A

Disaster Management (HUL2101) Study Report

On

"Bhopal Gas Tragedy"

Submitted

To

School of Applied Sciences

By

(15CSEB114)

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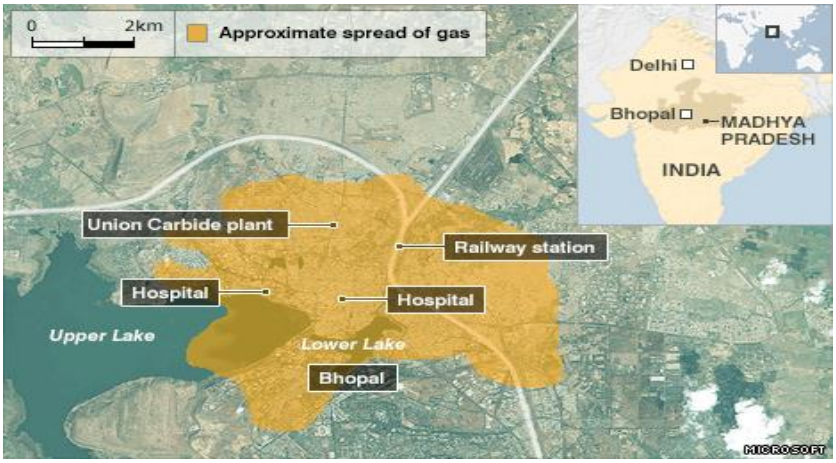
INTRODUCTION

In the early morning hours of December 3, 1984, a poisonous grey cloud (forty tons of toxic gases) from Union Carbide India Limited (UCIL's) pesticide plant at Bhopal spread throughout the city. Water carrying catalytic material had entered Methyl Isocyanate (MIC) storage tank No. 610. What followed was a nightmare. The killer gas spread through the city, sending residents scurrying through the dark streets. No alarm ever sounded a warning and no evacuation plan was prepared. When victims arrived at hospitals breathless and blind, doctors did not know how to treat them, as UCIL had not provided emergency information.

It was only when the sun rose the next morning that the magnitude of the devastation was clear. Dead bodies of humans and animals blocked the streets, leaves turned black, the smell of burning chilli peppers lingered in the air. Estimates suggested that as many as 10,000 may have died immediately and 30,000 to 50,000 were too ill to ever return to their jobs. The catastrophe raised some serious ethical issues. The pesticide factory was built in the midst of densely populated settlements. UCIL chose to store and produce MIC, one of the most deadly chemicals (permitted exposure levels in USA and Britain are 0.02 parts per million), in an area where nearly 120,000 people lived. The MIC plant was not designed to handle a runaway reaction. When the uncontrolled reaction started, MIC was flowing through the scrubber (meant to neutralize MIC emissions) at more than 200 times its designed capacity. MIC in the tank was filled to 87% of its capacity while the maximum permissible was 50%. MIC was not stored at zero degree centigrade as prescribed and the refrigeration and cooling systems had been shut down five months before the disaster, as part of UCC's global economy drive. Vital gauges and indicators in the MIC tank were defective. The flare tower meant to burn off MIC emissions was under repair at the time of the disaster and the scrubber contained no caustic soda. As part of UCC's drive to cut costs, the work force in the Bhopal factory was brought down by half from 1980 to 1984. This had serious consequences on safety and maintenance. The size of the work crew for the MIC plant was cut in half from twelve to six workers. The maintenance supervisor position had been eliminated and there was no maintenance supervisor. The period of safety-training to workers in the MIC plant was brought down from 6 months to 15 days.

THE AFFECTED AREA

The Bhopal disaster, also referred to as the Bhopal gas tragedy, was a gas leak incident in India, considered the world's worst industrial disaster. It occurred on the night of 2–3 December 1984 at the Union Carbide India Limited (UCIL) pesticide plant in **Bhopal, Madhya Pradesh**. Over 500,000 people were exposed to methyl isocyanate (MIC) gas and other chemicals. The toxic substance made its way into and around the shanty towns located near the plant .Estimates vary on the death toll. The official immediate death toll was 2,259. The government of Madhya Pradesh confirmed a total of 3,787 deaths related to the gas release. A government affidavit in 2006 stated that the leak caused 558,125 injuries, including 38,478 temporary partial injuries and approximately 3,900 severely and permanently disabling injuries. Others estimate that 8,000 died within two weeks, and another 8,000 or more have since died from gas-related diseases. Within a few days, trees in the vicinity became barren and bloated animal carcasses had to be disposed of. 170,000 people were treated at hospitals and temporary dispensaries; 2,000 buffalo, goats, and other animals were collected and buried. Supplies, including food, became scarce owing to suppliers' safety fears. Fishing was prohibited causing further supply shortages. It was estimated that 50,000 persons need alternative jobs, and that less than 100 gas victims had found regular employment under the government's scheme. The government also planned 2,486 flats in two- and four-story buildings in what is called the "widow's colony" outside Bhopal. The water did not reach the upper floors and it was not possible to keep cattle which were their primary occupation. Infrastructure like buses, schools, etc. were missing.



Leakage & Its Consequences

The Bhopal UCIL facility housed three underground 15000 gallon liquid MIC storage tanks: E610, E611, and E619. In the months leading up to the December leak, liquid MIC production was in progress and being used to fill these tanks. UCC safety regulations specified that no one tank should be filled more than 50% (here, 30 tons) with liquid MIC. Each tank was pressurized with inert nitrogen gas. This pressurization allowed liquid MIC to be pumped out of each tank as needed, and also kept impurities out of the tanks.

In late October 1984, tank E610 lost the ability to hold most of its nitrogen gas pressure. It meant that the liquid MIC contained within could not be pumped out. At the time of this failure, tank E610 contained 42 tons of liquid MIC. Shortly after this failure, MIC production was halted at the Bhopal facility, and parts of the plant were shut down for maintenance. Maintenance included the shutdown of the plant's flare tower so that a corroded pipe could be repaired. With the flare tower still out of service, production of carboryl was resumed in late November, using MIC stored in the two tanks still in service. An attempt to re-establish pressure in tank E610 on 1 December failed, so the 42 tons of liquid MIC contained within still could not be pumped out of it.

Consequences

The initial effects of exposure were coughing, severe eye irritation and a feeling of suffocation, burning in the respiratory tract, blepharospasm, breathlessness, stomach pains and vomiting. People awakened by these symptoms fled away from the plant. Those who ran inhaled more than those who had a vehicle to ride. Owing to their height, children and other people of shorter stature inhaled higher concentrations.

Thousands of people had died by the following morning.

Primary causes of deaths were choking, reflexogenic circulatory collapse and pulmonary oedema. Findings during autopsies revealed changes not only in the lungs but also cerebral

oedema, tubular necrosis of the kidneys, fatty degeneration of the liver and necrotisingenteritis. The stillbirth rate increased by up to 300% and neonatal mortality rate by around 200%.

Immediate aftermath

In the immediate aftermath, the plant was closed to outsiders (including UCC) by the Indian government, which subsequently failed to make data public, contributing to the confusion. The initial investigation was conducted entirely by the Council of Scientific and Industrial Research (CSIR) and the Central Bureau of Investigation. The UCC chairman and CEO Warren Anderson, together with a technical team, immediately travelled to India. Upon arrival Anderson was placed under house arrest and urged by the Indian government to leave the country within 24 hours. Union Carbide organized a team of international medical experts, as well as supplies and equipment, to work with the local Bhopal medical community, and the UCC technical team began assessing the cause of the gas leak.

The health care system immediately became overloaded. In the severely affected areas, nearly 70 percent were underqualified doctors. Medical staff were unprepared for the thousands of casualties. Doctors and hospitals were not aware of proper treatment methods for MIC gas inhalation

There were mass funerals and cremations. Photographer Pablo Bartholemew, on commission with press agency Rapho , took an iconic colour photograph of a burial on December 4, *Bhopal gas disaster girl.* Another photographer present, Raghu Rai, took a black and white photo. The photographers did not ask for the identity of the father or child as she was buried, and no relative has since confirmed it. As such, the identity of the girl remains unknown. Both photos became symbolic of the suffering of victims of the Bhopal disaster, and Bartholomew's went on to win the 1984 World Press Photo of the Year.

Bhopal disaster girl (Pablo Bartholemew)

Within a few days, trees in the vicinity became barren and bloated animal carcasses had to be disposed of. 170,000 people were treated at hospitals and temporary dispensaries; 2,000 buffalo, goats, and other animals were collected and buried. Supplies, including food, became scarce owing to suppliers' safety fears. Fishing was prohibited causing further supply shortages.

Lacking any safe alternative, on 16 December, tanks 611 and 619 were emptied of the remaining MIC by reactivating the plant and continuing the manufacture of pesticide. Despite safety precautions such as having water carrying helicopters continually overflying the plant, this led to a second mass evacuation from Bhopal. The Government of India passed the "Bhopal Gas Leak Disaster Act" that gave the government rights to represent all victims, whether or not in India. Complaints of lack of information or misinformation were widespread. An Indian government spokesman said, "Carbide is more interested in getting information from us than in helping our relief work".

Formal statements were issued that air, water, vegetation and foodstuffs were safe, but warned not to consume fish. The number of children exposed to the gases was at least 200,000. Within weeks, the State Government established a number of hospitals, clinics and mobile units in the gas-affected area to treat the victims.

Long-term health effects

A total of 36 wards were marked by the authorities as being "gas affected," affecting a population of 520,000. Of these, 200,000 were below 15 years of age, and 3,000 were pregnant women. The official immediate death toll was 2,259, and in 1991, 3,928 deaths had been officially certified. Ingrid Eckerman estimated 8,000 died within two weeks.

The government of Madhya Pradesh confirmed a total of 3,787 deaths related to the gas release.

Later, the affected area was expanded to include 700,000 citizens. A government affidavit in 2006 stated the leak caused 558,125 injuries including 38,478 temporary partial injuries and approximately 3,900 severely and permanently disabling injuries.

A cohort of 80,021 exposed people was registered, along with a control group, a cohort of 15,931 people from areas not exposed to MIC. Nearly every year since 1986, they have answered the same questionnaire. It shows overmortality and overmorbidity in the exposed group. Bias and confounding factors cannot be excluded from the study. Because of migration and other factors, 75% of the cohort is lost, as the ones who moved out are not followed.

A number of clinical studies are performed. The quality varies, but the different reports support each other. Studied and reported long term health effects are:

- Eyes: Chronic conjunctivitis, scars on cornea, corneal opacities, early cataracts
- Respiratory tracts: Obstructive and/or restrictive disease, pulmonary fibrosis, aggravation of TB and chronic bronchitis
- Neurological system: Impairment of memory, finer motor skills, numbness etc.
- Psychological problems: Post traumatic stress disorder (PTSD)
- Children's health: Peri- and neonatal death rates increased. Failure to grow, intellectual impairment, etc.

Missing or insufficient fields for research are female reproduction, chromosomal aberrations, cancer, immune deficiency, neurological sequelae, post traumatic stress disorder (PTSD) and children born after the disaster. Late cases that might never be

highlighted are respiratory insufficiency, cardiac insufficiency (cor pulmonale), cancer and tuberculosis.

A 2014 report in *Mother Jones* quotes a "spokesperson for the Bhopal Medical Appeal, which runs free health clinics for survivors" as saying "An estimated 120,000 to 150,000 survivors still struggle with serious medical conditions including nerve damage, growth problems, gynecological disorders, respiratory issues, birth defects, and elevated rates of cancer and tuberculosis.

Causes of the disaster: overview

There are two main lines of argument involving the disaster. The "Corporate Negligence" point of view argues that the disaster was caused by a potent combination of under-maintained and decaying facilities, a weak attitude towards safety, and an undertrained workforce, culminating in worker actions that inadvertently enabled water to penetrate the MIC tanks in the absence of properly working safeguards.

The "Worker Sabotage" point of view argues that it was not physically possible for the water to enter the tank without concerted human effort, and that extensive testimony and engineering analysis leads to a conclusion that water entered the tank when a rogue individual employee hooked a water hose directly to an empty valve on the side of the tank. This point of view further argues that the Indian government took extensive actions to hide this possibility in order to attach blame to UCC.

Theories differ as to how the water entered the tank. At the time, workers were cleaning out a clogged pipe with water about 400 feet from the tank. They claimed that they were not told to isolate the tank with a pipe slip-blind plate. The operators assumed that owing to bad maintenance and leaking valves, it was possible for the water to leak into the tank.

This water entry route could not be reproduced despite strenuous efforts by motivated parties. UCC claims that a "disgruntled worker" deliberately connecting a hose to a pressure gauge connection was the real cause.

Early the next morning, a UCIL manager asked the instrument engineer to replace the gauge. UCIL's investigation team found no evidence of the necessary connection; the investigation was totally controlled by the government, denying UCC investigators access to the tank or interviews with the operators.

Causes of the disaster: The "corporate negligence" argument

This point of view argues that management (and to some extent, local government) underinvested in safety, which allowed for a dangerous working environment to develop. Factors cited include the filling of the MIC tanks beyond recommended levels, poor maintenance after the plant ceased MIC production at the end of 1984, allowing several safety systems to be inoperable due to poor maintenance, and switching off safety systems to save money— including the MIC tank refrigeration system which could have mitigated the disaster severity, and non-existent catastrophe management plans. Other factors identified by government inquiries included undersized safety devices and the dependence on manual operations. Specific plant management deficiencies that were identified include the lack of skilled operators, reduction of safety management, insufficient maintenance, and inadequate emergency action plans.

Causes of the disaster: the "disgruntled employee sabotage" case

Now owned by Dow Chemical Company, Union Carbide maintains a website dedicated to the tragedy and claims that the incident was the result of sabotage, stating that sufficient safety systems were in place and operative to prevent the intrusion of water. **The impossibility of the "negligence" argument**

According to the "Corporate Negligence" argument, workers had been cleaning out pipes with water nearby. This water was diverted due to a combination of improper maintenance, leaking and clogging, and eventually ended up in the MIC storage tank. Indian scientists also suggested that additional water might have been introduced as a "back-flow" from a defectively designed vent-gas scrubber. None of these theoretical routes of entry were ever successfully demonstrated during tests by the Central Bureau of Investigators (CBI) and UCIL engineers.

An analysis by Arthur D. Little argues that the Negligence argument was impossible for several tangible reasons:

1. The pipes being used by the nearby workers were only 1/2 inch in diameter and were physically incapable of producing enough hydraulic pressure to raise water the more than 10 feet that would have been necessary to enable the water to "backflow" into the MIC tank.
2. A key intermediate valve would have had to be open for the Negligence argument to apply. This valve was "tagged" closed, meaning that it had been inspected and found to be closed. While it is possible for open valves to clog over time, the only way a closed valve allows penetration is if there is leakage, and 1985 tests carried out by the government of India found this valve to be non-leaking.
3. In order for water to have reached the MIC tank from the pipe-cleaning area, it would have had to flow through a significant network of pipes ranging from 6 to 8 inches in diameter, before rising ten feet and flowing into the MIC tank. Had this occurred, most of the water that was in those pipes at the time the tank had its critical reaction would have remained in those pipes, as there was no drain for them.

Additional Union Carbide actions

The corporation denied the claim that the valves on the tank were malfunctioning, and claimed that the documented evidence gathered after the incident showed that the valve close to the plant's water-washing operation was closed and was leak-tight. Furthermore, process safety systems had prevented water from entering the tank by accident. Carbide states that the safety concerns identified in 1982 were all allayed before 1984 and had nothing to do with the incident.

The company admitted that the safety systems in place would not have been able to prevent a chemical reaction of that magnitude from causing a leak. According to Carbide, "in designing the plant's safety systems, a chemical reaction of this magnitude was not factored in" because "the tank's gas storage system was designed to automatically prevent such a

large amount of water from being inadvertently introduced into the system" and "process safety systems—in place and operational—would have prevented water from entering the tank by accident". Instead, they claim that "employee sabotage—not faulty design or operation—was the cause of the tragedy".

Tactical response

The company stresses the immediate action taken after the disaster and its continued commitment to helping the victims. On 4 December, the day following the leak, Union Carbide sent material aid and several international medical experts to assist the medical facilities in Bhopal.

Financial response

The primary financial restitution paid by UCC was negotiated in 1989, when the Indian Supreme Court approved a settlement of US$470 million (₹1,055 crore (equivalent to₹79 billion or US$1.2 billion in 2016)). This amount was immediately paid by UCC to the Indian government. The company states that the restitution paid "was $120 million more than plaintiffs' lawyers had told U.S. courts was fair" and that the Indian Supreme Court stated in its opinion that "compensation levels under the settlement were far greater then

and would normally be payable under Indian law".

In the immediate aftermath of the disaster, Union Carbide states on its website that it put $2 million into the Indian prime minister's immediate disaster relief fund on 11 December 1984. The corporation established the Employees' Bhopal Relief Fund in February 1985, which raised more than $5 million for immediate relief. According to Union Carbide, in August 1987, they made an additional $4.6 million in humanitarian interim relief available.

Union Carbide stated that it also undertook several steps to provide continuing aid to the victims of the Bhopal disaster. The sale of its 50.9 percent interest in UCIL in April 1992 and establishment of a charitable trust to contribute to the building of a local hospital. The sale was finalised in November 1994. The hospital was begun in October 1995 and was opened in 2001. The company provided a fund with around $90 million from sale of its UCIL stock. In 1991, the trust had amounted approximately $100 million. The hospital catered for the treatment of heart, lung and eye problems. UCC also provided a $2.2 million grant to Arizona State University to establish a vocational-technical centre in Bhopal, which was

opened, but was later closed by the state government. They also donated $5 million to the Indian Red Cross after the disaster. They also developed a Responsible Care system with other members of the chemical industry as a response to the Bhopal crisis, which was designed to help prevent such an event in the future.

Charges against UCC and UCIL employees

UCC chairman and CEO Warren Anderson was arrested and released on bail by the Madhya Pradesh Police in Bhopal on 7 December 1984. Anderson was taken to UCC's house after which he was released six hours later on $2,100 bail and flown out on a government plane. These actions were allegedly taken under the direction of then chief secretary of the state, who was possibly instructed from chief minister's office, who himself flew out of Bhopal immediately. Later in 1987, the Indian government summoned Anderson, eight other executives and two company affiliates with homicide charges to appear in Indian court. In response, Union Carbide said the company is not under Indian jurisdiction.

From 2014, Dow is a named respondent in a number of ongoing cases arising from Union Carbide's business in Bhopal.

Fiction

In 1999, a Hindi film dealing with the tragedy. *Bhopal Express*, was released. The film stars Kay Kay Menon and Naseeruddin Shah.

Amulya Malladi's 2002 novel *A Breath of Fresh Air* relates the story of a mother and son who develop health issues as a result of exposure to gas at Bhopal. The book is based on Malladi's recollections of Bhopal during the incident.

Indra Sinha released *Animal's People* in 2007. The novel tells the story of a boy who is born with a spinal condition due to effects of the gas. The book was shortlisted for the Man Booker Prize.

In 2014, to coincide with the 30th anniversary of the disaster, historical-drama *Bhopal: A Prayer for Rain* was released, starring Martin Sheen as Union Carbide CEO Warren Anderson, Kal Penn, and Mischa Barton. The film earned global praise and *LA Times* critic Martin Tsai said the film was "ambitious and shattering" and that "Although the real-life events took place three decades ago, the cautionary tale could not be more relevant.

Activism

Since 1984, individual activists have played a role in the aftermath of the tragedy. The best-known is Satinath Sarangi (Sathyu), a metallurgic engineer who arrived at Bhopal the day after the leakage. He founded several activist groups, as well as Sambhavna Trust, the clinic for gas affected patients, where he is the manager. Other activists include Rashida Bee and Champa Devi Shukla, who received the Goldman Prize in 2004, Abdul Jabbar and Rachna Dhingra.

Local activism

Soon after the accident, representatives from different activist groups arrived. The activists worked on organising the gas victims, which led to violent repression from the police and the government.

Numerous actions have been performed: demonstrations, sit-ins, hunger strikes, marches combined with pamphlets, books, and articles. Every anniversary, actions are performed. Often these include marches around Old Bhopal, ending with burning an effigy of Warren Anderson.

International activism

Cooperation with international NGOs including Pesticide Action Network UK and Greenpeace started soon after the tragedy. One of the earliest reports is the Trade Union report from ILO 1985.

In 1992, a session of the Permanent Peoples' Tribunal on Industrial Hazards and Human Rights took place in Bhopal, and in 1996, the "Charter on Industrial Hazards and Human Rights" was adopted.

In 1994, the International Medical Commission on Bhopal (IMCB) met in Bhopal. Their work contributed to long term health effects being officially recognised.

Important international actions have been the tour to Europe and United States in 2003, the marches to Delhi in 2006 and 2008, all including hunger strikes, and the Bhopal Europe Bus Tour in 2009.

Some of the most important organisations are:

- International Campaign for Justice in Bhopal (ICJB), coordinates international activities.
- Bhopal Medical Appeal, collects funds for the Sambhavna Trust.
- Sambhavna Trust or Bhopal People's Health and Documentation Clinic. Provides medical care for gas affected patients and those living in water-contaminated area.
- Chingari Trust, provides medical care for children being born in Bhopal with malformations and brain damages.
- Students for Bhopal, based in USA.
- International Medical Commission on Bhopal, provided medical information 1994–2000.

End of Report.