DISASTER MITIGATION AND MANAGEMENT

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Bhopal Gas Tragedy

-The Night Of Death

INTRO

Bhopal disaster, chemical leak in 1984 in the city of Bhopal, Madhya Pradesh state, India. At the time, it was called the worst industrial accident in history. On December 3, 1984, about 45 tons of the dangerous gas methyl isocyanate escaped from an insecticide plant that was owned by the Indian subsidiary of the American firm Union Carbide Corporation. The gas drifted over the densely populated neighbourhoods around the plant, killing thousands of people immediately and creating a panic as tens of thousands of others attempted to flee Bhopal. The final death toll was estimated to be between 15,000 and 20,000.

Some half a million survivors suffered respiratory problems, eye irritation or blindness, and other maladies resulting from exposure to the toxic gas; many were awarded compensation of a few hundred dollars. Investigations later established that substandard operating and safety procedures at the understaffed plant had led to the catastrophe. In 1998 the former factory site was turned over to the state of Madhya Pradesh. (Britannica, 2020)

Bhopal

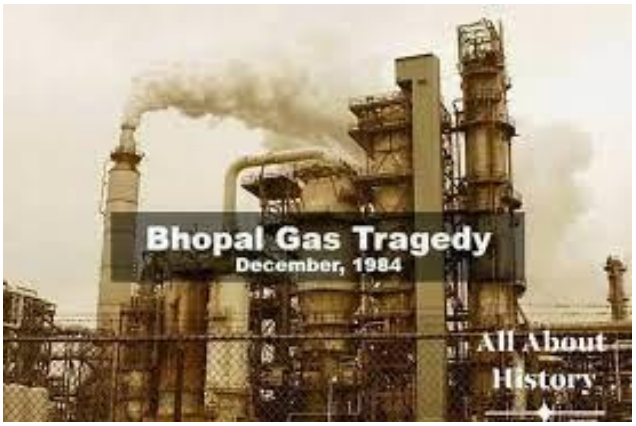
Bhopal, city, capital of Madhya Pradesh state, central India. Situated in the fertile plain of the Malwa Plateau, the city lies just north of the Vindhya Range, along the slopes of a sandstone ridge. It is a major rail junction and has an airport. Pop. (2001) 1,437,354; (2011) 1,798,218.

History

Bhopal was formerly a part of Bhopal princely state, which was founded in 1723 by Dōst Moḥammad Khan, an Afghan adventurer, and was the second largest Muslim principality of the British Empire. In its struggles with the Marathas, Bhopal was friendly to the British and concluded a treaty with them at the outbreak of the Pindari War in 1817. The Bhopal Agency, created in 1818, was a subdivision of the British Central India Agency and comprised the princely states of Bhopal, Rajgarh, Narsinghgarh, and several others. The headquarters was at Sehore.

Bhopal was constituted a municipality in 1903. At India's independence in 1947, Bhopal remained a separate province until 1949, when it acceded to India. In 1952 the nawab's absolute rule was abolished, and a chief commissioner's state was established. It merged with Madhya Pradesh in 1956, and Bhopal replaced Nagpur as the state capital.

In December 1984 Bhopal was the site of the worst industrial accident in history, when about 45 tons of the dangerous gas methyl isocyanate escaped from an insecticide plant that was owned by the Indian subsidiary of the American firm Union Carbide Corporation. The gas drifted over the densely populated neighbourhoods around the plant, killing thousands of people immediately and creating a panic as tens of thousands of others attempted to flee the city. The final death toll was estimated to be between 15,000 and 20,000, and some half million survivors suffered respiratory problems, eye irritation or blindness, and other maladies resulting from exposure to the toxic gas. Soil and water contamination resulting from the accident was blamed for chronic health problems of the area's inhabitants. Investigations later established that substandard operating and safety procedures at the understaffed plant had led to the catastrophe.



Bhopal is known as the "city of lakes"; its name is a derivation of Bhoj Tal ("Bhoj's Lake"), a lake constructed by Bhoj, a Hindu raja, in the 11th century. Today that lake is the Upper Bhopal Lake (Bada Talab), which is connected to the Lower Bhopal Lake (Chhota Talab) by an aqueduct. The lakes supply drinking water and are used for recreation. Around the lakes are several palaces and a fort dating from about 1728. Bhopal has several mosques, including the 19th-century Taj-ul-Masjid, the largest mosque in India. A three-day religious pilgrimage is held at the mosque annually, which attracts Muslim pilgrims from all parts of India. Other significant attractions in and around Bhopal include Fatehgarh Fort; Lakshminarayan Temple; Bharat Bhawan, a multipurpose arts centre; the Museum of Man, an open-air exhibit of replicas of different Indian tribal dwellings; and Van Vihar National Park, a zoological park.

Background

UCIL was a pesticide manufacturing plant that produced the insecticide carbaryl. Carbaryl was discovered by the American company Union Carbide Corporation, which owned a significant share in UCIL. As an intermediary, UCIL produced carbaryl using methyl isocyanate (MIC). Other techniques of producing the ultimate product are available, but they are more expensive. The very toxic chemical MIC is extremely dangerous to human health. Residents of Bhopal in the area of the pesticide plant began to feel irritated by the MIC and began fleeing the city.

Gas Disaster

For reasons that remain unclear, the cooling system of tank 610 was not functioning in the last months of 1984. Late in the evening of December 2nd, it is hypothesized that water (either through mechanical malfunction or operator error) entered the tank, mixing with the stored MIC.

The result was a violent, exothermic reaction, possibly catalyzed by ferrous corrosion of the tanks lining. By 01.00 a.m. the next morning, the tank ruptured and over the next few hours approximately 27 tons of vapor was discharged. Although most of this was probably pure MIC, products of hydrolysis (monomethylamine, carbon dioxide and various ureas) and pyrolysis (carbon monoxide, nitrous oxides and hydrogen cyanide) may also have been released in smaller quantities; the exact constitution of the discharged gases remains a matter for conjecture.

There is very little available information on meteorological conditions that night, but data from the city's airport suggest an air temperature of about 10 o C and a slow, northerly wind. At this temperature, the discharged MIC would have rapidly condensed and fallen groundwards, the plume passing over the northern edge of the city and towards its centre. An estimated 350 000 people were exposed. Immediate effects, and those over the following month, included the deaths of approximately 5000 people, most attributable to the direct respiratory effects of inhalation.

Over the next three years, health studies of survivors confirmed residual, obstructive airways disease, though its nature was poorly characterized. Ophthalmic sequelae, prominent in the weeks after the disaster, were believed to be more transient; the presence of disease in other organ systems was not convincingly established. Since 1986, only small case studies of persistent (respiratory) disease have been published and the question of causation has been poorly addressed. No further epidemiological studies ha

Reasons for gas leak

- During the buildup to the spill, the plant's safety mechanisms for the highly toxic MIC were not working.
- Many valves and lines were in disrepair, and many vent gas scrubbers were not working, as was the steam boiler that was supposed to clean the pipes.
- The MIC was stored in three tanks, with tank E610 being the source of the leak. This tank should have held no more than 30 tonnes of MIC, according to safety regulations.
- Water is believed to have entered the tank through a side pipe as technicians were attempting to clear it late that fatal night.
- This resulted in an exothermic reaction in the tank, progressively raising the pressure until the gas was ejected through the atmosphere.

Effects of Gas Leak

- Thousands had died as a result of choking, pulmonary edema, and reflexogenic circulatory collapse.
- Neonatal death rates increased by 200 percent.
- A huge number of animal carcasses have been discovered in the area, indicating the impact on flora and animals. The trees died after a few days. Food supplies have grown scarce due to the fear of contamination.

- Fishing was also prohibited.
- In March 1985, the Indian government established the Bhopal Gas Leak Accident Act, giving it legal authority to represent all victims of the accident, whether they were in India or abroad.
- At least 200,000 youngsters were exposed to the gas.
- Hospitals were overcrowded, and there was no sufficient training for medical workers to deal with MIC exposure.

Short Term Effects:

The short term effects of the exposure were

• Coughing,

• severe eye irritation

• 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 residents of shorter stature inhaled higher concentrations, as methyl isocyanate gas is approximately twice as dense as air and, therefore, in an open environment has a tendency to fall toward the ground (Wikipedia)

• 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 necrotising enteritis.[30] The stillbirth rate increased by up to 300% and neonatal mortality rate by around 200% (Wikipedia)

Long-term Effects:

Studied and reported long-term health effects are:

• Eyes: Chronic conjunctivitis, scars on cornea, corneal opacity, early cataracts, Blindness

• 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.

• Cancer

• Immune deficiency

• Soil and water contamination in the area was blamed for chronic health problems and high instances of birth defects in the area's inhabitants

Causes for Disaster

There are two main lines of argument involving the disaster:

1. Corporate Negligence

2. Worker Sabotage

• 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. (Wikipedia)

✓ This point of view also 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. (Wikipedia)

• 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. (Wikipedia)

• 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. (Wikipedia)

• Methyl isocyanate from chemical plant was advertently released into the air killing as many as 2,500 people and injuring thousands of others

Immediate Effects of the Disaster

The timing of the explosion was such that most of those exposed (an estimated 350 000) were asleep. Survivors report being awakened by an acrid ("chili-like") stinging of the eyes and throat. The low boiling point of MIC caused it to be re-vaporized at body temperature and inhaled deeply into the lungs; as a result, damage to the bronchial tree was extensive and post-mortem findings in those who died immediately after the leak reported widespread airway necrosis with pulmonary edema and hemorrhage. It has not been possible to enumerate such deaths exactly, since public health resources in the city were rapidly overwhelmed, a large part of the population fled the city and most bodies were cremated before they and the cause of death could be officially documented; nor, given the paucity of district population figures within the city, has it been possible to calculate area-specific mortality rates. As a result, the only available figures have been crude numbers of deaths. Within 24 hours, it is estimated that 1700 people died, and a similar number within the next three weeks. By 1989, a final toll of 3598 deaths attributable directly to the gas leak—almost certainly an underestimate—was set by the State Government of Madya Pradesh. Given the pathological findings described above, most early deaths were believed to be due to acute pulmonary toxicity

Epidemiological Studies

The literature on the human effects of the gas leak is surprisingly scanty and largely comprises case series, or crudely designed population studies. Within weeks of the disaster, research programs had been set up by a number of Indian and international bodies: these included the ICMR, the Tata Institute for Social Sciences (Bombay), the World Health Organisation (WHO) and Union Carbide itself, as well as epidemiological and clinical groups from Bhopal University and other academic institutions in India. In all instances, save one, published reports from these have been based on the

clinical experience of patients hospitalized in the period immediately after the leak. A large proportion of the long-term studies set up soon after the disaster has inexplicably failed to reach publication. Large cohort studies set up by the ICMR-sponsored Gas Disaster Research Centre have been reported only in the Council's Annual Reports, and even there in very little detail. There are, however, a small number of published studies reporting disease among survivors, though none with a follow-up of more than two or three years.

Subjects		Duration of follow-up	Major findings
n	Source		
500	hospital	72 hours	pulmonary oedema in 41%
978	hospital	2 days	symptoms of respiratory tract irritation; pulmonary oedema on selected CXR
33	hospital	1 week	respiratory tract irritation, pulmonary oedema (11%), 'pneumonia' (79%)
224	hospital	3 months	'obstructive' lung disease at spirometry (44%)
569	hospital	3 months	symptoms but not obstructive spirometry (22%) commoner in those living closer to the factory
1109	community volunteers	3 months	symptoms more frequent in those living closer to the factory. Radiographic changes 'caused by gas exposure' in 4%
82	hospital	6 months	'restrictive' lung disease at spirometry (78%) Interstitial deposits on CXR (95%)
87	hospital	2 years	spirometric evidence of small airways obstruction (grouped data)
459	community	3 years	gradient of symptoms with estimated exposure

Aftermath

In the United States, UCC was sued in federal court. In one action, the court recommended that UCC pay between $5 million and $10 million to assist the victims. UCC agreed to pay a $5 million settlement. The Indian government, however, rejected this offer and claimed $3.3 billion. In 1989, UCC agreed to pay $470 million in damages and paid the cash immediately in an out-of-court settlement.

Warren Anderson, the CEO and Chairman of UCC, was charged with manslaughter by Bhopal authorities in 1991. He refused to appear in court and the Bhopal court declared him a fugitive from justice in February 1992. Despite the central government's efforts on the United States to extradite Anderson, nothing happened. Anderson died in 2014 without ever appearing in a court of law.

Conclusion

Union Carbide's pesticide plant in Bhopal, India, was the scene of one of the worst industrial accidents in history when methyl isocyanate gas leaked from the plant and spread over a populated area, killing at least 2,000 people at the time of the accident and causing an estimated 15,000 to 20,000 subsequent deaths. Many thousands more sustained lifelong injuries.

Earth Provide enough to satisfy

every man's need, But not every man greed. . . .