

# [Worst industrial disaster](https://assignbuster.com/worst-industrial-disaster/)

### Abstract

Bhopal disaster was the worst industrial disaster in the world. On 3rd December, approximately 40 tons of hazardous methyl isocyanate (MIC) was accidentally leaked into the densely population in Bhopal, India. Thousands of people were killed immediately in this accident and many of the survivors still suffering from respiratory illness and permanent injuries. Lack of site maintenance was the primary contributing factors to the catastrophe. However, Union Carbide Corporation tried to shrug off the responsibility for this accident and claimed that the disaster was created by a disgruntled worker. About $470 million dollar had paid to the India government and the victims of the tragedy. The underground water around the plant was polluted because the company had refused to take the cleanup process to remove the remaining chemical lay in the site after the accident. The major causes and effects of the Bhopal disaster were the reminder to other industrial managements for preventing the similar accident and also to highlight the safety and health in industrial operation.

### 1. Introduction

The demand of the pesticides was extremely high in between 1956 and 1970 in India because of the effect of Green Revolution which is a scheme used by India government to increase productivity of the crops by using high modern input such as high yielding seed, machinery, fertilizers, and pesticides (Matilal & Hopfl, 2009). Thus, Union Carbide Corporation (UCC) decided to built up pesticides plant in Bhopal, India, as a joint venture with India investors

Bhopal plant was owned by UCC, but it was operated by its subsidiary Union Carbide India Limited (UCIL). At the time of Bhopal disaster UCC was the 7th largest chemical company in United Stated mainly in producing heavy chemicals, pesticides, batteries, carbon products, and plastics. Similarly, UCIL was a diversified company in India and 10, 000 people were hired at 13 manufacturing units producing batteries and pesticides (Patwardhan, 2004).

UCC built up pesticide plant in Bhopal, India because of its central location. The railway station and the Upper Lake of Bhopal was close to the plant, which provided adequate water source to the plant and the railway system was readily spanned over the major city of India like Bombay and Calcutta (Matila & Hopfl, 2009). In addition, cheap operating cost, and labor cost were offered in developing country particularly in India (TED case studies, 1996). Bhopal plant was welcomed because the company offered job opportunity to the local community.

Initially, the primary objective of the UCIL plant was to manufacture pesticides for use in agricultural purpose and provide sufficient pesticides to India market (Browning, 1993). UCC began losing money because the plant had problems of profitability resulted in reduction cost of maintenance and safety and health of the plant and also was the main contributing factor to the gas tragedy.

There were 800, 000 residents in Bhopal at that time, approximately 2, 000 people died immediately, and 300, 000 people were injured. Five year later, a series of studies have showed that, many of the survivors now live with ailments such as partial or complete blindness, gastrointestinal disorders, impaired immune system, post traumatic stress disorders, and menstrual problem in women (Sullivan, 1998).

Eventually, the report of Browning, a retired vice president, health safety, and environmental program of UCC (1993) stated that $470 million dollars was paid to India government and the victims of the tragedy in February 1989 as the final settlement for the litigation of this accident.

This topics will be covered in this study are the management structure of the company and its objectives. The major causes and effect of the disaster will also be covered. Further improvements are also suggested in this study to prevent the similar accident.

### 2. Management and Operation

### 2. 1. The Management and its Structure

The UCIL plant was owned 50. 9 % by Union Carbide and 49. 1% by the Indian investors (Eckerman, 2005). Bhopal plant was one of the divisions of UCIL and this plant was a key facility to manufacture the agricultural products. Managerial control over UCIL and other Asian affiliates was exercised by Union Carbide Eastern (UCE), a wholly owned subsidiary of UCC based in Hong Kong but this subsidiary was incorporated in Delware, US. At first, UCIL was reported to UCE and the reports were then handover to UCC headquarters in Danbury, US by UCE (Bhopal Industrial Accident, 2008).

In the early year, the plant was managed by the employees from USA. Afterward, it was turned over to Indian managers in 1982 due to the pressure of the India government. There was no direct reporting relationship between the UCC's headquarter and UCIL plant. However, the safety audits from UCC would visit the UCIL plant twice a year to perform the safety inspections. The status of UCIL plant had seldom reported to the managers in USA. Thus, the Bhopal plant was operated independently by the local management. (Steiner, 2005)

### 2. 2. The Objective of the Management

The primary objective of UCC management was an attempt to profit from green revolution and produce pesticide to boost the agricultural economy in India (Patwardhan, 2004). However, the objective of India government was to provide job opportunity to the people of India.

### 3. Industrial Processes

The essential material to manufacture Sevin (carbarly) was MIC and its process is shown in Figure 3. 1. Initially, methylcarbamoyl chloride (CH3NHCOCI) plus hydrogen chloride (HCI) were formed by reacting phosgene with methylamine (CH3NH2). Afterward, methylcarbomoyl was pyrolyzed to form methyl isocyanate (CH3NCO) and HCI. Finally, MIC was reacted with alpha-naphthol to obtain the final product which is Sevin (Lees, 1996).

Basically, the MIC storage system consisted of three storage tanks, two for normal use and one for emergency use. A 30 tons refrigeration system was provided to keep MIC at 0°C to avoid the MIC gases from overheating. Each storage tank was controlled by pressure controller and safety valve, high temperature alarm, and high and low level alarms were also installed. The vent gas scrubber (VGS) and flare were also installed to handle the leaked gas. The primary function of VGS was to receive the contaminated MIC (either in vapour or liquid form) and destroying it in the controlled manner (Lees, 1996). The VGS was also used to neutralize leaked MIC gases with caustic soda. Similarly, the flare was used to handle vented gases from the MIC storage tanks via flame neutralization (Peterson, 2009).

### 4. Causes of Accident

### 4. 1. Human Factors

The improper behavior of management of UCC resulted cost-cutting in manpower (Chouhan, 2005). The permanent work forces reduced from 859 to 642. The MIC plant operators were also reduced in every shift from eleven to five and the maintenance staff was also cut from four to two (Matilal & Hopfl 2009). For that, the maintenance work in the flare tower which is prime importance in eliminating dangerous MIC gases could not be completed within 8 hours because of the shortage of staff (Chouhan, 2005).

Besides that, the operators in the MIC plant did not have sufficient training and qualification to handle the MIC because the duration of training had been shortened from 18 to 2 months (Chouhan, 2005). Moreover, the lax implementation of safety and maintenance procedures had allowed the contaminants entered the MIC tanks for 6 weeks and thus the precondition for the accident was formed (Shrivastava, 1995).

In addition, Ingrid Eckerman (2001) pointed out that major hazards was found in the MIC units and the safety audits from the American parent company also had highlighted that the workers performance and safety standard in Bhopal plant were below the American standards in 1982. However, the UCIL was ready to take action on it, but UCC never sent professional to follow up this.

### 4. 2. Design and Process Factors

The location of UCIL plant was too close to the heavy populated area. This settlement was actually illegal but the India government had denied it (Lees, 1996). The UCIL plant design especially the safety systems was not constructed according to the West Virginia plant in US. In general, the design and technology was not sufficient to prevent runaway reaction and contamination (Chouhan, 2005).

Besides that, the jumper line, a connection between the process vent header and the relief valve vend header was installed to the plant without the inspection of the professional lead the water entered into MIC storage tank through this jumper line (Lees, 1996). In addition, a dangerous manufacturing process was used to produce pesticide by reacting MIC and alpha-naphthol (Matilal & Hopfl, 2009)

### 4. 3. Root Factors

Despite many newspaper articles regarding the predicting disaster of Bhopal plant were published, the India government still did not act tough on earlier accident because of the mutual benefit between Indian government and UCC. However, UCC had realized that the Bhopal plant was unprofitable but the company tried to make it profitable by shutting down the major safety systems (Gupta, 2002).

In addition, the communication between the local community and company was poor. Insufficient information about the potential impacts of the hazardous chemical that being produced to the community and site operators before the accident (Willey, Hendershot & Berger, 2006).

### 4. 4. Safety

According to T. R. Chouhan, ex-MIC plant operator, Bhopal (2005), the vent gas scrubber was designed to neutralize the toxic gases that come from the MIC tank. Unfortunately, it was not capable in handling the leaked gas.

On the other hand, suppose the flare tower was capable in burning out all of the excessive carbon monoxide and MIC vapors at the manageable level but it was not at the time of the incident. MIC storage 30 tons refrigeration system had been shut down for a couple of time to save electricity. This system was actually used to maintain the temperature of MIC below 5°C to prevent runaway reaction (Chouhan, 2005)

In addition, the warning alarm which is designed for the community was not functioning and caused the residents in Bhopal unaware from the leak accident. Lastly, there was no emergency plan for the community of Bhopal and the community was not told about the gas leakage after the accident. (Chouhan, 2005)

### 5. Consequences of the Effects of the Accident

### 5. 1. Health

About 3, 928 people were killed in the Bhopal disaster (Eckerman, 2001). The article (Devraj, 2004) reported that the victims who treated in Hamida hospital after the accident were 99% suffered from breathing problem, 86% had eye problems and 91% faced gastrointestinal problem. Cancer was also found in some Bhopal victims. Many children were born after the disaster with deformities such as cleft palate, three eyes, all finger joined, one extra finger, and different skull shapes (Sharma, 2002). Besides that, women's reproductive health was affected. The miscarriage rate increases dramatically and the spontaneous abortion rate was increase from three to four time (Eckerman, 2001). Similarly, infertile also occurs in men' reproductive system (Devraj, 2004).

### 5. 2. Environment and Ecology

Water pollution was also found. The underground water in Bhopal was polluted by the abandoned chemicals in the factory after the disaster and it was not safe for drinking (Willey, Hendershot & Berger, 2006). Large amount of cattle in the affected area were killed. The plant life was severely damaged and widespread defoliation of tree was also occurred (Ted Case Studies, 1996).

### 5. 3. Damage Costs/Compensation Costs

The $28 million UCIL plant was closed in India and caused the 650 workers lost their jobs. All local business and state government offices were closed for three weeks and resulted in losing of business (Shrivastava, n. d). Each dead individual was paid $800 and $100 for each hospitalized member of the family by India government. Union Carbide had to compensate $470 million to the damage caused in this accident (Varma, 2005).

### 6. Improvements and Preventions

### 6. 1. Design and Process

The local government of Bhopal should strictly avoid the hazardous industry set up in the urban area (Broughton, 2005). Besides that, a modification by removing the jumper line in piping system is required to avoid the water near to the MIC storage tanks (Kletz, 1999).

In addition, the replacement of the hazardous MIC with less hazardous material in manufacturing process of pesticide is one of the alternative choices. The good emergency plan should be designed to the neighbor community.

### 6. 2. Human Resource

The roles (Who will be responsible for the safety matter) of both parties (UCC & Indian investors) should be stated clearly before the UCIL plant starts working to avoid the dissociate responsibility after the accident. A quality training program should be provided to enhance the worker skill in handling the hazardous MIC substances before going into operation (Lees, 1996). Similarly, the company should ensure that the new recruits are meeting the standard.

In addition, the managers and supervisors should always pay enough attention to the safety and maintenance procedures and ensure that the operators are carrying out the maintenance works regularly.

### 6. 3. Safety and Health

India government should strengthen the safety regulations in their own country so that they will not vulnerable to industrial crisis. Besides that, the management should ensures that all the safety equipments should be working properly during the operation especially the MIC storage tanks and safety systems such as the refrigeration, scrubbing, and the flare should be inspected regularly and thus the precondition of disaster will be reduce significantly (Kletz, 1999).

On the other hand, all hazardous materials used to produce Sevin should be registered with the local emergency authorities, and its biochemical reactions in human tissue also should be examined clearly before releasing the license to the manufacturers. (Acquilla, 2005)

Moreover, the company should provide sufficient public information regarding the hazardous MIC to the community around the plant area through the local media such as radio, and newspapers so that the community will able to take appropriate emergency evacuation and proper action in case the accident happens.

In addition, research on new technologies and management practices should be carried on regularly to improve the safety standards for managing the industrial hazards. Lastly, the information regarding the causes and effects of the chemical contains are to be published to raise the safety awareness of the hazard (Conference Report, 2005).

### 7. Conclusion

The lesson of Bhopal disaster is a wake-up call of industrial crisis in developing country particularly in India. However, upgrading the safety equipments is more preferable rather than ignoring it. Although, the cost in upgrading the safety systems is very expensive but by doing this, the company would have minor cost incurred in medical claims, environmental clean-up and safety and health litigation. Additionally, a safety working environment will make the workers more willingly to perform confidently and motivated.

Even though multi-national company is welcomed to invest in developing country but the safety principles should never be ignored. However, the local government itself and international agency such as Occupational Safety and Health Administration (OSHA) should strengthen the safety regulations and standard especially in plant location and design.

Moreover, the main cause of Bhopal disaster was still uncertainty. The corporate policy should be stated as clearly as possible so that no arguments will be made in evading the responsibility for both corporate shareholders after the accident. However, based on the environmental consideration, closing the plant would be the better solution rather than ignoring the safety principles when there is no other alternative choice to get recovery from the lost investment.

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