Archives of Occupational Health | Volume 2 | Issue 4 | October 2018 | 233-9.

Original

Investigating the Causes of the Incidents and Monitoring the Safety System before and after the Implementation of OHSAS 18001 in a Combined Cycle Power Plant

Fereydoon Laal[1], Saber Moradi Hanifi[2], Yousef Mohammadian[2], Rohollah Fallah Madvari [3*]

1 Health Promotion Research Center, Zahedan University of Medical Sciences, Zahedan, Iran•2 Department of occupational health, School of public health and safety, Shahid Beheshti University of Medical Sciences, Tehran, Iran • [3]Ph.D Student of occupational health engineering, Student Research Committee, School of Public Health, Shahid Beheshti University of Medical Sciences, Tehran, Iran • * Corresponding Author: Rohollah Fallah Madvari, Email: Email: fallah134@gmail.com, Tel: +98-035-31492205

Abstract

Background: In order to protect human resources, health and safety management systems such as OHSAS 18001, which is based on prevention, are necessary in projects. Therefore, the present study analyzes the incidents and evaluates the monitoring safety performance indicators based on work experience before and after the implementation of OHSAS 1800. **Methods:** This descriptive analytical study was performed on all incident victims during 2004 to 2011 at Yazd Combined Cycle Power Plant by census method. Data were extracted from the incident report checklists as well as technical protection committee documents of the plant. The AFR, ASR, FSI, FR, and IR indices were calculated based on OSHA standard before and after the implementation of OHSAS 18001. Descriptive statistics, Kolmogorov-Smirnov and Chi-square were used for data analysis. Meanwhile, the significance level was considered equal to 0.05.**Results:** 287 work-related incidents occurred during an 8-year period (2004-2011). The 44.9% of incidences (n=129) were reported in the age group under 30 years and the lowest incidence rate was observed in the age group over 50. 97% of the incidents were reported in men while 2.8% of the incidents were reported in women. According to the results, there was a significant relationship between age and work experience as well as age and marital status. There was also a significant decrease in the indices in the years after the implementation of OHSAS 18001. **Conclusion:** The results showed that the implementation of safety systems and deployment of OHSAS 18001 has reduced the incident indices based on work experience. Therefore, health and safety management systems are suitable tools for reducing incident rates and incident indices are also appropriate for monitoring the safety performance.

Keywords: OHSAS 18001; Occupational accident; Incident indices

Introduction

Although human scientific development in recent decades has brought industrial progress, different facilities and relative prosperity, it also caused occupational incidents. So occupational accidents are one of the most important problems of the developed and developing countries.[1]

Citation: Laal F, Moradi Hanifi S, Mohammadian Y, Fallah Madvari R. **Investigating the Causes of the Incidents and Monitoring the Safety System before and after the Implementation of OHSAS 18001 in a Combined Cycle Power Plant.** Archives of Occupational Health. 2018; 2(4): 233-9.
Article History: Received: 18 July 2018; Revised: 11 August 2018; Accepted: 1 September 2018

According to the ILO, there are 120 million injuries annually in the world[2] and about one third of the deaths from work are caused by occupational accidents. Occupational accidents are also considered as one of the important factors in the loss of labor and working hours.[3] Incidents cause many direct and indirect economic losses for employees, employers and the community. Direct losses can be due to work interruptions, medical expenses and indemnity for temporary or permanent disability, and death. Also, incidents can cause irreparable damage to the family and community. According to the International Labor Organization, the incidents are the most massive and most difficult humanitarian compensation.[4] In a study conducted by Khodabandeh et al. in 2011 on epidemiology of work-related accidents in Kerman coal mines, the results showed 51 accidents resulted in death. Frequency rate, intensity rate and frequency-intensity index of incidents in this study were respectively 31.3, 4739.8 and 9.3.[5] Miller et al investigated occupational accidents and their economic costs in quantitative models. They concluded that preventive actions were one of the effective factors in reducing costs and increasing productivity.[6,7]

In a case study by Hamidi et al. aiming at the investigation of the effect of integrated management system (IMS) on safety and productivity indices in 2005-2010, a significant relationship between the various safety indicators before and after the implementation of IMS was found.[8]

Safety plans are one of the factors influencing labor productivity. Management systems are proposed as a way to create more coherence and coordination between different service and production systems. One of these systems is Occupational Health and Safety Management Systems (OHSAS 18001). The Occupational Health and Safety Assessment Series (OHSAS 18001) defines the requirements for an Occupational Health and Safety Management System (OH & S). Therefore an organization can improve its performance by controlling health and safety risks. In OHSAS 18000 standard, employee's protection against work-related accidents is very important. In fact, OHSAS 18000 can reduce accidents and its related costs and damages.[9,10] On the other hand, personnel working in production, transmission and distribution of electric power face range of occupational health hazards such as work in height, electromagnetic fields, work in heat and cold, shift work, etc.[11] Considering the incidence of occupational accidents in the country as well as the strategic position of the combined cycle power plants, investigation of accidents in these industries is very important. Yazd combined cycle power plant is one of the country's most important industry in electricity generation which is designed to meet the growing demand of Yazd province for electrical energy due to large industries such as alloy steel industry. According to available revised sources, limited studies have been carried out on the incidents of combined cycle power plants, or at least the reports have not been found in available resources. Considering the above reasons, this study decided to analyze the process of incidents and evaluate the safety performance monitoring indicators based on work experience before and after the implementation of OHSAS 1800 in an 8-year period.

Methods

The population of this descriptive-analytical study was all the people involved in the incidents in 2004 to 2011 at Yazd Combined Cycle Power Plant. The present study investigated and compared safety performance monitoring indicators before and after the implementation of OHSAS 18001 based on work experience and it also examined incidence rate according to marital status and work experience by census method.

Following the necessary coordination, a team composed of senior executives, experts in implementation of OHSAS 18001 and professional

health experts were formed to conduct the study. Then, necessary information for incident analysis was extracted from the checklist of accident reports as well as the technical protection committee documents from 2004 to 2011. It should also be noted that the IMS was implemented at the plant in 2005.

The study's limitations included the absence of a number of incident victims for interview, the lack of accurate record of accident report checklist, the lack of cooperation of a number of personnel due to fatigue and, consequently, the lack of precision in answering interview questions about the incident.

Moreover, an interview was conducted with the incident victims or witnesses of the incidents while necessary explanations were provided to them. In this study, incidents that at least resulted in the loss of a working day or a shift in work were considered as work-related accidents.

Accidents were classified according to their type and cause into three categories of unsafe acts, unsafe conditions and not using personal protective equipment (PPE) based on available documentation.

The AFR, ASR, FSI, FR and IR indices were calculated based on OSHA standard[12] and by using the related formulas (Formulas 1 to 5) and the data were obtained from the initial analysis. Then, the analysis of the process of incidents in the years before and after the implementation of OHSAS 18001 in different circumstances in terms of work experience was studied .

$$(1)\text{AFR} = \frac{\text{Number of incidents} \times 200000}{\text{Total efficient working hours of the workers in that specified time}}$$

$$(2)\text{ASR} = \frac{\text{Number of lost days} \times 200000}{\text{Total efficient working hours of the workers in that specified time}}$$

$$(3)\text{FSI} = \sqrt{\frac{\text{AFR} \times \text{ASR}}{1000}}$$

$$(4)\text{IR} = \frac{\text{Number of incidents in a year}}{\text{Number of employees in the same year}} \times 1000$$

$$(5)\text{FR} = \frac{\text{Number of incidents} \times 100000}{\text{Working hours}}$$

For trend analysis in different circumstances, frequency rate and incident rate were calculated. Collected data were entered into SPSS software and were analyzed by descriptive statistical tests, Kolmogorov-Smirnov and Chi-square. Accordingly, scientific solutions were presented for reducing incidents and making appropriate decisions. In this study, the significance level was considered equal to 0.05.

Results

According to the results 287 cases of work-related accidents were recorded among 1189 employees working at Yazd combined cycle power plant in an 8-year period (2004-2011). Moreover, all victims of incidents were over 20 years of age. The highest incidence rate (44.9%, n=129) was in personnel under 30 years old, and the lowest incidence rate was in personnel over 50 years old. Meanwhile, results by year showed that in 2004-2008, the highest incident rate occurred in the group under 30 years old, and in 2009-2011 the highest incidence rate was related to the age group of 30-39 years old. 97.2% of incidents occurred in men while 2.8% of incidents were in women.

According to Tables 1 and 2, the highest number of incidents occurred in the age group less than 29 years old.

Table 1. Frequency distribution and percentage of incident victims based on age and marital status

Age	Marital status (%)		Total
	Single	Married	
20-29	(61.53)80	(38.46)50	130
30-39	(8.47)10	(91.52)108	118
40-49	(0)0	(100)26	26
>50	(0)0	(100)13	13
Total	(31.35)90	(68.64)197	287
p-value= 0.0			

Table 2. Frequency distribution of incident victims based on age and work experience

Age	Work history (year) N(%)			Total
	5>	5-15	15<	
20-29	(86.15)112	(12.30)16	(1.53)2	130
30-39	(38.13)45	(58.47)69	(3.38)4	118
40-49	(7.69)2	(26.92)7	(65.38)17	26
>50	0	0	(100)13	13
Total	(55.40)159	(32.05)92	(12.54)36	287
p-value= 0.0				

Furthermore, the incident rate was reduced by gaining more work experience. So the most accidents occurred in the group with the work experience less than 5 years and the lowest incidents occurred in the group with the work experience over 15 years. It should be noted that this trend is proper for all years except 2011 in which the most incidents occurred in the group with the work experience of 5 to 15 years. The results showed that there was a significant relationship between age and work experience as well as age and marital status (p-value = 0.00). According to chi-square test, there was a significant relationship between marital status, literacy level and work experience in different years (P <0.05), however, there was no significant relationship between different work units, cause of accident and use of personal protective equipment in different years (P> 0.05).

The total number of incidents was 287 cases and the mean and standard deviation of the lost working days was 11.09 (3.8). The least number of incidents was in 2011 (20 cases) and the most number was in 2009 (49 cases). The results showed that the relative frequency of the incidents before the implementation of OHSAS 18001 was about 33% and in the years after that was about 22%.

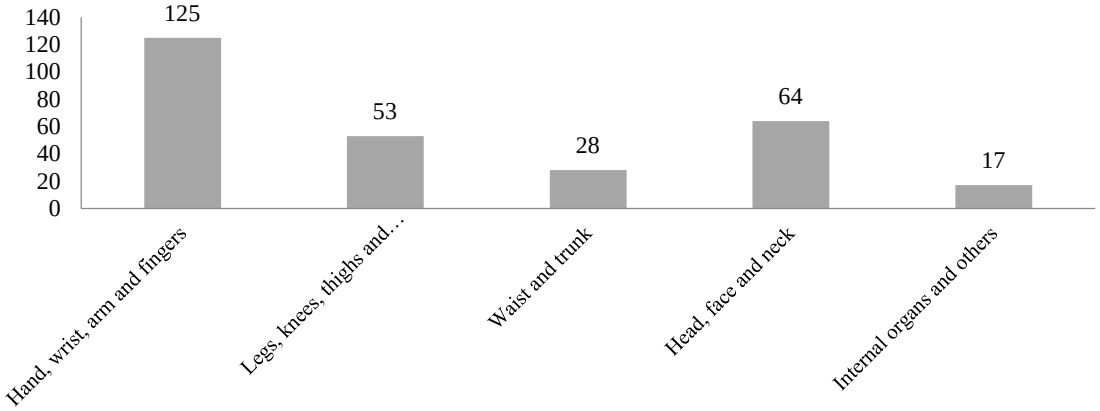

Figure 1. Frequency distribution of injured organs in incident victims at Yazd combined cycle power plant

Figure 2. Relative frequency distribution of the main causes of incidents at Yazd combined cycle power plant

Table 3. Average of indices based on work experience in years before and after implementation of OHSAS 18001

	Year	Indices	Work experience		
			Under 5 years	5-15 years	Over 15 years
Before IMS	2004	AFR	29.41	32.50	71.42
		ASR	86.27	87.50	185.71
		FSI	1.59	1068	3.64
		IR	294.10	325.00	714.20
		FR	14.70	16.25	35.71
After IMS	2005	AFR	29.41	15.90	142.85
		ASR	88.23	38.63	500.00
		FSI	1.61	0.78	8.45
		IR	294.10	159.00	1428.50
		FR	14.70	7.95	71.42
	2006	AFR	44.00	9.23	60.00
		ASR	114.66	24.61	200.00
		FSI	2.24	0.47	3.46
		IR	440.00	92.30	600.00
		FR	22.00	4.61	30.00
	2007	AFR	38.88	14.51	30.00
		ASR	98.61	37.09	70.00
		FSI	1.95	0.74	1.44
		IR	388.80	145.10	300.00
		FR	19.44	7.25	15.00
	2008	AFR	32.72	14.50	25.00
		ASR	394.55	22.91	50.00
		FSI	3.59	0.57	1.11
		IR	327.20	145.00	250.00
		FR	16.36	7.29	12.50
	2009	AFR	29.29	15.30	38.46
		ASR	101.01	29.59	46.15
		FSI	1.72	0.67	1.33
		IR	292.90	153.00	384.60
		FR	14.64	7.65	19.23
	2010	AFR	20.20	17.34	33.33
		ASR	38.38	593.59	50.00
		FSI	0.88	1.01	1.29
		IR	202.00	173.40	333.30
		FR	10.10	8.67	16.66
	2011	AFR	1.02	18.55	10.00
		ASR	7.14	51.54	30.00
		FSI	0.08	0.97	0.54
		IR	10.20	185.50	100.00
		FR	0.51	9.27	5.00

According to Figure 2, the main causes of incidents in this 8-year period were respectively unsafe act (74%), unsafe condition (16%), and not using personal protective equipment (10%). Meanwhile, there was no significant relationship between the cause of incidents and work experience of the accident victims (*P*-value> 0/005).

According to Table 3, the indices values in 2004 (before the implementation of OHSAS 18001) were significantly lower than the years after the implementation.

Discussion

The results of the study showed that there was a significant relationship between age and work experience and when the age and work experience increase, the incident rate decreases, which is consistent with the results of Mohammadfam[13] and Halvani.[14] Having insufficient training courses, having a lot of curiosity, rushing to carry out the activities and not having the proper skill to use the devices and equipment can be the main causes of accidents.

There was no incident in employees under 20 years of age in the present study which was due to a barrier to adolescents' employment in this critical industry and this result was consistent with Mohammadfam's results.[13] Most of the accidents victims in the current study were married, which was consistent with the results of Khosravi[15] and Faqih.[16] Psychological stress in workplace and family can increase the rate of unsafe acts in married individuals. Improving organizational communication, individual and group counseling, improving the environment, using safety and ergonomics methods, as well as using relaxation techniques such as different exercises can reduce stress. The reduction of incident indices in this study was consistent with Hamidi's[8] findings.

The results of this study showed that the safety status according to the trend of indicators and based on work experience in the years after the implementation of OHSAS 18001 (2005-2011) has improved compared with the year before implementation of this system (2004).There will be a dramatic reduction in accident indices if the safety is improved and an orderly management system is implemented.

Zeng et al. (2008) in a study to assess the implementation of occupational health and safety management systems concluded that standards should be aligned to the quality management standard.[17] Coleman has also considered a safety and health program necessary to assess the safety of miners and the reduction of the lost working days. [18]Indicators in this study had a downward trend that was consistent with the result of Jamali. Jamali[19] that studied the incident rate and the frequency rate in a 4-year period (1382-1379). The frequency rate had a downward trend, while the incident rate grew in 1382, which can be due to traditional attitude toward safety, lack of training as well as lack of continuous monitoring of the implementation of the safety instructions. There was a significant relationship between the implementation of safety plans and incident indices in the study of Omidvari et al.[20] According to Goldenhar's study in 2001, integrated management systems would have an impact in long time (typically 2 to 3 years).[21] To establish integrated management systems, training and annual audits are necessary to reduce accidents. Therefore, the reduction of these indicators can be attributed to these management systems.

Conclusion

According to the results, development of safety plans and implementation of OHSAS 18001 has reduced the incident indices based on work experience. Therefore, health and safety management systems are appropriate tools for reducing accident rate and accident indices is also a suitable way for monitoring safety performance as well as health and safety management systems. Also, the main causes of incidents in this 8-year period were unsafe acts, unsafe conditions and not using personal protective equipment.

Acknowledgments

The authors sincerely appreciate the manager and personnel of Yazd combined cycle power plant and all those who collaborated in this study. This article is a part of the dissertation for the MSc program in 5/10/1391 with code of (P/17/1/135207).

References

1. Ghodsi A, Alhani F, Anosheh M, Kahoei A. Epidemiology of occupational accidents in Semnan (2002-2006). Koumesh. 2009;10(2):1-2. [Persian]
2. Barkhordari A, Shirazi J, Halvani GH, Baghianimoghaddam MH, Fallahzadeh H, Sabzemakan L, et al . Review in relationship o quality of life with occupational accidents in RudbarLorestan Dam & plant in 1389. Occupational Medicine Quarterly Journal. 2011;2(1):44-50. [Persian].
3. Jouyani Y, Raadabadi M, Kavosi Z, Sadeghifar J, Momenei K. Relationship between the occupational accidents and absence from work employees in shiraz namazi hospital. Payavarde salamat. 2011;5(3):70-9. [Persian]
4. Morsch CM, Gonçalves LF, Barros E. Health-related quality of life among haemodialysis patients relationship with clinical indicators, morbidity and mortality. Clin Nurs. 2006; 15(4):498-504.

5. Khodabandeh S, HaghDoost AA, Khosravi Y. Epidemiology of work-related Accidents in Kerman Coal Mines during 1991-2006. Iran occupational health journal. 2012;8(4):18-28. [Persian].
6. Watson W, Ozanne-Smith J. The cost of injury to Victoria: Monash University Accident Research Centre Melbourne; 1997.
7. Miller TR, Galbraith M. Estimating the costs of occupational injury in the United States. Accident analysis & prevention. 1995;27(6):741-7.
8. Hamidi N, Omidvari M, Meftahi M. The effect of integrated management system on safety and productivity indices: Case study; Iranian cement industries. Safety science. 2012;50(5):1180-9.
9. Shakeri A, Ayvazian M. Integrated Management Systems (IMS). [POSTER] at: Proceeding of Second National Conference of Industrial Engineering in Yazd University; 2013March 6-7; Najaf Abad - Islamic Azad University, Najaf Abad Branch. Esfahan; 2013 [Persian]
10. Labodová A. Implementing integrated management systems using a risk analysis based approach. Cleaner production. 2004;12(6):571-80.
11. Batra PE, Ioannides MG. Electric accidents in the production, transmission, and distribution of electric energy: a review of the literature. International journal of occupational safety and ergonomics. 2001;7(3):285-307.
12. Revelle JB. Safety training methods. New York: Wiley-Interscience; 1980. P: 258.
13. Mohammadfam I, Zokayi HR, Simayi N. Epidemiological study of fatal occupational accidents and human costs associated in Tehran. Tabibe shargh. 2006;4(4):229-307.
14. Halvani GhH, Falah H, Barkhordari A, Khoshkdaman R, Behjati M, Koohi F. ASurvey of causes of occupational accidents at working place under protection of Yazd Social Security Organization in 2005. Iran occupational health. 2010;7(3):19-24. [Persian]
15. Khosravi J, Hashemi SS, Dehghanifard S, Jabari K. Study of fatal occupational accidents in workers Landscape Contractors by city services and municipalities Tehran in 2004 and 1384. Scientific Journal of Legal Medicine. 2007;13(2):68-77.
16. Faghih N, Talebnejad A, Asadi F, Mohammadi A, Abbasi A. Study and analysis of work-related accident in fars province. Int j business manag tomorrow. 2012;2:1e6.
17. Zeng SX, Tam VWY, Tam CM. Towards occupational health and safety systems in the construction industry of China. Safety science. 2008;46(8):1155-68.
18. Coleman PJ, Kerkering JC. Measuring mining safety with injury statistics: Lost workdays as indicators of risk. Safety research. 2007;38(5):523-33.
19. Jamali K, Janfaza S. Analysis of occupational accidents of Pars Aluminum Factory during the years 2000-2002. [POSTER] at: Proceeding of The 4th National Conference on Occupational Health of Iran Hamedan; 2004 Oct 13-15; Hamedan, Hamedan University of Medical Sciences and Health Services. Iran: Hamedan; 2004:255-60.
20. Omidvari M, Javaheri Zadeh N, Nourmoradi H, Davodi M. Effect of safety programs on occupational accidents and diseases indices in food industries of ilam province over a 5-year period. Health. 2011;2(3):14-23. [Pwrsian]
21. Goldenhar LM, Moran SK, Colligan M. Health and safety training in a sample of open-shop construction companies. Safety research. 2001;32(2):237-52.