Number of hours worked in 10 weeks}} \quad \text{Eq(6)}$$

The population of the study was 20 people who work in an industrial and electromechanical service company, whose main activities are the manufacture of mechanical parts, metal structures, helical threads, CNC lathe service, CNC machining center and related services for the industrial, metallurgical, mining, construction and boiler-making sector.

3. Results

3.1 Occupational Safety and Health Management System (OSHS):

The information of the indexes collected before and after the implementation of the proposal took into consideration the following dimensions and indicators:

- **Occupational Health**:

Table 1 shows the index about the compliance of occupational medical examinations before (August, September, October and November 2017) and after the launch of the OSHS from February to April 2018). There was a 100% of compliance after the implementation of the OSHS proposal, compared with the index value before (0%).

- **Planning:**

Regarding the process of identifying hazards and risks of company's activities through the formulation of the IPER matrix, with the application of the OSHS the index improved, from 39.61% to 86.54%. Details for a 10 weeks period of evaluation are shown in Table 1

Table 1 Compliance with Occupational Medical Examinations and identification of hazards and risks before and after the implementation of the OSHS

	Before (August, September, October, November 2017)	After (February, March, April 2018)

Dimensions SGSST	Weeks	Medical Examinations performed	Medical Examinations Planned	Index	Weeks	Medical Examinations performed	Medical Examinations Planned	Index
Occupational Health: Compliance with Occupational Medical Examinations	10	0	10	IEO: 0%	10	20	20	IEO: 100%
Planning: Hazard Identification and Risk Assessment	10	61	154	IIPER: 39.61%	10	135	156	IIPER: 86.54%

- Implementation and decision-making:

An important factor in an OHSH is the training of workers so that they can take responsibility at work taking care of their physical and mental integrity. In this sense, the number of workers trained and the hours of training before and after the implementation of a proposed new *OSHS* were evaluated. The results are shown in tables 2 and 3. There was an increase from 52.78% to 96.43% in the number of workers trained and about the training rate, and in terms of the number of hours spent in training the index increased from 53.66% to 96.77%.

Table 2 Training of personnel prior to implementation of the OSHS

Time (August to November)	Number of workers trained	Number of workers programmed for training	Workers trained rate	Effective Training hours	Hours for training programmed	Training rate
10 weeks	38	72	52.78%	88	164	53.66%

Table 3 Staff training after OSHS implementation

Time (February to April)	Number of workers trained	Number of workers programmed for training	Workers trained rate	Effective Training hours	Hours for training programmed	Training rate
10 weeks	81	84	96.43%	180	186	96.77%

- Inspections and Monitoring

Inspections were scheduled to verify the compliance of the OSHS compulsory activities. Table 4 shows the results of compliance with inspections and monitoring carried out before and after the implementation of the OSHS. The comparison shows, it was obtained an improvement from 59.71% to 97.44%.

- Audit

Internal audit is an essential activity in an *OSHS*. Table 4 shows the level of compliance of audits. It improved form 33.33% to 100% after the implementation of the OSHS.

Table 4 Comparison of inspection compliance and monitoring and Audits before and after implementation of the OSHS

	Before (August, September, October, November 2017)				After (February, March, April 2018)			
Dimensions del SGSST	Weeks	Made (amount)	Planned (amount)	Compliance index	Weeks	Made (amount)	Planned (amount)	Compliance index
Occupational Health: compliance with inspections and monitoring	10	163	273	IM 59.71%	10	266	273	IM: 97.44%
Audit: compliance with audits	10	1	3	IA: 33.33%	10	3	3	IA: 100%

Details about Inspection and monitoring program after the implementation of the OSHS is shown in Table 5.

Table 5 Inspection and monitoring program after OSHS *implementation*

OBJECTIVE	ACTIVITY	DETAIL	STAFF INVOLVED	SCHEDULE													
				2017					2018								
				Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	Jun	Jul	Total	REAL %

Verify compliance with standards, procedures and controls required to strengthen the safety and health system and achieve the objectives set	Internal audit	Audit will be conducted	Semisa Company personnel	P		x	x	x		1	100%
				E		x	x	x		0	0%
	External audit	Audit will be conducted	OSH Supervisor and Company personnel	P		x				1	100%
				E						0	0%
	Physical Agent Monitoring: Noise	To carry out at the factory´s facilities	Semisa Company personnel	P						1	100%
				E						0	0%
	Physical Agent Monitoring: Luminosity	To carry out at the factory´s facilities	Semisa Company personnel	P						1	100%
				E						0	0%
	Monitoring of Chemical Agents	To be carry out at the factory´s facilities	Semisa Company personnel	P						1	100%
				E						0	0%
	Psychosocial Risk Monitoring	To carry out at the factory´s facilities	Semisa Company personnel	P						1	100%
				E						0	0%
	Monitoring of Disergonomic Risk	To carry out at the factory´s facilities	Semisa Company personnel	P						1	100%
				E						0	0%
	Equipment Inspections, Machines, Tools	Monthly inspections	Semisa Company personnel	P						1	100%
				E						0	0%
	Inspections of lift elements (25)	Monthly inspections	Semisa Company personnel	P		x	x	x		3	100%
				E		x	x	x		3	100%
	Control of fire extinguishers (13)	Monthly inspections	Semisa Company personnel	P		x	x	x		3	100%
				E		x	x	x		3	100%
	Work stations	Monthly inspections	Maintenance personnel	P		x	x	x		3	100%
				E		x	x	x		3	100%
	Inspection of personal safety equipment (20)	Monthly inspections	Maintenance personnel	P		x	x	x		3	100%
				E		x	x	x		3	100%

3.2 Accidents at works

The results for this variable were accounted as accidents with temporary and permanent disability

Accidents of temporary disability:
For a period of 10 week of monitoring, Table 6 shows the comparasion about of the number of accidents before and after the implementation of the proposed OSHS. At the beginning, there were 8 accidents with temporary incapacity; it reduced to just 1 accident after the implementation of the OSHS. In terms of frequency, it was found that the initial accident frequency of 0.0741% was reduced to 0.009% (reduction of 87.85%).

Tabla 6 Accidents with temporary disability before and after OSHS implementation

Before			After		
Time (August to November 2017)	Number of accidents with temporary incapacity	Frequency of accidents with temporary incapacity (AF) index	Time (February – April 2018)	Number of accidents with temporary incapacity	Frequency of accidents with temporary incapacity (AF) index
10 weeks	8	0.0741%	10 Weeks	1	0.009%

3.3 Implementation of Occupational Safety and Health Management System (OSHS) proposal

The proposed improvement of the OSHS that was implemented in the company that resulted in the reduction of accidents at work.
Table 7 shows the activities programmed in the system that were developed from August 2017 to May 2018.

Table 7 Planned and implemented activities of the GSS proposal

	ACTIVITIES
	POLITICS
1	To develop of occupational safety, health, quality and environmental policies
2	Communicate the policy to all of the workers and exhibit it
	SCOPE OF THE SYSTEM
3	Develop formats to be used in the OSH Management System
	PLANNIG

	Baseline study
4	Conduct the baseline study of the OSH Management System
	Hazard identification and risk assessment
5	Develop the procedure and a methodology for developing the IPER
6	Develop IPER for all jobs and work areas
7	Develop and publish the risk maps
	Objectives, targets and programmers
8	Define objectives and goals in the OSH Management System
9	Publish objectives and targets in the OSH Management System in a visible place
10	Develop an annual programmer for safety and health at work
	IMPLEMENTATION AND OPERATION
	Resources, functions, responsibility and authority
11	Develop an Organigram and a Job Manual for all jobs
12	Appoint an employer Representative for the development, implementation and monitoring of OSHS results
13	Appoint a security Supervisor
	Competence, Training and awareness
14	Develop an annual training program, and an induction plan for new staff
	Communication, participation and consultation
15	Develop a means to ensure communication between staff and management
16	Provide workers personal protective equipment according to the work they do.
	Documentation
17	Develop the OSHS handbook and procedure
18	To keep a record of delivery of internal safety regulations of the OSH management system to workers.
	ACTIVITIES
	Operational Control
19	Developing rules governing the conduct of workers and working procedures
20	Perform pre-use inspections on critical equipment
21	To have supplementary insurance for hazardous work
22	To make a safe work analysis and get a high – risk work authorization
23	Develop a procedure for a safe management of chemical substances
	Emergency preparedness and response
24	Define contingency plans and organize brigades for each potential emergency
	VERIFICATION
	Monitoring and measurement
25	Assessing management performance against OSH objectives and develop safety and health statistics
	Assessment legal compliance
26	Verify legal compliance, whether staff are on the payroll or by contract
	Inspections
27	Conduct safety inspections
	Monitoring and risk factor
28	Record the monitoring of physical agents (noise, temperature, luminosity, humidity and others)
29	develop a chemical and biological monitoring agents register and a psychosocial risk factor factors monitoring
30	Develop a monitoring record of risk factor disergonomic
31	Calibration certificates of the work equipment
	Occupational medical evaluations.
32	Develop and perform occupational medical examinations
33	Prepare aptitude reports and take them in consideration for assigning tasks to the staff
	Audit
34	Develop an audit procedure
35	Conduct an external audit
	Accidents investigation
36	Prepare register of occupational accidents and diseases

4. Discussion

The results of the evaluation of the implementation of a System of Safety and Health at Work (OSHS) improved the indicators of training of workers in personal safety issues at work; also, operations of the company improved the productivity and the compliance of labor regulations (Law 29783 and amending Law 30222). This is a strategy of companies to improve their visibility and confidence with their potential consumers, projecting an image of a responsible company with their collaborators. Those practices bring benefits as the improvement of their processes and compliance with standards such as ISO 45001 (Castiblanco et al., 2020). For a proper implementation of an OSHS, the managerial commitment, we participation of all the staff of the organization, diagnosis and planning, continuous improvement and monitoring and measurement must be taken into account (Lopez, 2016).

The study identified that compliance with planned programs within a management system is very important, the commitment of those administering the system is fundamental to the success of a management system for the safety and health of workers; also descriptive retrospective studies-Analytic help to realize an efficient baseline to then implement the management system with the relevant improvements that result in a significant decrease of occupational accidents, problems are overcome by ergonomic and mechanical factors, among others (Karimi et al., 2020)

The most important aspect of the study was the decrease in the cases of accidents with work incapacity of the workers of this company in the category of industrial metallurgy, reducing this indicator from 8 cases to a single case for the same evaluation period (10 weeks) before and after the introduction of a new Occupational Safety and Health System. This is due to the continuous improvement of the way in which activities related to work and working conditions were managed, such as the use of protective equipment, awareness of hazards and risks when promptly identified, training, inspections and monitoring of compliance with safety standards. Thus, in Korea, a study showed similar results in companies that implemented the KOSHA 18001 system by lowering their accident rate compared to companies that did not (Kim, 2021).

5. Conclusion

The implementation of a Management System for Safety and Health at Work allowed to the company the reduction of frequency rate of accidents with work incapacity by 87.85%. In addition, it reduces the absenteeism of workers due to illnesses acquired in the course of their activities, avoids financial penalties for non-compliance with legal standards, economic benefits and a responsible corporate image

Acknowledgments

To César Vallejo University for academic support in the development of research.

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