The effectiveness of process safety management (PSM) regulation for chemical industry in Korea

Hyuck-myun Kwon*

Center for Chemical Plant Safety, Korea Occupational Safety and Health Agency, 34-4, Gusandong, Bupyunggu, Incheon 403711, South Korea

Received 23 March 2005; accepted 23 March 2005

Abstract

From the 1960s, Korean industries have been encouraged by the government to nurture heavy and chemical industry and to modernize the economics and industrial structures. The development of chemical industry particularly became the turning point in industrial development, and played a major role in the construction of a new industrialized country. However, the process systems in the chemical industry have become more complex and larger, and the inventories of dangerous chemicals that are produced or consumed have continuously increased. Therefore, the hazards from potential accidents such as fire and explosion or release of toxic chemicals have also increased. In fact, from the end of 1980s to the beginning of 1990s in Korea, a number of major industrial accidents such as ABS extruder explosion, TDI release and dryer explosion, etc. occurred and caused many fatalities. As the chemical companies recognized the importance of preventing major hazards, PSM system, the prevention of major industrial accidents, was introduced in January 1995 by amending Industrial Safety and Health Act, and it has been enforced from January 1, 1996. According to the law, the business owner of a workplace with hazardous or dangerous equipment shall submit a process safety report to the Government to prevent any accidents, which could inflict an immediate damage on workers or on areas in the vicinity of the workplaces. As a result of PSM implementation for 7 years, various kinds of effectiveness have been made. Accident rate including number of fatalities has been decreased, and productivity has been increased as well as product quality.

Keywords: Process safety management (PSM); Major industrial accident

1. Background for legislation of PSM system in Korea

In case of the toxic chemical release, fire, or explosion, there are major catastrophic consequences not only to employees but also to residents as well as environment. In addition, financial losses caused by the damage of the facility are enormous, and it takes long time to repair the facility; these bring other impacts such as insufficient supplies of raw materials to the related industries.

To prevent such major industrial accidents many countries including USA and EU have been implementing chemical accident prevention system.

In July, OSHA in USA announced the plan to declare the federal regulation; this became the starting point of establishing the special law to prevent major industrial accidents in USA, and PSM regulation was enacted in November, 1992 (CCPS and AIChE, 1989).

In 1982, European Union adopted EC Directives (Seveso Directives) which was similar structure to PSM system in USA. EC Directives presented minimal legal standards for every country in European Community to observe; the objectives of this directive were to prevent major industrial accidents and mitigate the damage to people and environment. Member countries of EU have to apply more severe standards than this directive in their own legislation.

A dire need for national plan of chemical accident prevention arose after the MIC release resulted in fatalities of 2500 in Bhopal, India in December 1984 (ILO, 2001), and ILO announced the declaration in 1985 that there should be a systematic procedure for preventing major industrial accidents. Prevention of major industrial accidents was enacted as the 174th Convention in June, 1993 (KOSHA, 2001).

In terms of preventing many numbers of major accidents occurred in Korea from the end of 1980s to the beginning of 1990s, new safety management system like PSM became necessary in chemical plants.

* Tel.: +82 32 5100 681; fax: +82 32 5128 315.
E-mail address: hmkwon@kosha.net.
2. The PSM related law

As the chemical companies recognize the importance of preventing major hazards, PSM system for the prevention of major industrial accidents was introduced in January 1995 by amending Industrial Safety and Health Act, and it has been enforced from January 1, 1996.

The major contents of Industrial Safety and Health Law concerning PSM system are as follows.

(1) An employer of hazardous installations shall submit the process safety report to Ministry of Labor/KOSHA under the Presidential Decree for preventing major industrial accidents such as fire, explosion and release of toxic chemicals which can cause a serious danger to employees, residents in the nearby community.

(2) The process safety report prepared by employer shall be reviewed by the Safety and Health Committee in the workplace before submission. If the committee was not established, the report shall be reviewed by the representative of employees.

(3) The Ministry of Labor/KOSHA shall assess the process safety report and can order the employer to change the report in case it is necessary for the safety and health of employees.

(4) An employer and employees shall take necessary measures in compliance with the process safety report.

Hazardous installations prescribed in the Law shall be the following business categories or installations handling and storing hazardous materials more than threshold quantities as listed in Table 1.

- Refineries
- Re-processing of by-products of petroleum refining
- Petrochemical organic chemicals or synthetic resins
- Fertilizers industries
- Pesticide/herbicide
- Explosive powder/fireworks products

Nuclear power plants and military facilities are excluded from the PSM regulation as they are controlled by the separate laws.

The following contents shall be included in the process safety report prescribed in the law.

(1) Process safety information
(2) Hazard analysis and risk assessment report
(3) Procedure and planning for safe operations for installations
  - Procedure and manual for safe operation
  - Procedure and specification for mechanical Integrity
  - Procedure for hot work permit
  - Safety control procedure for contractor’s work
  - Education and training plan
  - Procedure for management of change
  - Procedure for pre-startup
  - Audit procedure
  - Procedure for incident investigation
  - Others related to safety management
(4) Emergency planning and response

3. Implementation of PSM

In March 1995, KOSHA established the Center for Chemical Plants Safety consisting of professional engineers to implement PSM system for the prevention of major industrial accidents. There are 642 PSM sites which are controlled by PSM regulation recently.

The PSM companies are categorized in accordance with their business category and number of employees as shown in Table 2. Among 642 companies, 178 belong to

---

### Table 1

<table>
<thead>
<tr>
<th>Hazardous material and threshold quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flammable gases</td>
</tr>
<tr>
<td>Combustible liquid</td>
</tr>
<tr>
<td>Methyl isocyanate</td>
</tr>
<tr>
<td>Phosgene</td>
</tr>
<tr>
<td>Acrylonitrile</td>
</tr>
<tr>
<td>Ammonia</td>
</tr>
<tr>
<td>Chlorine</td>
</tr>
<tr>
<td>Sulfur dioxide</td>
</tr>
<tr>
<td>Sulfur trioxide</td>
</tr>
<tr>
<td>Carbon disulfide</td>
</tr>
<tr>
<td>Hydrogen cyanide</td>
</tr>
</tbody>
</table>

---

### Table 2

<table>
<thead>
<tr>
<th>No. of employees</th>
<th>Business category</th>
<th>Refinery</th>
<th>Petro chemical</th>
<th>Fertilizer</th>
<th>Pesticide</th>
<th>Explosive</th>
<th>Hazardous material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>38</td>
<td>107</td>
<td>8</td>
<td>12</td>
<td>13</td>
<td>464</td>
<td></td>
</tr>
<tr>
<td>&lt;50</td>
<td>21</td>
<td>29</td>
<td>2</td>
<td>7</td>
<td>5</td>
<td>152</td>
<td></td>
</tr>
<tr>
<td>50–99</td>
<td>5</td>
<td>20</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>100–299</td>
<td>4</td>
<td>40</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>105</td>
<td></td>
</tr>
<tr>
<td>300–499</td>
<td>–</td>
<td>12</td>
<td>–</td>
<td>–</td>
<td>1</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>500&gt;</td>
<td>8</td>
<td>6</td>
<td>2</td>
<td>–</td>
<td>2</td>
<td>93</td>
<td></td>
</tr>
</tbody>
</table>
the business categories and the other 464 belong to the hazardous installations handling or storing hazardous materials. And there are 322 small and medium sized plants in which the number of employees is below 99.

Meanwhile, in order to evaluate the status of PSM performance in chemical companies, 561 sites was checked and graded into three groups as shown in Table 3

One hundred and fifty-seven companies, which form about 28.0 percent ranked P level that means PROGRESSIVE, while 299 companies, which form about 53.3 percent received S level that means STAGNANT. And 105 companies with poor and unreliable condition in safety management, which form 18.7 percent, ranked M level that means MISMANAGEMENT. According to our analysis, portion of P level in large companies is relatively higher than that in small companies, and portion of M level in small companies is relatively higher than that in large companies. Based on the result of grading, performance based inspection criterion is applied to the PSM sites as follows;

- **P** (Progressive): self implementation of PSM
- **S** (Stagnant): check of implementation of PSM more than once per year by the concerned authorities.
- **M** (Mismanagement): check of implementation of PSM, more than twice per year by the concerned authorities. Technical advice for the checked item and PSM training every 6 months

### 4. PSM effectiveness

As a result of PSM implementation for 7 years, various kinds of effectiveness were made. The number of major industrial accident including the number of fatalities has been decreased after PSM implementation and productivity has been increased as well as product quality as shown below (Process Safety Progress, 2002):

1. Sixty-two percent of fatality, 58 percent of injury and 82 percent of near miss were decreased
2. Quality (96.3%) and productivity (98.2) were improved
3. Technical data were well reorganized
   - P&ID, HAZOP and operating procedure, etc.
4. The number of emergency shut down cases was decreased
5. The property damage was reduced
6. The problem of reinsurance was solved.

Since implementation of PSM system in 1996, the 82 major industrial accidents have occurred up to year 2003. We analyzed, the accidents according to the year and business category as listed in Table 4.

According to our analysis referred to Table 5, 34 accidents, which form 41.5% occurred due to the inadequate implementation of safe work permission. The next contribution cause is inadequate operating procedure/operation error that is corresponding to 18.3%—15 accidents. The third main cause is inadequate MOC by which 11 accidents were occurred (form to 13.4%).

### 5. Conclusion

From the end of 1980s to the beginning of 1990s, many major accidents occurred in Korea due to various reasons including lack of well trained operators in the chemical plants, lack of mechanical integrity in process equipment, lack of safety consciousness or safety culture, and inadequate safety measures, procedures and management systems, etc.

Since we have introduced PSM System in 1996, there has been a lot of debates on gain and loss of PSM
implementation. However, it is obvious that gains are greater than the losses from the PSM implementation such as reduction of industrial accident, systematic documentation and as-built, improvement of process technology, reduction of operational error, increase of quality and productivity, reduction of insurance rate and finally foundation of self-operated safety management system. Regardless of the effectiveness of PSM system, major industrial accidents still happen because of design error, mechanical failure, human error, poor management of MOC and, etc. As the final conclusion and recommendation, the use of PSM systems, as a tool for the assurance of inherently safer plants and the prevention of major accidents, shall be intensified as long as possible.

References

KOSHA (2001). The effects analysis of an implementation and further development on process safety management.