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ORIGINAL ARTICLE

Feasibility Study of Implementing Process Safety Management (PSM) Requirements in an Iranian Petrochemical Company

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ABSTRACT

The establishment of good process safety management (PSM) is widely considered as the most effective means of improving safety levels in process industries. This study was conducted to evaluate the feasibility of establishing and implementing PSM requirements based on Occupational Health and Safety Assessment Series 18001 standards (OHSAS 18001) and Health, Safety and Environment management systems (HSE-MS) in an Iranian petrochemical plant. Firstly, the requirements of PSM, OHSAS 18001 standards and HSE-MS were compared via literature review and their levels of agreement were determined. Next, the degree of implementation of PSM requirements at a selected petrochemical site was investigated. The study's results show that PSM requirements complied with HSE-MS to a greater degree than with OHSAS 18001 standards. Although the plant studied had not yet formally applied process safety management requirements, based on the HSE-MS and OHSAS 18001 it had already applied, 67% of PSM requirements had in effect been put in place. By revising certain requirements of existing management systems, including PSM requirements in them, and providing the outstanding necessary documentation, this study concludes that the establishment of a PSM system in the plant is feasible.

Keywords: *Petrochemical industries, Process safety management, Occupational Health, Safety Management System*

INTRODUCTION

In process industries, raw materials are converted into intermediate or final products using physical and/or chemical processes [1]. In these industries, production, storage, transportation, use and disposal of chemicals are inherently dangerous and the potential for catastrophic accidents is very high [2-3].

As accidents in these industries may lead to loss of life and damage to equipment, economic losses and environmental pollution [4-5], great efforts have been made to improve safety. This has been promoted by traditional safety measures and a passive approach toward developing preventive laws and regulations, such as the introduction of process safety management (PSM) [6].

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Table 1. Comparison of PSM requirements with OHSAS 18001 and HSE-MS

PSM requirements	OHSAS 18001	HSE-MS
Process Safety Information	–	–
Process Hazard Analysis	√	√
Operating Procedure	√	√
Training	√	√
Contractors	–	√
Pre-startup Safety Review	–	–
Mechanical Integrity	–	–
Hot Work Permit	–	–
Management of Change	–	√
Incident Investigation	√	√
Emergency and Response Planning	√	√
Compliance Audit	√	√
Employee Participation	√	√
Trade Secret	–	–
No. of common requirements	7	9

PSM was introduced in 1990 by the U.S. Occupational Safety and Health Administration (OSHA) and its final, complete version was published in 1992 [7, 8]. Process industries have since used this management system to limit and control chemical risks [9-10]. OSHA estimated that 6 to 10 years after the implementation of PSM, the risk of accidents had decreased 80% and nearly 264 deaths and 1,534 injuries or illnesses had been prevented each year [11].

Although PSM implementation costs are estimated to be high, most companies implemented it have achieved equal or higher benefits and are generally happy with it [12]. A study of chemical industries of South Korea found that seven years after the implementation of PSM, the number of deaths, injuries and "near misses" had been reduced by 62%, 58% and 82%, respectively. Additionally, quality and productivity had improved, and the number of emergency process shutdowns had decreased, as had damage to equipment [13].

Petrochemical facilities are a very important sector of process industries due to the nature of the flammable and toxic materials they process, operational conditions, and the severity of consequences resulting from accidents [14].

Iran is the second largest producer and exporter of petrochemicals in the Middle East, with more than 54 petrochemical complexes. Currently, none of these petrochemical plants has implemented PSM, although nearly all of them use the OSHA Series 18001 standards (OHSAS 18001) for managing their health and safety issues. Recently some of these companies have started to establish health, safety and environment management system (HSE-MS) based on the International Association of Oil & Gas Producers (OGP) guidelines for managing all health, safety and environment issues in an integrated management system. Nevertheless, over the last 10 years, more than 198 fatal accidents have occurred in these petrochemical facilities, indicating that current management systems are not effective at preventing major accidents.

Considering the benefits which result from the establishment of good PSM in process industries, this study was conducted in order to evaluate the feasibility of establishing and implementing PSM requirements (in relation to OHSAS 18001 and HSE-MS requirements) in a selected petrochemical company.

MATERIALS AND METHODS

Compliance Study of PSM Requirements with OHSAS 18001 and HSE-MS

In the first phase of this study, to understand how many of the requirements of PSM were already present in the established management systems used in the selected petrochemical industry (including OHSAS 18001 and HSE-MS), all the requirements of these systems were studied and compared via a literature review. PSM requirements were extracted from the OSHA process safety management system administration guide [7]. For OHSAS 18001 and HSE management system requirements, OHSAS 18001: 2007 [15] and OGP guidelines [16] were used respectively.

As the focus of this compliance, study was health and safety issues, the environmental requirements in HSE-MS were not considered.

In order to quantify the degree of PSM compliance with OHSAS and HSE-MS requirements, the detailed items of each PSM requirement were presented in a questionnaire and their degree of agreement were measured by giving a score from zero to 3 (zero for not-at-all compliant to 3 for full compliance with PSM requirements).

Subsequently, the overall degree of documentary compliance of OHSAS 18001 and HSE-MS with PSM was determined.

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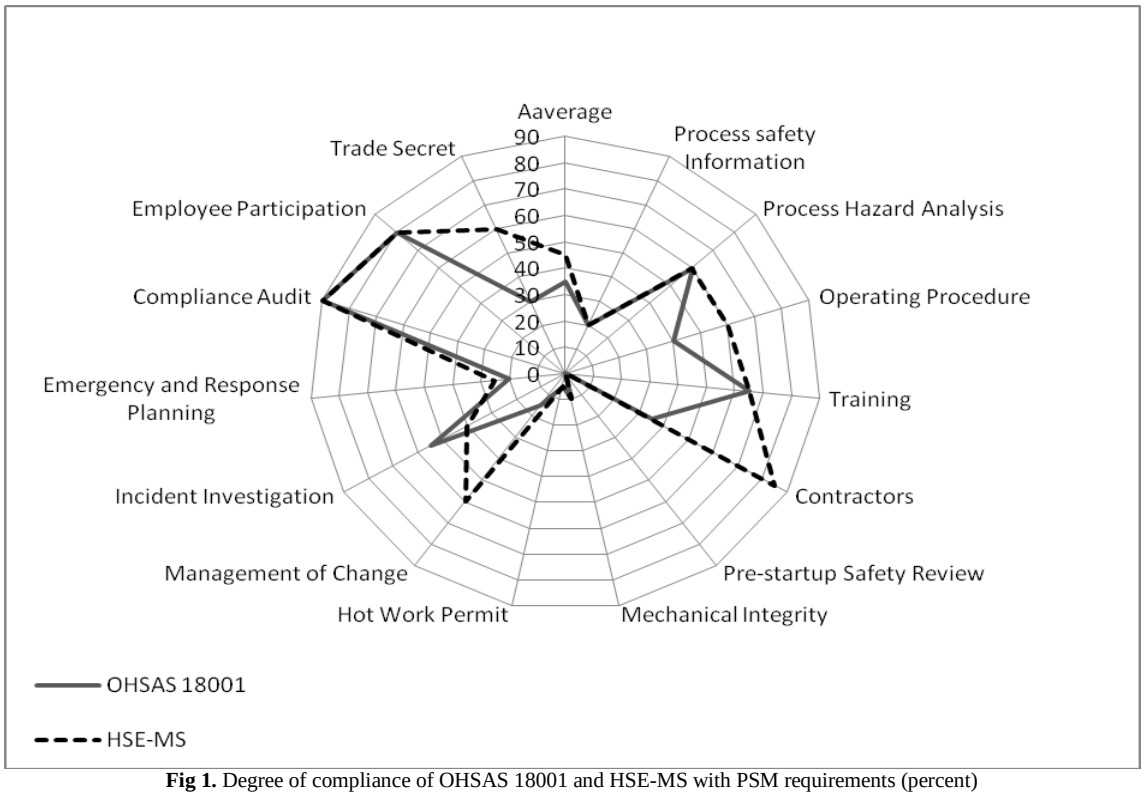

Fig 1. Degree of compliance of OHSAS 18001 and HSE-MS with PSM requirements (percent)

Implementation of PSM requirements

In a second phase, the level of implementation of PSM requirements in a specific Iranian petrochemical plant was studied, based on OHSAS 18001 and HSE-MS requirements. To do this, the plant was audited for PSM requirements using an audit questionnaire according to the OSHA audit guidelines for OSM. This questionnaire consisted of three main parts, including a review of existing evidence and documents, interviews with process employees, and a field survey of process equipment and the working environment. Each answer in the audit questionnaire was quantified with a score from zero to three (zero for not implemented at all, to 3 for full implementation of PSM requirements). Three process safety experts confirmed the validity of the audit questionnaire prepared.

Finally, gaps in the implementation of PSM requirements were identified and the modifications required in existing OHSAS 18001 and HSE-MS procedures, as well as the necessary new documentation for full implementation of PSM, were determined.

RESULTS

Table 1 shows the requirements of PSM in comparison with OHSAS 18001 and HSE-MS. As can be seen, the fourteen elements of PSM are matched by seven OHSAS 18001 requirements and 9 HSE-MS requirements.

Figure 1 shows the degree of compliance degree of OHSAS 18001 and HSE-MS with PSM requirements. As can be seen, HSE-MS's overall compliance with PSM is higher than that of OHSAS18001.

Figure 2 presents the level of implementation of PSM requirements in the specific plant studied. The highest and lowest levels of the implementation of PSM requirements are shown to be in the *trade secret* and *management of change* provisions respectively.

Figure 2 suggests that by using the existing OHSAS 18001 and HSE-MS requirements, the selected petrochemical plant has implemented about 67% of the PSM requirements.

This study also shows that the level of concordance between PSM and OHSAS 18001 and HSE-MS for common requirements is 35% and 45% respectively.

DISCUSSION

This study shows that although PSM has not been established in the selected plant, the average level of implementation for specific requirements of PSM, including *PSSR*, *mechanical integrity* and hot work permit is high (nearly 70%). Interestingly, the plant's average level of implementation for requirements common to PSM and the established management systems (OHSAS 18001 and HSE-MS) was 50%. This is mainly because the level of concordance between PSM and OHSAS 18001 and HSE-MS for common requirements is 35% and 45% respectively.

There are seven common elements across the three management systems: *hazard analysis*, *training*, *operating controls*, *incident investigation*, *emergency response planning*, *compliance audit* and *employees'*

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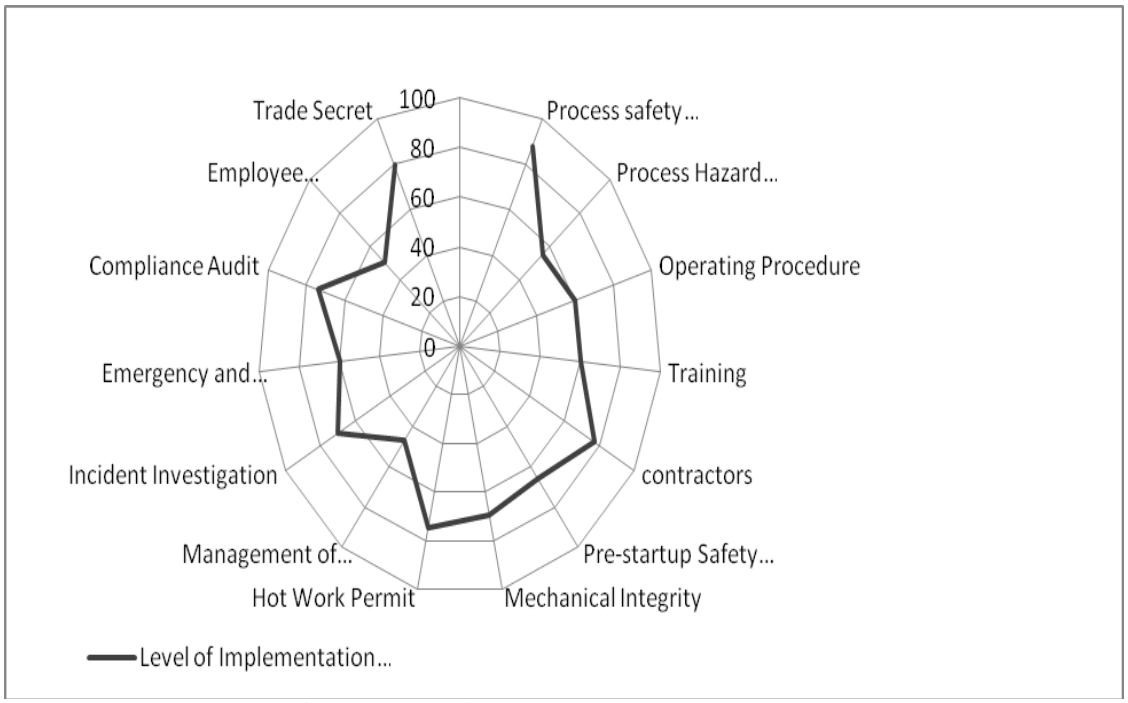

Fig 2. Proportion of implementation of PSM provisions in the petrochemical plant studied (percent)

participation. Of the fourteen provisions of PSM, five elements are specifically related to the PSM system and not directly mentioned in either OHSAS 18001 or HSE-MS.

Four elements (*policy and strategic objectives*, *resources*, *monitoring*, and *performance measurement*) are clearly mentioned in the OHSAS 18001 and HSE-MS, but are not considered directly in the PSM.

HSE-MS's overall compliance with PSM is higher than that of OHSAS18001 (Fig. 1). The highest level of compliance is in the *compliance audits* provision, and the lowest levels of compliance are related to *pre-startup safety review* (*PSSR*), *hot work permit* and *mechanical integrity* which are explained below;

Neither OHSAS 18001 nor HSE-MS consider *PSSR* provision but the audit conducted showed that 66% of PSM requirements for *PSSR* had been implemented. However, in a few cases, records of training received by employees involved in operating certain processes were not available.

The degree of compliance for *mechanical Integrity* using both OHSAS 18001 and HSE was 12% and 70% of the PSM requirement for this element was implemented in the plant. However, as with other procedures, Persian versions of the procedures concerning *mechanical integrity* were not available.

In the plant studied, hot work was considered as an operational control and a written procedure had been prepared for that. By using the prepared procedure, 75% of PSM requirements had been implemented. However, this element is a specific requirement of PSM and is not directly considered in the two other management systems.

The detailed description of other PSM requirement, in terms of compliance via OHSAS 18001 and HSE-MS, and their degree of implementation in the selected plant, are explained below.

Although, degree of compliance for *Process Safety Information* was 20% for both OHSAS 18001 and HSE-MS, 88% of PSM requirements for this element had been implemented (Fig. 2).

The degree of compliance with *process hazard analysis* in PSM was about 60% for both management systems and 55% of PSM requirements for this element had been implemented in the selected petrochemical plant. The most important cases of noncompliance were related to lack of corrective actions taken following risk assessments.

Operating procedure/controls is a requirement common to all three management systems. The degree of compliance for this element of PSM by both OHSAS 18001 and HSE-MS was about 40% (Fig. 1). However, in the plant audited, about 60% of requirements for this element of PSM had been implemented.

Lack of Persian versions of some operating instructions, and a lack of clear responsibilities for operators in case of an emergency shutdown were the most important cases of noncompliance with PSM requirements.

Although *training* is a provision common to all three studied management systems, the degree of compliance for this element of PSM via both OHSAS 18001 and HSE-MS was about 65%. This is mainly because in PSM, training is more focused on process hazards rather than general hazards.

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While in PSM and HSE-MS, there is a specific provision for *Management of Change (MOC)*, in OHSAS 18001 this item is considered indirectly in a paragraph on "identifying and assessment of hazards and operational control". In the plant audited, only 47% of PSM requirements for this element had been implemented. In this plant, in some cases the records of previous risk assessments conducted before changes were not available.

For *incident investigation*, OHSAS 18001's degree of compliance with PSM requirements was higher than that of HSE-MS (55% vs. 40%). However, 70% of PSM requirements were implemented in the selected plant. The most cases of noncompliance were lack of system for reporting and investigating near-miss incidents, and for accidents related to contractors' employees.

Emergency Planning and Response (EPR) is one of the most important requirement common to all three studied systems. However, the degree of compliance for this provision of PSM, to be only 20% with OHSAS 18001 and 25% with HSE-MS. Meanwhile, in the plan studied 60% of PSM requirements for *EPR* had been implemented. For full compliance with PSM requirements, a site-specific incident command system with clear responsibilities should be considered for the plant's *EPR*.

Despite the high level of compliance for *Compliance Audit* and *employee participation* in PSM with two other management systems, their degree of implementation in the selected plant were 74% and 50% respectively. This low level of implementation for *employee participation* was mainly due to lack of a written procedures.

CONCLUSION

HSE-MS exhibited a higher total degree of compliance to PSM requirements than OHSAS 18001. Although, the petrochemical plant studied had not officially established PSM, but based on its implementation of HSE-MS and OHSAS 18001 requirements, 67% of PSM requirements had effectively been established in the plant.

Therefore, with revising some requirements of OHSAS 18001 and HSE-MS systems and including PSM requirements in them and providing the remained specific documents of PSM system, establishment of PSM system in the studied plant seemed feasible.

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