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Analysis of Occupational Hazardous Causes: Ergonomics, Thermal Stress, Noise and Vibration; Provision of HSE_MS Improvement Resolutions for Refinery A of Assaluyeh, Iran

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ABSTRACT

Studying and analyzing hazardous causes in occupation fields play impressive roles in improving health key indicators, consequently accomplishing HSE_MS establishment. Paying attention to the connection of hazardous causes with HSE_MS and performance assessment, it is tried to study the impact of the hazardous causes on HSE performance assessment and HSE_MS improvement. The assessment of key performance indicators of health field expresses some rebellious results and noncompliance with standards in some cases. The most important sources of in efficiencies in Health indicators are recognized as the hazardous causes: Ergonomics, Thermal stress, Noise and Vibration. The health key indicators: SAR, GAR, UAR, AAE, ASD and AFR are defined, identified and assessed based on FMEA method: Failure Mode and Effect Analysis. Most of the health indicators – exceeding the OGP standard –urge the analyses of hazardous causes and root finding measures. Among the hazardous causes, Ergonomics and Vibration present proper patterns satisfying time dependency because of the managerial measures: HSE culture and CBA (Cost Benefit Analysis) studies. While, Thermal stress is the only agent which illustrates not suitable variations mainly because of bad weather conditions of the Assaluyeh. The role of strategic management of the hazardous causes – as a preventive measure – in reduction of risk of various kinds of diseases and health accidents is quite undeniable.

KEYWORDS: HSE performance indicator, HSE_MS, South Pars Gas Complex, Hazardous causes

1-INTRODUCTION

There are different kinds of hazards in health, safety and environment fields for occupational areas especially oil and gas industries. Operating several assets has resulted in more complexity and so occurrence of some major accidents in the refining industries[1]. Although the safety or environmental standards are rising rapidly, more and more failures have serious consequences in these areas [2]. Obviously, a key element in the improvement of health and safety conditions at work is occupational risk prevention [3]. Societal risk perceptions have been described by Weinstein (1980) as a reflection of the values, symbols, ideology and history of a society [4]; Sjöberg et al. (2004) further imply that risk perception is a social and cultural construct and that "the conflict between expert and public risk perception is at the basis of the social dilemmas of risk management" [5]. Risk assessment determines the qualitative analysis of risk potential regarding the sensitivity or vulnerability of the surrounding environment [6].Britain Standards Institute defines risk as combination of occurrence and results of a hazardous event [7]. In this study, the safety definition is based on Standard ISO 8402: 1992 defined as: The state in which the probability of hazards to damage humans and/or properties is decreased to an acceptable amount. However, the human injuries are highlighted the most in the study due to hazardous causes for health field.

Based on Deming's Continuous Improvement Cycle; the Health, Safety, and Environment Management Systems are the acclaimed systems that not only would significantly minimize the risks to the enterprise human, natural, and capital resources; but also could boost their performances through continuous learning from the past experiences as well as effective benchmarking of their rivals. Indeed, management systems as such have become the main organizational pillars and the key prerequisite for their survival [8]. Performance assessment can be defined as a set of activities performed in order to improve optimized levels of resource uses for achieving the systematic goals and arriving at an economic condition fulfilled with efficiency and effectiveness [9].Hazard analysis is a tool for recognition of hazards by their relevant risks via the available paths in occupational processes in order to delete or control the adverse conditions. After the hazard analysis is performed the following achievements can be attained:

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1. Identification of defective conditions_ inefficiencies or anomalies_ of the system which have potential to bring about accidents.
2. Provision of controlling measures as well as correcting acts and reformations.
3. Providing perspective for accident analysis and consequence modeling.
4. Identification of direct and indirect costs and subsequently hazard cost optimization.

One of predominating targets of management systems such as ISO 14001, OHSAS 18001 and HSE_MS is to obtain certainty that health, safety and environment affairs are structurally considered and documented within the organization strategies [10,11]. HSE plans try to decrease the losses and damages on humans and/or environment due to occupational incidents [12, 13].As well as in this issue, fuzzy cognitive maps for human reliability analysis in production systems were used [14]. In another case study, Bin and et al., have used in production engineering and management under fuzziness and ergonomics study of a semiconductors factory in an IDC for improvement in occupational health and safety [15].

2-RESEARCH METHOD

2-1-Determination of Health Indicators

The schematic of the present study is shown as figure 1. Accordingly, in Refinery A of SPGC (South Pars Gas Complex) Assaluyeh, Bushehr province, Iran; it is dealt with performance assessment via HSE key performance indicators especially Health indicators by FMEA and AHP[1] methods. The important factors in varying the naming indicators would be the naming Hazardous causes. The relationship between Hazardous causes and HSE indicators and the role of hazard sources can be recognized the best via the analytical studies like the present one which focuses on the improvement resolutions for HSE_MS establishment. The predominant hazard causes in the study are identified as: Ergonomics, Noise, Thermal stress and Vibration.

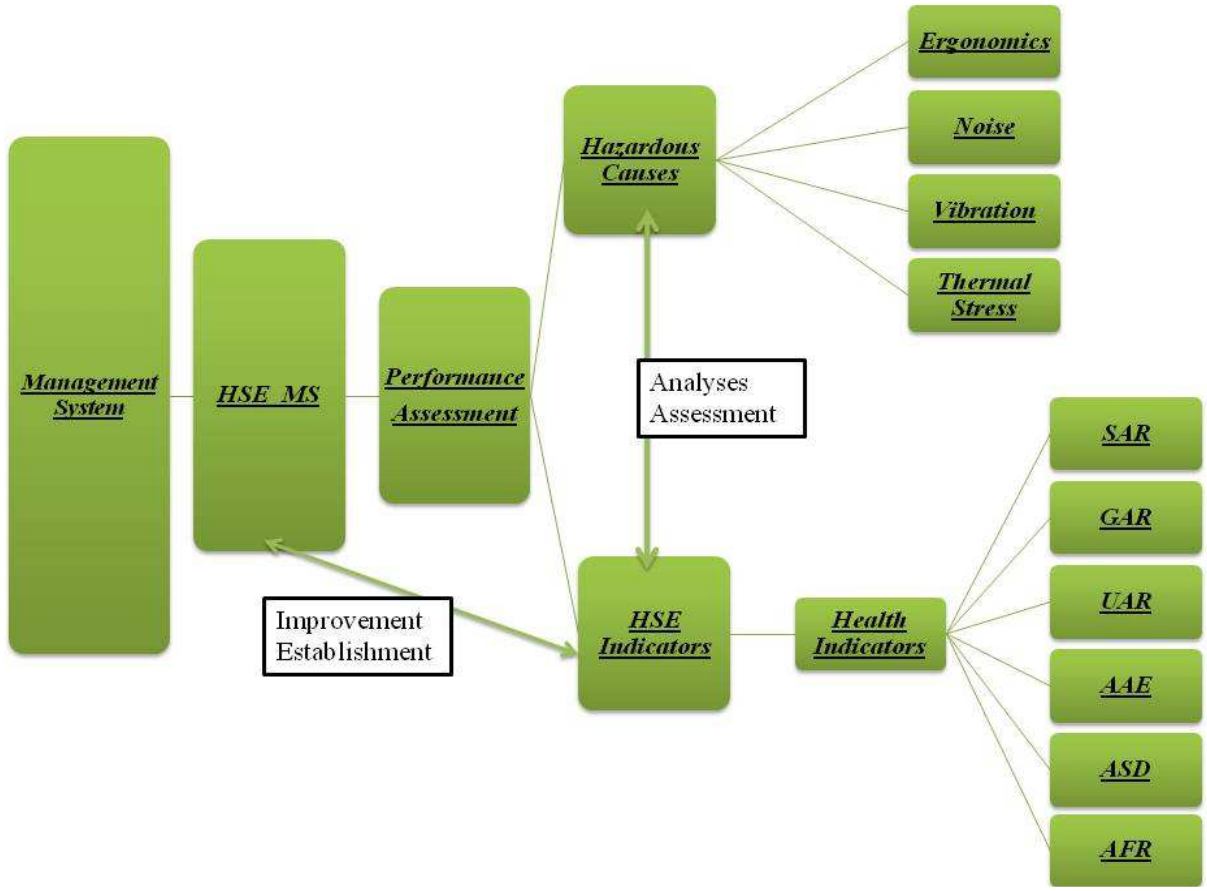

Figure 1: Present study schematic perspective

[1]Analytical Hierarchy Process

Among various performance indicators of health field, the following indicators which are based on personnel absences are known as key indicators:SAR[2], GAR[3], UAR[4], AAE[5], ASD[6] and AFR[7]. The naming indicators are defined as follows by OGP[8] standard:

$$\times 100 SAR = \frac{Total\ Days\ of\ medical\ treatment\ absenses}{Total\ working\ Days \times Number\ of\ workers} \quad (1)$$

$$\times 100 GAR = \frac{Total\ Days\ of\ medical\ treatment\ absenses\ and\ other\ absences}{Total\ working\ Days \times Number\ of\ workers} \quad (2)$$

$$\times 100 UAR = \frac{Total\ Days\ of other\ absences}{Total\ working\ Days \times Number\ of\ workers} \quad (3)$$

$$\times 100 AAE = \frac{Total\ absense\ Days}{Number\ of\ workers} \quad (4)$$

$$\times 100 ASD = \frac{Total\ medical\ absense\ Days\ (absence\ days<14)}{Total\ number\ of\ medical\ cases\ (absence\ days<14)} \quad (5)$$

$$\times 100 ARF = \frac{Total\ absense\ Days\ (medical\ treatment\ and\ Others)}{Number\ of\ workers} \quad (7)$$

About the origins and dimensions of the naming hazard causes it can be stated: Noise is measured by quantity: Sound Pressure Level in units of db, Thermal stress is measured by quantity WBGT in units of degrees centigrade, Vibration is measured by quantity frequency in units of Hertz and Ergonomics is measured by quantity: total number of stations in units of percent.

3-RESULTS AND DISCUSSION

3-1-Health Performance Indicators

Most health performance indicators are studied via comparing with standard levels and/or time dependent pattern.

Figure 2 presents health performance indicators of the project in year 2013 as well as OGP corresponding levels. It is noted that all the presented indicators had decreasing time dependent patterns in period from 2011 up to 2013;being served as an outstanding achievement of HSE_MS establishment in the organization.

[2]Sickness Absence Rate
[3]Gross Absence Rate
[4]Unauthorized Absence Rate
[5]Average Absence Employee
[6]Average Spell Duration
[7]Absence Frequency Rate
[8] Oil and Gas Producers

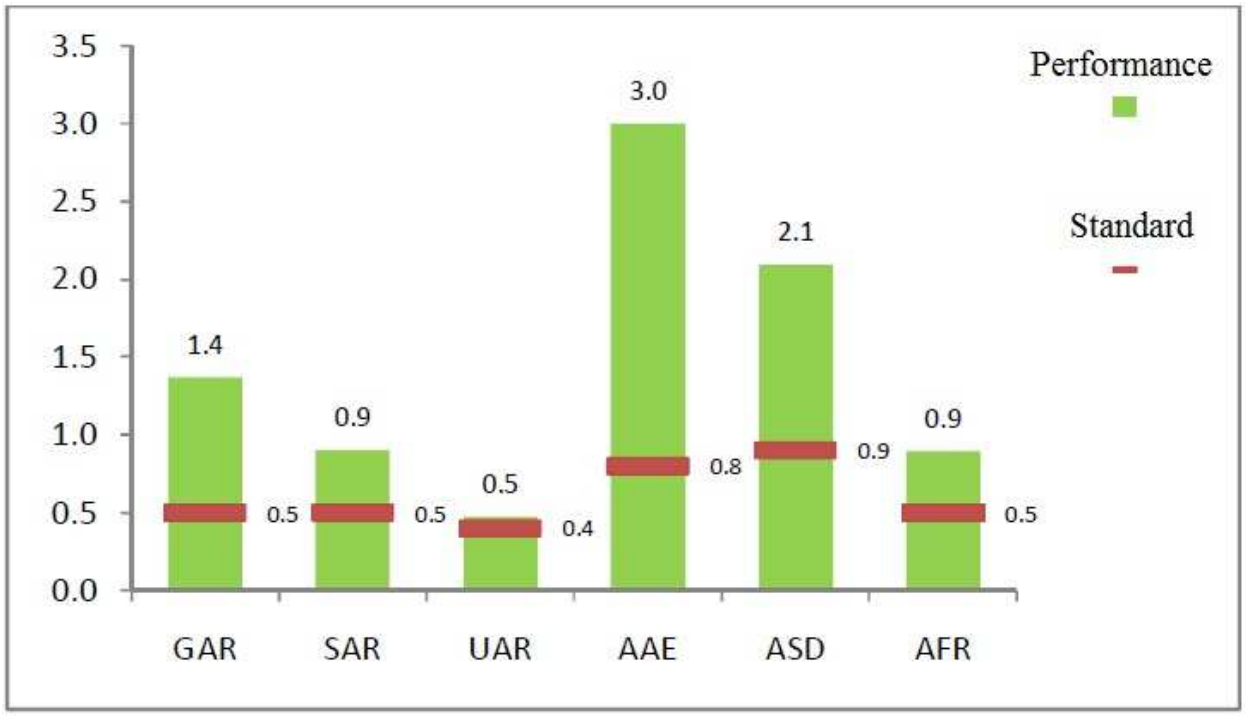

Figure 2 Comparison bars for project health performance indicators and OGP (2013)

According to figure 2, it can be stated that all health indicators in year 2013 had values greater than OGP levels. This issue _ the best_urged the high demand for both preventive and corrective acts achieved from processes of occupational hazardous cause analysis. On the other hand, according to decreasing time dependent pattern for all studied indicators; it is found that the management system had fair continuous improvements following its Plan, Do, Check and Act measures.

The major resolutions for minimization of performance indicators along with HSE_MS establishment would be:

- Identification of hazardous causes in working fields
- monitoring of Hazardous causes
- Assessment of hazardous causes
- Elimination and/or reduction of hazardous causes
- Control of Hazardous causes

3-2-Occupational hazardous causes

The most important reasons for personnel absence are identified as Noise, Thermal stress, Vibration and Ergonomics.

3-2-1-Noise

According to figure 3, the amounts of sound pressure levels for the study in 2013 had higher values than standards: OSHA and ACGIH. On the other hand, these amounts express improvements compared to the first monitoring in 2011. This is while each working area deals with noise sources usually different from other areas, thus they require different attitudes. Based on the results of analysis of Noise in refinery A, the most important Noise sources are:

- All rotary equipments such as: compressors, pumps, turbines, generators and fans.
- Steam lines and steam vessels
- Safety valves and Joul-Thamson valves
- Cooling towers and ventilation systems
- Transportation systems.

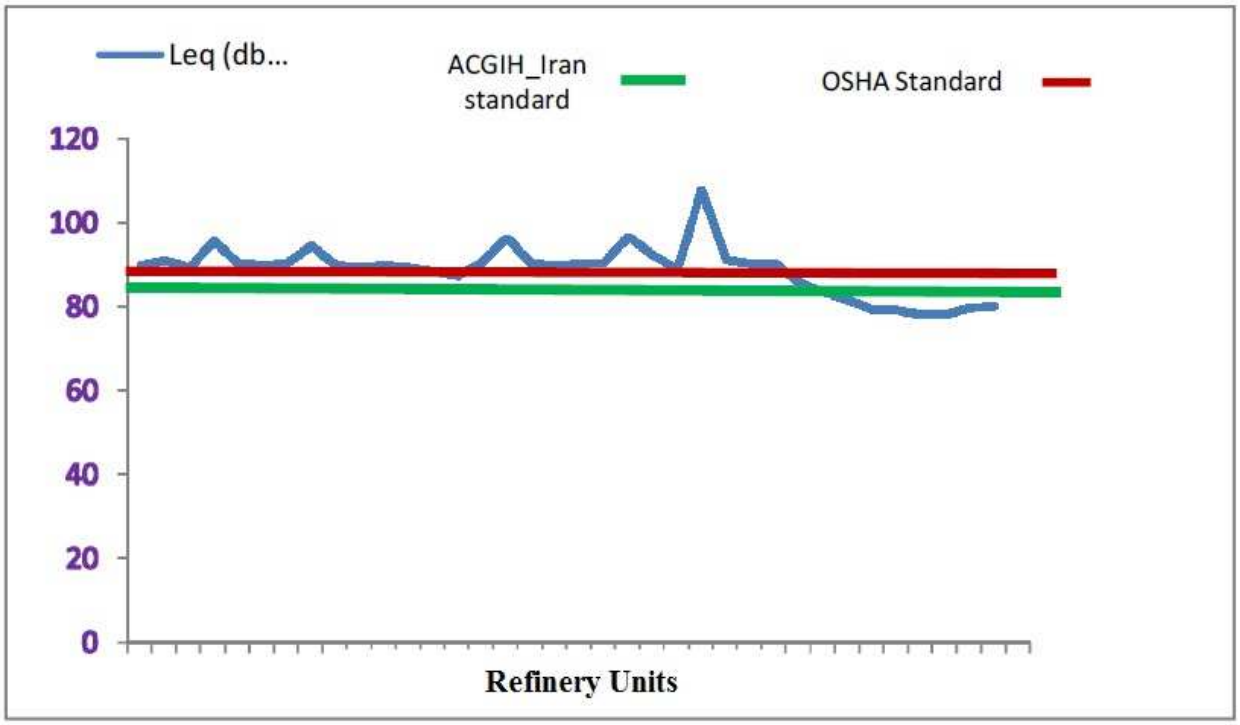

Figure 3 Comparison of sound pressure level in study, OSHA and ACGIH_Iran (2013)

3-2-2-Theramal stress

Figure 4 illustrates WBGT values for Thermal stress measured in period from 2011 to 2013. Accordingly, measurements represent inefficient patterns such that the number of non-conformed stations increased with time (from 17 to 25). This is while the hazardous cause: Thermal stress is an important agent in increasing personnel absence indicators. Hence it implies the urgent need for compliance of all stations with corroborated occupational health standards. This cause could be an important root for non-conformances found in AFR (0.5<0.9) as well as increases in total number of diseases related to Thermal stress and Thermal shocks.

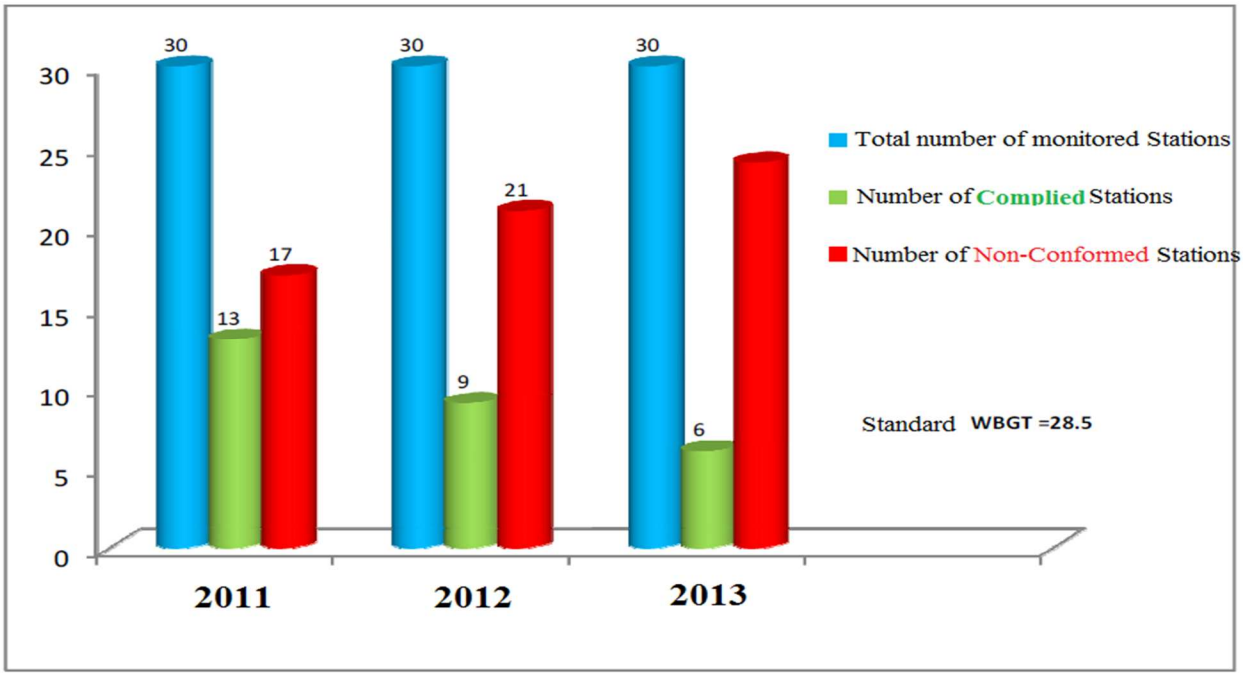

Figure 4 Thermal stress comparison bars measured in dimension of WBGT ^{o}C from 2011 to 2013

3-2-3-Vibration

The results of monitoring of the hazardous cause: vibration for the study is illustrated as figure 5.On this basis, time dependent distribution for this cause source represents an ideal pattern. The number of non-conformed stations decreased efficiently (from 6 in 2011 to 1 in 2013).

3-2-4-Ergonomics

Paying attention to figure 6, it is found that the time dependent pattern is decreasing (from 35 in 2011 to 11 in 2013) and it can represent well-designed management. It is inferred that the condition of Ergonomics in studied stations received high quality preventive and corrective acts during the revisions as an important outline of continual improvement. The major measures taken by HSE_MS strategies are:

- Performing learning courses
- HSE culture
- Performing TBM tool box meetings and induction courses
- Documenting procedures for Ergonomics
- Procuring qualified and standard technologies and equipment

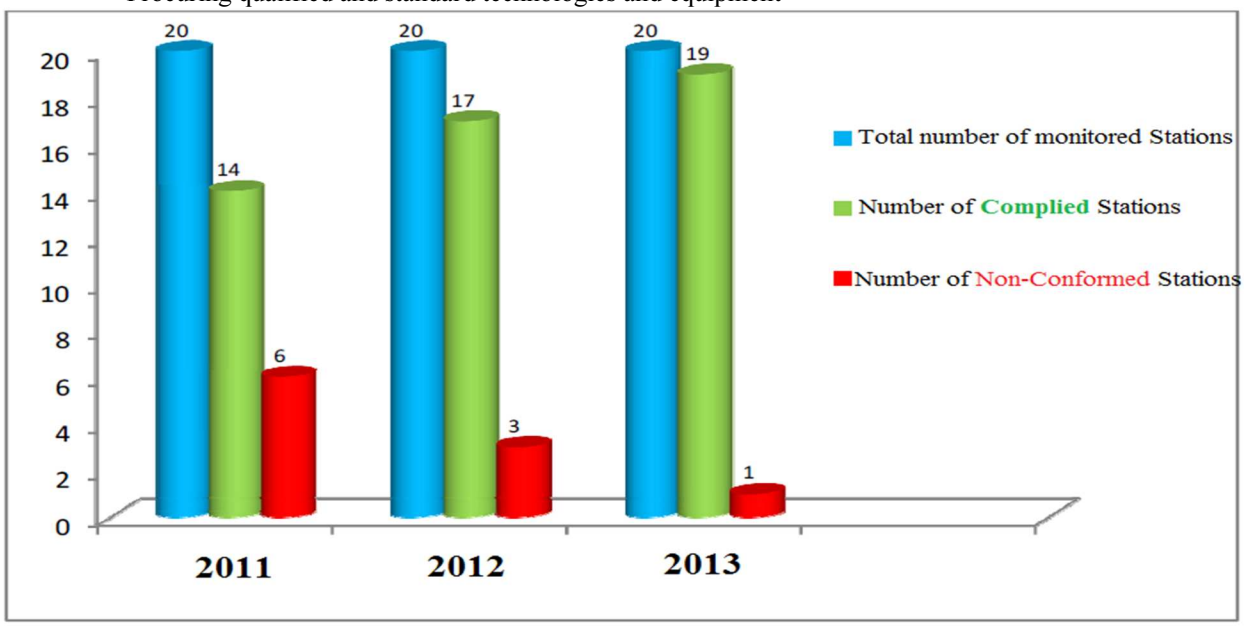

Figure 5 Vibration comparison bars measured in dimension of Frequency: Hertz from 2011 to 2013

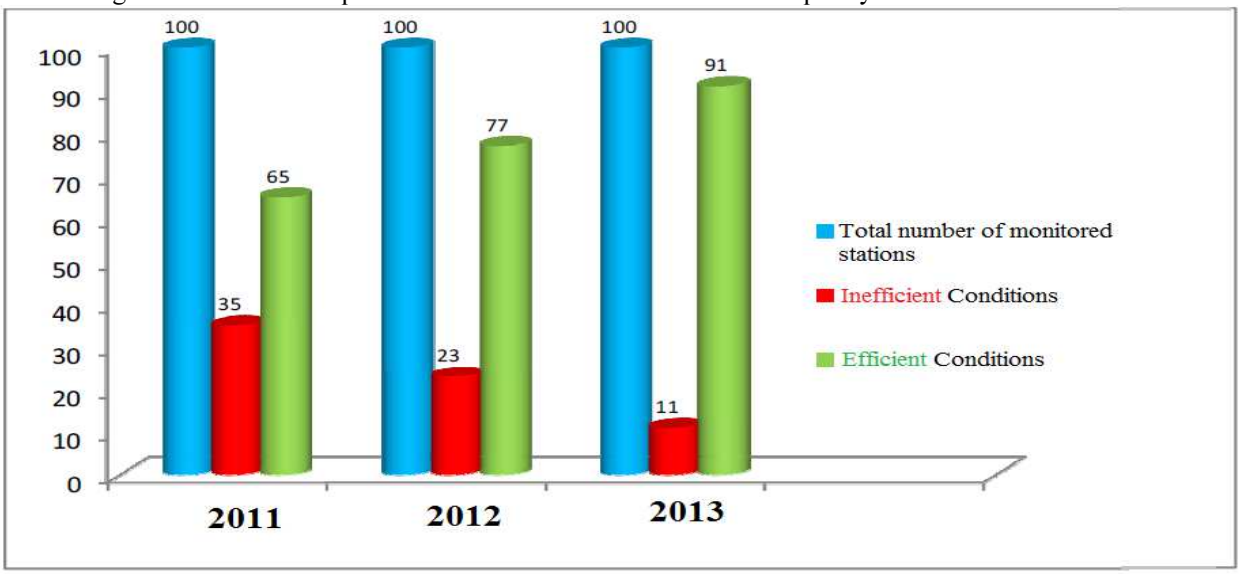

Figure 6 Ergonomics comparison bars measured from 2011 to 2013

4-Conclusion

The issue of Health _as the prime subject in integrated field of study: HSE_ requires sustainable academic and intellectual studies all through occupation fields, most importantly the industries. This is also verified by sustainable development which knows human as the axis of its conformation. In the present case study, the health indicators represent efficient time dependent patterns. However, the assessed health performance indicators had non-conformed levels based on OGP standard even in 2013 among which the AAE and ASD had the most noncompliance's respectively. This fact expresses higher levels for both the frequency and severity of adverse consequences to personnel by occupational accidents and also by the occupational hazardous causes. Higher levels of risk exert more cost for accomplishment of risk assessment and risk management. On the other hand, the most compliance is found in UAR which could be due to the personnel commitment for decreasing the numbers of unauthorized absences.

The major occupational hazardous causes in this study are recognized as: Ergonomics, Thermal stress, Vibration and Sound pollution. Among the analyzed hazardous causes, Ergonomics and Vibration had very suitable decreasing patterns in the 3-year period between 2011 and 2013 mainly due to HSE culture and CBA studies. Learning courses and qualification of equipment are important factors for improvement of ergonomics. Thermal stress is reported as the only inefficient hazard source which can be justified by the considerations of bad weather conditions of the project location needing for more intellectual and profound researches.

The variations of health indicators in period from 2011 to 2013 are proper; however, the indicators exceeded the relative standard levels which require concentrating the resources and policies more and more on HSE and especially Health subjects. Auditing management systems of OHSAS and HSE_MS can play impressive roles in identification and optimization of inefficiencies in the studied project.

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