

Process Safety Management in India

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After the Bhopal disaster in 1984, a number of changes were made in the Indian Factories Act and environmental legislation. Over the last decade the Indian Chemical industry has been striving to improve its safety and environmental performance. Twenty years after Bhopal, what are the lessons that we have learnt in India ? This paper examines the following in the context of the current Indian scenario and also suggests the way ahead:

- Changes in safety and environmental legislation – Are they adequate to prevent another Bhopal?
- Process Safety Management in India –
 - Current trends in process safety management and business strategy
 - Process Safety Information: Design data and their limitations in the light of old plants
 - Contractor safety in the Indian context
 - Emergency response planning and off site emergencies: Limitations and problems faced
 - Management of change in the light of globalisation and cost cutting initiatives
 - High personnel turnover and training
 - Incident Investigation
 - Improvements needed in the measurement and tracking of process safety performance
 - Industry Institution interaction and its need in the Indian context
 - Terrorism and process safety

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Introduction:

After the Bhopal gas disaster in 1984, the Indian legislation governing safety and environment underwent significant changes. Specifically, the Factories Act was amended to assign the responsibility of the “occupier”, who is legally responsible for the safety of the workplace and workers, to the highest level of management in an organization. For a company, this meant that one of the directors on the board had to be designated as “occupier”. The Environmental legislation also underwent changes, with the Environment Protection Act introduced in 1986. Under this act, a number of new legislations were framed. The Manufacture, Storage and Import of Hazardous Chemical rules, 1989 was introduced with the objective of preventing another Bhopal type of disaster. Specifically, this rule required safety audits to be carried out in hazardous chemical factories, storing more than a threshold limit of hazardous chemicals.

The Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996 was also introduced. Preparation of on-site Emergency Plan by the Industry and Off-site Plan by the District Collector and the constitution of four-tier Crisis Groups at the Centre, State, District and Local level for management of chemical accidents are mandatory under these Rules. These rules also focus on accident prevention, preparedness and mitigation for achieving adequate safety by minimising risks while handling hazardous chemicals during production, storage, transport, trading and use of chemicals.

Under these rules, the industries have been identified as ‘Major Accident Hazard’ based on exceeding threshold quantities of hazardous chemicals specified in Schedules 2 and 3 of the rules.

The Public Liability Insurance Act, 1991 was also promulgated, which mandates compulsory insurance for the purpose of providing immediate relief to persons affected by accidents that occur in handling any hazardous substance.

Are the changes in the Indian legislation enough to prevent another Bhopal?

After Bhopal, a number of serious chemical incidents took place in India. Some of them are listed in Table 1. The table indicates that incidents

involving hazardous chemicals still continue to occur in India. Many of the near miss chemical incidents go unreported.

Meanwhile, in the USA, after Bhopal and other disasters, the Process Safety Management System developed by Occupational Safety and Health Administration became mandatory in 1992 for industries handling, storing and manufacturing hazardous chemicals above a threshold quantity specified.

The PSM system comprises of 13 elements:

1. Process safety information
2. Process hazard analysis
3. Operating procedures
4. Contractor control
5. Pre start up safety review
6. Training
7. Hot work permit
8. Incident investigation
9. Mechanical integrity
10. Management of change
11. Emergency planning and response
12. Trade secrets
13. Compliance audits

Recently, incidents due to reactive chemicals have gained prominence in the USA. Based on the experience of adopting PSM for more than a decade in the USA, India must leapfrog to the latest PSM standards, adopt and enforce them in hazardous industries.

The enforcement of legislation by the Indian authorities must be made effective by training the law enforcers in the latest developments in risk prevention, inspection and management system audit techniques.

The safety officers employed in hazardous industries are mandatorily required to be trained in any of the Regional Labour Institutes across the country. However, during their training, they are not exposed to the latest trends in Process Safety Management Systems. This results in the inadequate knowledge of process safety issues and inability to solve them when they arise.

As per KPMG (2003) , the Indian Chemical Industry contributes to 6.7 % of India's GDP, with revenues of USD 28 billion. As per Indian Chemical Manufacturer's Organisation (website,2004) the industry has the following credits to its name:

- The Indian fertilizer industry is the fourth largest in the World.
- It is the largest manufacturer of pesticides in Asia, second only to Japan
- The Indian Pharmaceutical industry is the largest in the developing World.

The large scale players in the industry have been proactively adopting management systems for process safety, occupational health and environment. Though the Process Safety Management system is not mandated by Indian law, a number of chemical industries in India are voluntarily adopting the PSM system developed by OSHA, USA.

Process Safety Management is increasingly being woven into business strategy, during the project conceptualization stage itself.

While the large scale players are systematically adopting best practices in process safety management, the fragmented medium and small scale manufacturing sector is yet to systematically adopt process safety management.

Process Safety Information: design data and their limitations in the light of old plants:

The Process Safety Information is the heart of the PSM system. Indian chemical industry has a mix of old and new chemical manufacturing plants. For the old (plants of 10 years or more), critical process safety information like design basis of safety valves, safe operating limits, electrical area classification, reaction chemistry, reactivity data, thermal and chemical stability data are either missing or inadequate. These plants undergo constant modifications to increase productivity or process different grades of products. Lack of critical process safety information may cause a major incident later.

The old plants also suffer from a lack of knowledge management of previous R & D efforts. In the pharmaceutical sector, scale up of new molecules from

R & D lab to the manufacturing plant needs updated process safety information. Lack of such information have caused serious incidents.

In newer plants, while process safety information is available, in many cases, they are not kept updated. Piping and instrumentation drawings (P & ID's) and material and equipment specifications are prone to changes due to modifications. Unless a systematic system for managing changes is implemented, the process safety information does not get updated in a timely way. This results in Hazard and Operability studies being performed on old P & ID's.

Contractor safety in the Indian context:

As part of cost cutting initiatives, some of the organizations outsource activities like maintenance functions and operations activities like bagging and manual handling of products. In many of the activities that are outsourced, the contractor employs an unskilled worker. A contract employee in a developing nation like India displays a high risk taking ability, driven by his urge to earn his daily living. This leads to many accidents involving contractors. In many large Indian organizations that have implemented a contractor safety management program, it is observed that the most effective control programs are those which levy a monetary penalty for any safety violation by a contract worker.

In the context of the above, it is imperative that the regulations governing employment of contractors in hazardous chemical plants be strengthened. The safety training requirements for contractors working in hazardous areas of the plants must be defined and the contractor should be held accountable for the safety performance of his employees.

Emergency response planning and off site emergencies: limitations and problems faced:

The Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996 was introduced after the Bhopal disaster. Preparation of the on-site Emergency Plan by the Industry and Off-site Plan by the District Collector and the constitution of four-tier Crisis Groups at the Centre, State, District and Local level for management of chemical accidents are mandatory under these Rules. Based on the experience gained after the implementation of the rules, the following are observed:

- Specialised training in Chemical disaster management should be made mandatory for all members of the four tier crisis groups. Refresher training program for the members on latest crisis management techniques must be implemented.
- Policies for handling media communication during crisis management should be developed for the four crisis groups. Training on “communicating during emergencies” should be made mandatory to the personnel of the crisis committees.
- The results of the mock drills conducted by the Crisis committees need to be shared at a national level by establishing a national database. This database should be available to all members of the crisis committees.
- The Crisis Groups must critique every major incident for lessons learnt. These learnings must be shared with all crisis groups across the country.

Management of change in the light of globalisation and cost cutting initiatives:

The Indian Chemical Industry is gearing itself for the challenges from globalization. Managing change during these times is very important to prevent incidents. The cost cutting initiatives that are taken up need to undergo an effective management of change process. Managing changes to technology, facilities and personnel in a Chemical Industry are not the same as managing change in any other industry. The implications on safety are enormous. The Bhopal disaster stands a testimony to this.

Some of the issues facing the Indian Chemical Industry in managing change are:

- Reduction of personnel, as part of cost cutting initiatives, is not assessed for risk versus monetary gain. In many cases, the monetary gain overshadows the increased risk. This can lead to incidents caused by inadequate competence or manning.
- Some of the line managers view change management as an unnecessary burden. This results in ineffective management of change.
- While developing new products or modifying existing processes, lack of updated process safety information leads to assumptions. Due to time pressures, these assumptions are not validated.

- The importance of managing change is sometimes not stressed by top management. This results in the bypassing of systems to manage change.
- Knowledge management of changes is poorly handled, with ineffective training and poor sharing of information.

High personnel turnover and training:

The Indian chemical industry faces a paradox. While fresh chemical engineering graduates are available in plenty, experienced engineers leave the shores for lucrative jobs in the Middle East and Far East countries. Highly automated plants with redundant safety shutdown systems would not normally cause incidents. In some of these plants, in times of poor business performance, the integrity of such systems gets compromised.

Many of the batch processes in the industry are operated on manual control. Lack of trained personnel in such areas could cause a major accident.

Some of the industries have process simulators to effectively train their new recruits. But these are not available to everyone. The large scale plants in the Indian Chemical Industry should transit towards making simulator training compulsory for operators prior to manning the control room of plants.

Process Safety Training is still not given a focus in the medium and small scale plants. The Government should develop institutes which impart the basic process safety training at operator level.

Incident Investigation

Root cause analysis and human factors

Many of the Indian Chemical Plants have been certified to OHSAS 18001 (Occupational Health and safety management system). As part of its requirements, it requires an incident investigating system to be in place. Investigating a process safety incident requires proper training on root cause techniques and human factors. The investigation of human factors in process safety incidents should be made mandatory. The categorization of root causes of incidents needs to be discussed by top management to spot inherent weaknesses in the systems and take timely corrective action.

The need for a process incident database and knowledge management:
A number of incidents continue to occur in Chemical plants. Some of them are reported to the statutory authorities (Factory Inspectorate) as part of the legal rules framed under Factories Act. However, the lessons learnt from the incident are not available in a national database. In the USA, the Chemical Safety and Hazard Investigation Board, plays a very important role in investigating and sharing the results of these investigations.

In India, the Directorate General of Factory Advice Service and Labour Institute (DGFASLI), with its central and regional labour institutes, has the responsibility for providing technical advice to factory inspectorates on matters connected with the administration of the Factory Act. It is also responsible for undertaking the necessary research, training and educational activities related to the promotion of safety and health in factories. The DGFASLI should develop a National Process Safety Incident Database, based on the inputs from its inspectorates. This database should share lessons learnt from chemical plant incidents.

Improvements needed in the measurement and tracking of process safety performance

The “Responsible Care®” movement was started by chemical manufacturing industries in the developed countries after Bhopal and other incidents. This voluntary initiative is recently morphing to a “Responsible Care Management System®”, certifiable by third parties. In India, the Indian Chemical Manufacturers Association (ICMA) has actively encouraged its members to adopt the Responsible Care® movement. However, only 85 organisations have signed up to the initiative, when over 1000 industrial plants have been identified in the Maximum Accident Hazard category.

Measuring and tracking process safety performance needs a process safety management system in place. Performance metrics must be defined to monitor and measure the process safety performance of an organization. The process safety management system could be audited with performance metrics for each element of the system. Some of the examples are:

- Number of process related incidents that are repeated (Indicates poor quality of investigation or poor implementation of recommendations)

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- Number of top management reviews for process safety held as per schedule (Indicates top management commitment)
- Number of public complaints received (indicates the effective control over hazardous chemicals)
- Number of times a parameter for emission or effluent has exceeded legal norms.
- Number of times incidents have occurred due to bypassing of safety systems (Indicates line management's commitment towards safety)
- Number of times an equipment failure has triggered an incident (indicates the effectiveness of the mechanical integrity program)
- Number of incidents involving contractor workmen (Indicates the effectiveness of the contractor control program)

Industry Institution interaction and its need in the Indian context

After Bhopal, much remains to be done in improving industry – institution interaction.

The management of process safety should be dealt as a separate subject in all undergraduate courses of Chemical Engineering and Diploma in Chemical Technology. . Refresher courses in the latest management systems for process safety should be developed for working engineers and managers.

In institutions with good laboratory and research facilities, the pilot plant studies of new products and the potential problems during scale up are areas where interaction could be improved.

Terrorism and process safety:

Terrorism rears its ugly head worldwide. In India, the attack on the oil facility in Assam, last year, is one example. Chemical plants are potential targets for terrorist attacks. In India, the policy makers are yet to give a clear thought to this aspect. Security and process safety are interlinked. While the large plants in India do have some semblance of a security system in place, a security risk analysis should be made mandatory for all hazardous chemical factories, with an inventory of chemicals exceeding those specified in the Chemical Accidents (Emergency Planning, Preparedness and Response Rules), 1996. The risk analysis should also cover transportation of hazardous chemicals.

The results of these risk analysis should be incorporated in the emergency response plans of the organizations.

The Way Forward:

Has the land of Bhopal learnt the lessons from the World's worst Industrial disaster? From the author's perspective, a lot remains to be done in the realm of process safety to ensure that another Bhopal does not occur in India. Specifically, the following needs to be done in the areas of legislation and initiatives by the industry:

1. Legislation:

The implementation of a Process Safety Management System based on PSM standards developed must be made mandatory for all industries covered under the Chemical Accidents (Emergency Planning, Preparedness and Response Rules), 1996 . The standards must learn from the experience of the OSHA of USA and include the management of chemical reactivity hazards. Security risk analysis should be made mandatory under the PSM standard.

The enforcement of legislation by the Indian authorities must be made effective by training the law enforcers in the latest developments in risk prevention, inspection and management system audit techniques.

The Regional Labour Institutes who impart training for Safety Officers employed in hazardous industries should include Process Safety Management and reactive chemical hazards in their curriculum.

Specialised training in Chemical disaster management should be made mandatory for all members of the four tier crisis groups formed under the Chemical Accidents (Emergency Planning, Preparedness and Response Rules), 1996. Refresher training program for the members on latest crisis management techniques must be implemented.

Policies for handling media communication during crisis management should be developed for the four crisis groups formed under the Chemical Accidents (Emergency Planning, Preparedness and Response Rules), 1996. Training on "communicating during emergencies" should be made mandatory to the personnel of the crisis committees.

The safety regulations governing employment of contractors in hazardous chemical plants need to be strengthened.

The Government operated Technical Training Institutes should include Process Safety Training for those personnel who will be employed in Chemical plants.

2. Industry Initiatives:

- 2.1 A system to update and maintain Process Safety Information needs to be implemented
- 2.2 Contractor safety management systems must address the enforcement and accountability of contractors in the safety of their workers. The safety training requirements for contractors working in hazardous areas of the plants must be defined and the contractor should be held accountable for the safety performance of his employees.
- 2.3 Management of Change initiatives in the industry should focus on changing the attitudes of line management, assessing risks when reducing manpower and management of knowledge associated with the changes.
- 2.4 In large organizations, training of operators using simulators should be practiced for control room operators.
- 2.5 The investigation of incidents should account for human factors also. Sharing of the lessons learnt from Chemical Plant Incidents should be carried out through an Industry – Government initiative.
- 2.6 The tracking of process safety performance should be made as part of the industry's voluntary reporting to public.
- 2.7 Industry – Institution interaction should be strengthened in the areas of pilot plant studies and refresher courses for employees in process safety management need to be provided.

References:

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Table 1:*Chemical Incidents in India after Bhopal*

Location	Year	Origin of incident	Chemical involved	Number of		
				Deaths	Injured	Evacuated
Cochin	1985	Release	Hexacyclopentadiene	-	200	-
New Delhi	1985	Release	Sulphuric acid	1	340	>10
Bombay	1988	Fire in refinery	Oil	35	16	-
Bhatinda	1989	Leakage	Ammonia	-	500	-
Nagothane	1990	Leakage	Ethane and propane	32	22	-
Calcutta	1991	Leakage from a pipeline	Chlorine	-	200	-
Vishakhapatnam	1997	Refinery fire	LPG	60	31	150000
Vellore	2003	Explosion	Explosives	25	3	
Mohali	2003	Fire	Not known	4	25	-
Cochin	2004	Fire	Toluene	-	Not known	-