Union Carbide Disaster in Bhopal : Building the Struggle, Creating possibilities

Personal Introduction:

My name is Satinath Sarangi [Sathyu]. I have come from Bhopal where I have been ever since the Union Carbide disaster 17 years ago. I did my M. Tech in Metallurgical engineeing and dropped out of PhD in my third year. I have been involved with relief, agitation, research, publications, community organizing, campaigns, legal actions and other actions in support of the struggle for justice in Bhopal. I am the founder member of two organizations: Bhopal Group for Information and Action a survivors support organization and Sambhavna Trust that provides free medical care to the survivors.

What I would like to do today is to share the current condition of the survivors, briefly describe the lingering medical, social, economic and issues of Bhopal and recount the efforts being made to confront the principal authors of this continuing disaster.

About the city of Bhopal: Bhopal is the situated almost at the geographical centre of India, at the heart of our country. A city with about 1.4 million people and it is the capital of the state of Madhya Pradesh.

Company's profile: In 1969 as part of its global empire, Union Carbide Corporation set up its pesticide formulation unit in the northern end of the city. The factory in Bhopal was one of the 14 facilities operated by Union Carbide in India. Initially it mixed and packaged pesticides imported from USA but was gradually expanded to include production of Methyl Iso Cyanate (MIC) the main ingredient for Carbamate pesticides. MIC was first imported from the USA in 1973 and in December 1979 a MIC plant was installed with a capacity of 5000 tones.

About the Disaster: On the night of 2nd - 3rd December 1984, during routine maintenance operations in the MIC plant, starting at about 10 p.m. a large quantity of water entered storage tank no. 610 containing over 60 tones of MIC. This triggered off a runaway reaction resulting in a tremendous increase of temperature and pressure in the tank and nearly 40 tones of MIC along with Hydrogen Cyanide and other reaction products burst past the rupture disc and in to the night air of Bhopal at around 12:30 a.m. Safety systems were grossly under designed and inoperative. Senior factory officials knew of the lethal build up in the tank at least one hour before the leakage, yet the siren to warn neighborhood communities was sounded more than one hour after the leak started. By then the poisons had enveloped an area of 40 Sq. Kms killing thousands of people in its immediate wake. Over 8000 people died in the first three days and over 500 thousand people suffered from acute breathlessness, burning in eyes and vomiting as they ran in panic to get away from the poison clouds that hung close to the ground for more than four hours.

Hazardous design of the plant, unsafe location, reckless operation and maintenance procedures, reduction in personnel and deliberate cutting down of vital safety systems are the immediate causes of the disaster. There is ample evidence of "double standards" being followed by the American multinational, Bhopal's sister plant in West Virginia being far superior in storage, production and safety systems. There are enough documents to show that Union Carbide and its senior most officials knew that the factory in Bhopal was a ticking time bomb and did nothing because they did

not want to spend money on a plant that was yet to yield big bucks. It was a directive from the head quarters of the company, in Danbury, Connecticut, USA that resulted in the retrenchment of workers and shutting down of safety systems.

Health Impact:

Epidemiological and clinical studies carried out by the Indian Council of Medical Research (ICMR), the official research agency, have shown that the toxins crossed in to the blood stream of those exposed and have caused damage to the respiratory, ocular, gastro-intestinal, reproductive, neurological, immunological, psychological and other systems. They have also established that the toxins did indeed cross the placaental barrier leading to faetal poisoning. and caused chromosomal aberrations among those exposed.

A survey carried out by the International Medical Commission on Bhopal (IMCB), composed of 14 medical specialists from 11 different countries reported significant multi-organ symptoms persistent among the exposed population 10 years after the disaster. Clinical examination carried out members of the Commission have shown significant lung impairment, marked reduction in control over limb movements, reduced memory function and a range of neuro-toxic injuries not studied by the ICMR

In addition to the host of physical and mental illnesses that have gripped people and never left them, there are new diseases that are manifesting after so many years. Currently the number of people with Cancers and Tuberculosis is alarmingly high and rising. Young women who had been exposed at infancy, have chaotic and painful menstrual cycles on attaining puberty. Many have three to four cycles in a month and there are those as old as seventeen and eighteen who have yet to have their periods. The total number of persons in desperate need of appropriate medical care is well over one hundred and twenty thousand. The current death toll is well over 20, 000.

Two studies carried out by Sambhavna, the clinic where I work, recently, show that young males, who were conceived and born to gas exposed parents within two years of the disaster are currently much lower in weight, smaller in height and have much smaller cranial circumference. We have also found that diabetes is at least twice more prevalent in an exposed community compared to national urban figures.

Environmental Problems: Communities in the vicinity of the Carbide factory continue to be exposed to heavy metals and toxic chemicals such as Dichlorobenzenes, Polynuclear Aromatic Hydrocarbons and Phthalates that are injurious to the lung, liver and kidneys and can cause cancer. The international environmental organisation, Greenpeace named the area around the factory in Bhopal a "Global toxic hotspot" Their report indicates severe contamination of the groundwater and soil with heavy metals and carcinogenic chemicals. In 1990 the Bhopal Group for Information and Action (BGIA) reported the presence of at least seven toxic chemicals based on a testing done by the Citizens Environmental Laboratory, Boston.

Over 10,000 people, the majority of them gas victims, are routinely ingesting toxic chemicals as a result of the poisoning of drinking water sources in Jaipraksh Nagar, Atal-Ayub Nagar, Annu Nagar and other communities. Union Carbide Corporation, USA who were in control of the factory when these toxic chemicals were recklessly dumped is yet to pay for containing the toxic groundwater, rehabilitating the degraded land or make arrangements for alternate supply of drinking water. Dow Chemical the current owner of Union Carbide refuses to accept Bhopal's environmental liabilities.

Economic and Social Impact: There has hardly been any systemic effort to document the social and economic impacts of the disaster. Official information on orphaned children and families that lost their breadwinners in the immediate or long aftermath is scanty, if available at all. Over 70 % of the exposed population has been in the unorganized sector, with people earning subsistence wages through day labour or petty trade. A large number of men and women who pushed handcarts, carried loads, dug soil, repaired scooters and did other jobs can no longer pursue their trades after being exposed to Carbide's gases.

Gas exposed factory workers in textile and paper mills are more sensitive to occupational hazards and are absent from work due to illness as much as 15 days in a month. Given the complete inadequacy of official rehabilitation efforts the loss of regular income has driven tens of thousands of families to chronic starvation conditions. Loss of income also make people borrow money from local money lenders who charge up to 200% interest so that chances of paying back are low and debts keep growing.

Legal Issues:

Subsequent to the disaster the Indian government through the Bhopal Gas Leak Disaster (Processing of Claims) Act in March 1985 arrogated to itself, sole powers to represent the victims in the civil litigation against Union Carbide. On behalf of the victims the Indian government filed a suit for the compensation of more than 3 billion US $ in the Federal Court of Southern District of New York. However, in May 1986 the case was sent to the Indian courts on grounds of forum non-convenience, under the condition that Union Carbide would submit to the jurisdiction of Indian Courts. On Feb 14, 1989 the Indian Supreme Court passed an order approving the settlement that had been reached between the government of India and Union Carbide without the knowledge of the claimants in Bhopal. According to the terms of the settlement, in exchange of payment of US $ 470 millions the Corporation was to be absolved of all civil liabilities, criminal cases against the company and its officials were to be extinguished and the Indian government was to defend the Corporation in the event of future suits. The settlement sum, nearly one-seventh of the damages initially claimed by the government, while being far below international standards is also lower than the standards set by Indian Railways for railway accidents. There were widespread protest by the Bhopal victims and many organizations and individuals including prominent members of the parliament who supported the call to oppose the infamous settlement.

Several petitions seeking review of the order on settlement were filed and the Supreme Court announced its revised judgement on October3, 1991. This final judgement upheld the settlement amount paid by Carbide but directed the Indian government to make good any shortfall during the distribution of compensation. The criminal cases against the Corporation and its officials were reinstated in the final judgement.

Criminal case against Carbide

A First Information Report for causing death by negligence and a number of other serious offences was registered on December 3, 1984 at the local police station. On December 1, 1987 the government's prosecution agency, the Central Bureau of Investigation (CBI) pressed charges in the Bhopal District Court against UCC and its Asian and Indian subsidiaries, namely Union Carbide Eastern (UCE), Hong Kong and Union Carbide India Limited (UCIL) respectively, as well as nine officials including the then Chairman, Warren Anderson. The 12 accused were charged [under section 304 (Part 11) 326, 324 and 429 of the Indian Penal Code] with culpable homicide, grievous assault, assault, causing death of and poisoning animals and other serious offences. The corporation blamed a fictitious saboteur and later a disgruntled worker for causing the disaster and organised public relations campaign to distance itself from criminal liability. The CBI, with the cooperation of the workers of the factory, presented a strong case linking key managerial decisions to the disaster.

As the proceedings in the Bhopal District Court began in the aftermath of the disaster, Union Carbide and its officials repeatedly chose to ignore the Court's summons. In early 1992, a non-bailable arrest warrant was issued against Anderson and the Chief Judicial Magistrate, Bhopal, attached the shares of Union Carbide in its Indian subsidiary. More than seven years have passed but the Indian government has yet to take steps towards seeking the extradition of the foreign accused. Since Union Carbide has de-registered UCE, Hong Kong in 1992, the CBI has express its inability in Court to proceed against it.

On September 13, 1996, in response to an appeal moved by Keshub Mahindra and other accused officials of Union Carbide India Ltd. (UCIL), the Supreme Court passed an order diluting the charges of culpable homicide to death caused by negligence (Sec. 304 A of the IPC), thereby reducing the maximum sentence to two years or fines. Trials of the Indian accused are currently going on before the Chief Judicial Magistrate , Bhopal but at an extremely slow pace of less than one hearing per month.

Compensation : The amount paid as compensation (Rs . 715 crores) has multiplied as a result of the increase in the value of the dollar and the accruing interest. Out of this amount, about Rs. 1200 crores have been paid to over 400 thousand claimants and a balance of about Rs. 1100 crores remains to be disbursed.The procedures for compensation disbursement have been tortuous and thoroughly unjust. More than 95 % of the claimant have been paid a sum less than Rs. 25000 [~ 500 US $] as compensation for personal injuries out of which nearly Rs.10,000 have been routinely deducted against interim monetary relief paid by the government from 1990. The remaining money does not half cover the medical expenses borne by the claimants in the last several years let alone provide for future expenses.Out of the over 21,000 death claims adjudicated a very large number have been rejected or converted into personal injury cases. Judges at the claim courts are completely ignorant of the medical consequences of the toxic exposure and administration of compensation is riddled with corruption so that the claimants' inability to pay bribes often results in the denial of compensation.

Rehabilitation :

The government programmes for economic rehabilitation have been badly designed and only a few have been implemented. While as estimated population of 50.000 is in need of alternate jobs currently less than 100 gas victims have found regular employment under the government's scheme.

Till date there has been no official attention towards the urgent need of life long pension for widows, orphans chronically ill and disabled survivors. The Supreme Court's direction with regard to

provision of insurance coverage to about one lakh children likely to suffer delayed effects of the lethal gases is also being ignored by the Central government.

Despite the expenditure of over Rs. 70 crores in environmental rehabilitation basic necessities such as clean drinking water and sanitary facilities remain unavailable to the majority of the gas affected communities.

The medical disaster in Bhopal

The industrial disaster in Bhopal was quickly followed by a medical disaster of unmatched proportions. Suppression of medical information by Union Carbide, absence of treatment protocols, indiscriminate prescription of potentially harmful drugs, abandonment of research and health surveillance by the government and a total dependence on hospital based care that has failed to provide sustained relief are the main elements of this disaster whose principal authors are the same.

The merger of Union Carbide and Dow Chemical

In February this year Union Carbide Corporation, while still absconding criminal charges in India, merged with The Dow Chemical Company, another US multi national and co-founder of the military-industrial complex. Dow has thus become the second largest chemical corporation in the world. Dow produced Agent Orange during the US aggression on Vietnam. Also as the number one producer of Dioxin Dow is responsible for a large proportion of the dioxin related illness, death, and deformity worldwide. In June last year Dow was forced to withdraw its main product Dursban from the American market following a mass of scientific information about this brain damaging chemical. Today Dow is promoting Dursban in India as a household chemical "safe for humans and pets" and its setting up factories for production of Dursban.

The struggle for justice in Bhopal

In the immediate aftermath of the disaster over 300 local and regional social and charity organizations and thousands of individuals provided medical relief and other services to the survivors of the disaster. International relief organizations, for reasons yet unstated, chose and continue to choose to remain away from Bhopal. Organization initiated and led by the survivors themselves continue to struggle at Bhopal. Women have played a more active and sustained role in the survivors' organization. In the last 17 years, organizations have marched on over 200 occasions on non-violent demonstrations with an average participation of over one thousand people. In addition to ill-health, poverty, family restrictions and bureaucratic apathy, women survivor activists have had to face government repression at its cruelest. These demonstration have been attacked by policemen with sticks and stones at least 40 times, leading to bleeding heads and fractured limbs on several occasions. Thousands of survivors activists have been arrested and detained.

Betrayed by the Indian government through the settlement of 1989, survivors and their support organizations filed a class action suit in the US Federal court in November 1999. In response to the suit and a subsequent appeal, recently on November 15, the second circuit court of appeals in the US has held Anderson and Union Carbide liable for contamination of groundwater and health problems caused by it.

Through their legal and extra legal interventions, survivors and their support organizations have gained significant victories in the struggle for justice and a better deal. Most government relief and rehabilitation measures, withdrawal of criminal immunity for Carbide and its official and some measure of control over resources allocation have become possible through the efforts of these organizations.

Fresh impetus to the campaign for justice in Bhopal has come in the form of a new international coalition of survivors and support organizations. Called Action against Corporate crime and Toxic terror: Bhopal [AaCcTt:Bhopal] this coalition has two of the survivors organizations and such support organizations as the National Campaign for Justice in Bhopal, The Other Media, New Delhi, Greenpeace and BGIA.

About Sambhavna:

As one word 'Sambhavna' means "Possibility" and if you read as 'Sama' 'bhavana' it means 'similar feeling' or "compassion". Sambhavna Trust (Bhopal Peoples' Health & Documentation Centre) is a registered charitable trust working for the welfare of gas victims since September 1995. At Sambhavna, survivors are offered free medical care through allopathy, Ayurveda [an indigenous system of medicine based on herbs] and Yoga. The 20 staff members of the Sambhavna clinic [among whom 9 are survivors themselves] include five physicians, two yoga and two Panchakarma therapists and four community health workers who carry out health surveys, health education and community organisation for better health.
The primary objective of Sambhavna is to contribute to the welfare of the survivors of the Bhopal gas disaster through medical care, research, health education and information dissemination.

In the last five years over 10,500 chronically ill persons have been registered at our clinic and everyday between 70 to 100 survivors visit Sambhavna.

We pay special attention to women's health. The Dominique Lapierre City of Joy Sambhav a gynecological clinic is the only clinic in Bhopal that provides facilities for regular cervical scree g to the survivors. We are soon going to start Colposcopy and LLETZ for screening, diagnosis and treatment of cervical cancer.

We carried out a clinical study in treatment of exposure induced lung problems through Yoga. We demonstrated that through Yoga practice there was significant increase in lung functions. Medicine consumption was much reduced and half the people in the study were able to do away with medicines altogether.

In order to tackle the problem of tuberculosis, we have developed a community-based program on TB care. This program consists mainly of health education, identification of persons with TB, prevention of the disease and supervision of treatment and constant health monitoring.

Through educational campaigns and meetings we have encouraged the formation of health committees in four communities. The members of these committees voluntarily accept responsibilities for identification of individuals in need of medical attention, counseling regarding treatment, organizing meetings and holding health camps in the communities.

The documentation unit of the Sambhavna clinic has a unique collection of documents, books and articles related to medical, scientific, legal and other aspects of the gas tragedy. These information are made available to the clinic staff, survivors, researchers, journalists and others. Special efforts are made to make information accessible to the survivors.

Beside this we also organize local, national and international workshops and seminars on medical issues of the disaster. Recently on November 28th we organized a one-day workshop on what local doctors could do to make a difference to the health and health care of the survivors.

The work carried out by the Sambhavna Trust over the last five years has shown that it is possible to evolve simple, safe, effective, ethical and participatory ways of monitoring treatment and research for the survivors of Bhopal.

Recently on December 3 Sambhavna staff members demonstrated with masks on and holding posters and a banner demanding that Dow Chemical and the Indian government assume long term responsibility for Bhopal and stop the medical disaster in Bhopal.

<u>The global implications of Bhopal</u>

Contrary to its projection in mainstream media the disaster in Bhopal is not an isolated event. There are slow and silent Bhopal's occurring in a routine manner in almost every part of the world. Corporate crimes that lead to death and ill health of hundreds of thousands of workers and community people go unpunished as business goes "as usual". This has become more institutionalized, more legitimate and more intense with the advent of globalization. If the agencies and individuals responsible for the worst industrial massacre are allowed to go unscathed the world [and in particular countries of the South] is that much unsafe.

The medical issues of Bhopal are also of international relevance. More than 60,000 chemicals are today in commercial use less than 5% have been tested fully for their toxic effect on living systems. And each year as the toxic corporate empire spreads several hundred new chemicals enter the circle of poison threatening our lives, health and the very survival of the planet. In many areas of environmental and occupational health modern medicine appears to be reaching its limits. The work of Sambhavna and other such efforts are creating possibilities for non toxic therapy of new industrial diseases as well as for community involvement in research and health surveillance.

<u>Current demands of Bhopal</u>

DOW must...

1. Ensure that prime accused Warren Anderson, former chairman of Union Carbide, and the authorised representatives of the company face trial in the Bhopal criminal court.

2. Assume liability for the continuing and long term health consequences among the exposed persons and potentially their future generations. This includes medical care, health monitoring and necessary research work. The company must provide all information on the leaked gases and their short and long term medical consequences.
3. Clean up contamination of the ground water and soil in and around the abandoned Union Carbide factory
4. Assume liability for the loss of livelihood caused as a result of the disaster. This includes liabilities for families where the breadwinner has been killed or rendered incapacitated to earn a livelihood and for persons too sick to pursue their usual sources of livelihood.

The Indian government must

1. Take immediate steps to extradite Warren Anderson and other representatives from USA and present them in Bhopal court
2. Proceed against Dow Chemical and its Indian subsidiaries to pursue the pending criminal liabilities of the disaster.
3. Support the class action suit filed in the US courts by survivors' organisations against Union Carbide and Warren Anderson by filing a supportive Amicus Curae brief.
4. Revive the special prosecution cell in the criminal case against Union Carbide India Limited and its Indian officals.
5. Set up a National Commission on Bhopal with the participation of survivors and their sympathisers for long term health monitoring, research, care and rehabilitation of the survivors of the disaster. The funds left after distribution of compensation must be entrusted to this Commission.
6. Take immediate steps to ensure the publication of the results of the 24 research studies carried out by the Indian Council of Medical Research on the health effects of exposure to Carbide's gases.
7. Scientifically assess and claim damages from Union Carbide for the contamination of groundwater and soil in and around the factory.
8. Take note of the indictment of the Comptroller and Auditor General regarding misappropriation of public money in Bhopal by the MP Government. Institute an inquiry by the Central Bureau of Investigation on expenditures made and results obtained in relief and rehabilitation of Bhopal victims in the last 17 years.
9. Declare December 3 as a National Day of Mourning for the Victims of Industrial Disasters.
10. The disaster in Bhopal must be made part of text-books in school and university education in the country.

Support the Bhopal struggle

We appeal to you to support the struggle of Bhopal and the work of rebuilding at initiatives such as Sambhavna.

Please:

a. Convey your concerns regarding the survivors of Bhopal to Dow offices in your respective countries.

OH-1A.

SURVIVING BHOPAL: 20 YEARS ON

A FACT FINDING MISSION

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9th November 2004

Dear Thelma,

Greetings !

As we all remember, in the midnight of 2nd December 1984, the world's worst chemical disaster unfolded in Bhopal. The corporation *Union Carbide's* pesticide plant in Bhopal spewed tons of the deadly gas- MIC into the air. Half a million people were exposed to the poisonous gas and around 20,000 people have succumbed so far from the exposure. Innumerable people still suffer from ailments caused by the accident and the subsequent pollution at the plant site. As a result of the routine and reckless dumping of chemical wastes in and around the factory by *Union Carbide*, toxic chemicals and heavy metals have leached into the soil and groundwater and contaminated it.

The abandoned factory site continues to poison the 20,000 odd people residing in the vicinity of the factory who are forced to drink this contaminated water. *Union Carbide* after a partial and paltry settlement with the Government of India washed its hands over the entire incident. Its new owner, *Dow Chemical International Limited* has steadfastly ignored and evaded any pending responsibility or liability of the gas leak. Twenty years hence, the impact of the gas leak continues to linger and affect the lives of the people and communities in Bhopal. And justice still eludes the victims, the survivors and their families.

Over the years, he Government of India's stoic apathy and insensitivity has manifested in numerous forms- from inadequate compensation to insufficient medical and health care to lack of socio-economic rehabilitation of the survivors to disinterest in pursuing the criminal liabilities of the fugitive corporation and its employees. This bleak scenario witnessed the coming together of Bhopal based survivor/support organizations and Delhi based groups to intervene meaningfully in the ongoing crisis. The mission was to evolve a long term monitoring mechanism of the situation of the Bhopal gas survivors.

In this backdrop, the ***Fact Finding Mission (FFM)*** **was launched in 1998** to study and assess the prevailing situation in Bhopal in the aftermath of the disaster. Fifteen diverse areas were identified and the studies were sought to investigate, compile and analyze comprehensively all aspects related to the Bhopal gas tragedy. Eleven reports on the following areas have been compiled – ***Role of Union Carbide Corporation, Mental Health Consequences, Environmental Impacts of the Disaster, Labour and Economic Rehabilitation, Role of State and Central Governments, Medical Care and Rehabilitation, Legal Aspects, Media Response, Role of NGOs and People's Organizations, Disaster Management and Memorial.*** Three of the abovementioned reports- Role of *Union Carbide Corporation, Environmental Impacts of the Disaster and Mental Health Consequences were released in January 2002.*

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(one copy for RN, has been sent)

The findings of these different reports have been envisaged to give a new lease of direction to those working on Bhopal and to serve as an effective tool to mount pressure on the Government to remain accountable to the continuing suffering of the people of Bhopal.

As you are aware, this year marks the twentieth anniversary of the gas disaster. Twenty long years have elapsed, but Bhopal still symbolizes an unparalleled and unresolved corporate crime. We need to take forward the struggle against rogue corporations and multinationals and ensure justice is duly meted out.

In this context, **we are organizing a three-day National Convention in Bhopal from 26th to 28th November 2004 in Bhopal** to release the remaining reports of the *Fact Finding Mission (FFM)* and also discuss and debate the findings of these different reports. The Convention would focus on strategies and recommendations to counter the continuing sufferings of the people. The Convention aims to build pressure on the increasingly apathetic Government for suitable rehabilitation and monitoring mechanisms.

We cordially invite you to participate in the Convention. We are aware of your struggle and fight against erring corporations and your involvement in ensuring corporations remain socially and ethically responsible for their policies and actions. We strongly believe that your involvement and sharing of experiences and strategies would make the Convention more meaningful.

We would like you to stay for the entire three-day programme. A detailed agenda of the programme will be forwarded shortly. We are willing to bear the expense of second-class train travel as well as the costs of a modest accommodation in Bhopal..

Kindly fill up the registration form and send it to us by 16th November 2004 .

The details of the National Convention are :

Date - 26th, 27th, 28th November 2004
Venue - Mullah Ramuji Sanskrti Bhavan, Baan Ganga, Near 45 Bungalow, Bhopal

We look forward to seeing you at the Convention.

In solidarity

E.Deenadayalan
General Secretary
The Other Media

Travel Advisory

National Convention, Bhopal
26th-28th November 2004

Arrival –
Participants are requested to arrive from 25th noon onwards or 26th early morning. Most trains to Bhopal halt at Bhopal Junction. Participants are advised to disembark/get down at Bhopal Junction. The hotel is a 10-minute drive from the Bhopal Junction station. Participants are advised to hire an auto rickshaw. It would approximately cost Rs.20/- from the station to the hotel. For those who disembark at Habibganj station, the hotel is a 30-minute drive and would approximately cost Rs.50/-.

Climate –
It is winter in Bhopal in November and would be very cold.. It is advised that participants bring warm clothing and woolens.

Accommodation-
Arrangements for accommodation have been made from 25th noon to 29th morning. Accommodation would be on twin-sharing basis. The arrangements would be modest and simple.

The address of the hotel is-
Hotel Banjara
Behind Alpana Takies,
Hamidia Road, Bhopal
Phone- 5255367/2713105

Ticket-
For reimbursement purposes you are requested to produce original tickets along with their photocopies and receipts related to your travel expenses.

Food-
Vegetarian food would be served. At the hotels, the participants would be served common breakfast and dinner. Lunch would be provided at the venue of the Convention. Any special dietary requirements should be intimated to the organizers.

First Aid –
First aid facilities would be available with the organizers.

Thank you.

Registration Form

National Convention in Bhopal, 26-28 November 2004, Bhopal

Please send the completed form by November 16th, 2004.

1. Name of the participant	
2. Age	
3. Gender	
4. Name of the organization	
5. Address	
6. Telephone	
7. Fax	
8. E-mail	
9. Arrival in Bhopal **Date** **Time** **Train number** **Station**	
10. Cost of Ticket (to and from)	
11. Any special dietary requirements	

Thank you.

OH-1A.

MENTAL HEALTH IMPACT OF BHOPAL GAS DISASTER*

by

R. SRINIVASA MURTHY

For The Fact Finding Mission On Bhopal

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CONTENTS

SUMMARY

During the night of December 2-3, 1984 the world's worst industrial disaster took place in the city of Bhopal in Central India. Large amount of toxic gas leaked from the plant into the surrounding area, which was densely populated. More than 2,000 died immediately and over 200,000 populations were directly affected in a city of 700,000 population. The disaster-affected population have been investigated for the effect of the disaster on their physical and psychological health. Community level studies carried within one month of the disaster to 10 years after the disaster report higher levels of physical and mental health morbidity. Though efforts to provide psychological support to the affected population were initiated using the primary care personnel by focussed training programmes, a system of comprehensive community based health care in general and mental health care in particular, is still not in place. In addition there is need for continuing the research studies into the long-term effects of the disaster and the morbidity in the affected population. The magnitude of the Bhopal disaster and the research efforts to understand the health effects have resulted in greater awareness in India of the psychological aspects of disasters and to include psychological support as part of relief and rehabilitation activities following all disasters.

The Setting:

Bhopal gas leak disaster is the greatest industrial disaster in human history .On the night of 2/3 December 1984, about 40 tons of methyl isocyanate (MIC) from tank 610 of Union Carbide India Limited (UCIL) factory at Bhopal, in central India, leaked into the surrounding environment. This leak of an " *extremely hazardous chemical* " which occurred over a short span of few hours killing more than 2,000 people covered the city of Bhopal in a cloud of poisonous gas.

The Bhopal disaster is of importance from mental health point for a number of reasons.

Firstly, it is one of the largest man-made disasters in a developing country.

Secondly, the disaster effects were a combination of both the substances inhaled and the psychological effects of living through a disaster experience.

Thirdly, no formal mental health infrastructure was available to provide post-disaster mental health care.

Fourthly, a number of innovative approaches were developed to provide mental health care, especially suitable for use in developing countries.

Fifthly, this disaster was the subject of intensive health research in a prospective manner for the first five years.

This research included mental health aspects of the disaster on the population.

The scope of the article will be to describe the mental health effects, the interventions undertaken and identify issues for future research and interventions. A detailed description of the disaster is covered by other authors in this volume and elsewhere (Srinivasa Murthy,2002).

HEALTH EFFECTS:

The immediate impact of the exposure to the toxic chemical affected mainly the eyes, lungs and the gastrointestinal systems. The health effects have been recorded systematically by individual doctors, researchers from India and abroad as well as the *Indian Council of Medical Research*, New Delhi (ICMR). The reported effects of the toxic chemical inhalation involved eyes[1], respiratory system[2] and general health[3]. They all report a higher morbidity in the affected population and a gradient of the adverse effects in relation to the exposure amount. The other health studies included gynaecological and obstetric problems[4], incidence rates of cancer[5], chromosomal variations[6], and immunological changes[7]. These have been extensively reviewed in this document and elsewhere (SrinivasaMurthy, 2002)

IMPACT ON MENTAL HEALTH

Bhopal disaster is the first disaster in India to be studied systematically for the mental health effects. Information is available about the mental health effects from a number of sources. These are from studies as part of general health surveys as well as specific studies on mental health. The direct involvement of the psychiatrists/neurologists at the field level did not occur till about 8 weeks after the disaster. This delay was inspite of the recognition of the importance of mental health effects of the disaster within the first fortnight of the disaster. By coincidence the Fourth Advisory Committee on Mental Health of ICMR was meeting on December 12-14,1984. The experts in the meeting recognised the need of the affected population as follows:

> *"the recent developments at Bhopal involving the exposure of 'normal' human beings to substances toxic to all the exposed and fatal to many, raises a number of mental health needs. The service needs and research can be viewed both in the short-term and long-term perspectives. The acute needs are the*

understanding and provision of care for confusional states, reactive psychoses, anxiety-depression reactions and grief reactions. Long term needs arise from the following areas, namely, (i) psychological reactions to the acute and chronic disabilities, (ii) psychological problems of the exposed subjects, currently not affected, to the uncertainties of the future, (ii) effects of broken social units on children and adults, and (iv) psychological problems related to rehabilitation"[8].

However, in spite of this early recognition of the need for mental health interventions there was a delay of 6-8 weeks before mental health professionals were involved. An important reason for this was the lack of mental health professionals in the state of Madhya Pradesh and the city of Bhopal. At that point of time none of the 5 medical colleges had a psychiatrist in their faculty.

General Health Studies including Mental Health Aspects:

Andersson et al. (1988) reported the first community survey within two weeks of the disaster. The survey was conducted in eight exposed areas and two non-exposed clusters of households. There was a two month follow-up. The focus of the survey was eye and lung problems. As part of this study authors note that the pupillary reflex was normal. Based on this they conclude, *"the fact that this reflex was normal in all groups can not be taken as evidence that neurotoxicity did not occur"*.

Misra et al (1988) report on 33 adult patients treated during the acute phase at the Medical College Hospital. They found that symptoms of severe cough and dyspnoea were followed by fainting in 55% of the patients. The duration of unconsciousness ranged from 30 minutes to 3 days. One patient who had suffered from prolonged unconsciousness had myoclonic jerks localised to the right upper extremity and generalised hyperreflexia, suggestive of encephalopathy. Three patients who had prolonged unconsciousness and brisk deep tendon jerks and extensor plantar response. Mild to moderate headache (55%), giddiness (46%), burning sensation in hands and feet (9%) and hypoanaesthesia (3%) were also reported. At the 3 month follow-up of this group of patients, depression and irritability were the commonly reported symptoms.

Gupta et al (1988) studied systematically 687 affected persons of various age groups and from different affected areas at two months after the disaster and another 592 persons after the 4 month period. These studies included "behavioural studies". There was a control population. The behavioural studies were carried out in 350 adults. The psychological tests used were to "detect non-intellectual personality disturbances, changes in mood, readiness for affective reactions, neuroticism and the dimension of extroversion/ introversion. The specific tests administered were digit span test, Benton visual retention test, digit symbol test, Bourdon Wiersma vigilance test, simple reaction time, Santa Ana test, Rorscharch and Eysenck personality inventory. The behavioural tests showed that memory, mainly visual perceptual and attention/response speed along with attention/vigilance were severally affected in the gas-exposed population. Further statistically significant differences were observed between the controls and the exposed groups on all the parameters tested. The gas exposed groups; especially the females had poor scores in the auditory memory tests. The exposed male group showed significant low visual memory as compared to controls and females. The visual memory was more affected than the auditory memory. Perceptual motor speed was significantly lower in the gas-exposed group. All these changes were associated with subjective complaints of lack of concentration and poor attention. In the manual dexterity tests there were no differences across the groups. The questionnaire (EPI) results showed that 79.6% had poor scores on general lability items, whereas 88.6% with poor scores had a tendency to general fatigue with somatic complaints. Only 4.5% had neurotic tendencies. As a group women were more affected than men and this difference was statistically significant.

Cullinan et al (1996) carried out an epidemiological study of a representative gas-exposed population, nine years after the disaster, in January 1994. They studied 474 subjects and a control group. Of this sample, 76 were subjected to detailed neurological testing which included vestibular and peripheral sensory function and tests for short-term memory. In this study a high proportion of subjects reported a wide variety of neuropsychiatric symptoms like abnormal smell, abnormal taste, faintness, headache, difficulty to stay awake and abnormal balance. Headache was reported by 80% of the subjects as compared to 50% in the control population. Neurological examination showed that a high proportion was judged to have clinical evidence of central, peripheral or vestibular neurological disease. The mean short-term memory scores were lowest among those heavily exposed (1.0 Vs 3.0). There was some evidence of impaired extrapyramidal functions. There was also abnormal vertical drawing test among the exposed.

In this group the psychological symptoms reported were fatigue (88%), anxiety (65%), difficulty in concentration (64%). Difficulty in decision-making was reported in 80% as compared to 35% in the control population.. Irritability was reported by 33% as compared to nil in the control group. There was a consistent gradient across the separate exposure groups for all symptoms except depression. Approximately 25% reported symptoms of depression.

MENTAL HEALTH STUDIES:

The initial assessment of in the first week of February 1985 (about eight weeks after the disaster). R. Srinivasa Murthy (RSM), of the National Institute of Mental Health and Neuro Sciences (NIMHANS), Bangalore, and Professor B. B. Sethi (BBS), of K.G. Medical College (KGMC), Lucknow. They visited the City had interacted with the general population, the patients attending the health facilities and the medical personnel to understand the magnitude and nature of the mental health problems in the affected population. Their observations, over a week's time, were based on clinical and unstructured interviews. These initial observations led to an estimate of the magnitude of mental health needs of the population at 50% of those in the community and of about 20% of those attending medical facilities (SrinivasaMurthy, 1990).

Immediately following these observations, during February-April 1985, a KGMC team carried out systematic studies. As a first step, ten general medical clinics in the disaster-affected area were chosen. A team consisting of a psychiatrist, a clinical psychologist, and a social worker visited one clinic a day, by rotation in a randomized fashion, on three occasions and screened all the newly registered adult patients with the help of a self-reporting questionnaire (SRQ). Subjects identified as probable psychiatric patients were then evaluated in detail by the psychiatrist with the help of a standardized psychiatric interview, the Present State Examination (PSE)[9]. Clinical diagnoses were based on the International Classification of Diseases (9th revision) (ICD-9)(WHO, 1975).

During a period of 3 months (February-May 1985), of the 855 patients screened at the 10 clinics, on the basis of their SRQ scores, 259 were identified as having a potential mental disorder. Of these potentially mentally ill people, 44 could not be evaluated, and 215 were assessed using the PSE. The confirmed number of psychiatric patients was 193, yielding a prevalence rate of 22.6%. Most of the patients were females (8.11%) under 45 years of age (74%). The main diagnostic categories were anxiety neurosis (25%), depressive neurosis (37%), adjustment reaction with prolonged depression (20%), and adjustment reaction with predominant disturbance of emotions (16%). Cases of psychosis were rare, and they were not related to the disaste[9].

During the same period, in the third month of the post-disaster period, neurological studies were carried out[10]. This was a survey of the gas-affected patients admitted to the various hospitals in the Bhopal City. A total of 129 adults and 47 children were studied for neurological problems. Evidence of involvement of the central nervous system was present in three patients in the form of stroke, encephalopathy and cerebellar ataxia. Affection of the peripheral nervous system was observed in 6 patients. Vertigo and hearing loss occurred in 4 patients. Many patients reported transitory symptoms like loss of consciousness (50%), muscle weakness, tremors, vertigo, ataxia and easy fatigability. Most of these symptoms cleared up after varying periods of time. Of the 47 gas affected children, loss of consciousness at some time or other occurred in half of the patients. Fits occurred during the course of the illness in 3 children. Mental regression was observed in one child who had commenced speaking in sentences but stopped talking after the disaster. There were no abnormalities in the neurological examination in all of the children. An important observation by the doctors who had examined the children during the early phase of illness was generalized hypotonia and weakness. Two children were noted to be "floppy" with weakness of limb movements and had difficulty in getting up from the ground. Of the 3 patients who had central nervous system involvement, the patient with stroke died. His autopsy showed intense congestion and petechial hemorrhages of the gray and white matter with frank hemorrhage in the circle of Willis area, perhaps indicating the sustained microvascular damage by the circulating MIC.

Subsequently, from June 1985, the Lucknow team with the funding from ICMR, New Delhi team conducted a detailed community-level epidemiological study, along with the community level epidemiological study for other health effects. This study included recording of the complaints of subjects, and the record of illnesses and deaths in 100 000 population in the different areas of Bhopal .A fresh census of the total population was undertaken prior to the study. The sampling frame was drawn in such a manner that populations variously exposed to the disaster were included along with a control group located far away from the gas-exposed area, but from the City itself.

The methodology used for screening of the households was interview with the head of the household for the presence of symptoms from a standardized checklist. Those found to have symptoms were further seen by a qualified psychiatrist who administered a detailed mental status examination instrument (PSE-9th version) and arrived at the ICD- 9th Version diagnosis. Each year a new set of families were sampled and studied in addition to follow-up of the patients diagnosed in the previous years.

The results of the first-year survey involved 4,098 adults from 1,201 households. A total of 387 patients were diagnosed to be suffering from mental disorders, giving a prevalence rate of 94/1,000 population. Most of the population consisted of females (71%); 83% were in the age group 16-45 years. Ninety-four percent of the patients received a diagnosis of neurosis (neurotic depression, 51%; anxiety state, 41% and hysteria, 2%) and had a temporal correlation with the disaster. For the next three years, the team repeated the annual surveys and follow-up of the initial patients identified by the community survey. Detailed case vignettes and descriptive accounts of the patients from the Bhopal disaster were prepared.

These general population psychiatric epidemiological studies show that the gas exposed population were having significantly higher prevalence rates for psychiatric disorders in comparison to the general population. The gradient relationship of higher rates of psychiatric morbidity with severity of exposure to the poisonous gas was maintained throughout the 5 years of the survey period. At the end of the five-year period the number recovering fully recovered was small and large numbers continued to experience the symptoms along with significant disability in functioning.

MENTAL HEALTH INTERVENTIONS

One of the challenges faced by the team of psychiatrists was the provision of psychiatric services to the affected population. For a total population of 700,000 and the affected population of about 200,000, there was no psychiatric help available in the city.

A number measures were taken to meet this challenge.

Firstly, the senior psychiatrists (RSM and BBS) worked to prepare clinical vignettes of patients to sensitize the medical professionals and the administrators. Because of the issues of compensation, majority of the administrators and medical professionals considered that the complaints, especially the psychiatric symptoms were imaginary and compensation related. This misconception was corrected by demonstrating the real nature of the symptoms and the universality of the disaster aftereffects on the mental health of the affected population.

Secondly, starting from February 1985, teams of psychiatrists, clinical psychologists, psychiatric social workers from Lucknow were located in the city for periods of 2-4 weeks to provide psychiatric care to the affected population. This was a short-term measure (Sethi et al, 1987).

Third measure was to take up the training of the general medical officers working with the affected population with the essential skills for of mental health care. This was indeed very challenging but was a rapid way of increasing the mental health care in the city.

In view of this importance and it was carried out for the first time in India, and possibly in a developing country, it is described in detail.

Soon after the disaster, additional medical officers were moved to the city and located in the different gas affected areas to provide general medical care to the population. In April 1985, about 50 medical officers were working in the various health facilities in the gas-affected areas. Most of the doctors had no training in mental health as part of their initial medical training, as there were no teachers of psychiatry in the State medical colleges. This lack of training was reflected in their poor perception of the emotional needs of the disaster-affected population. The basic orientation of these doctors was highly medical/biological. In the pre-training interviews most of them expressed the view that distribution of monetary compensation would solve the physical complaints of a large number of their patients. Some expressed the view that the free rations (food grains and other essentials) provided by the state was the reason for the complaints of weaknesses and inability to work reported by most patients. The medical officers believed that the "lethargy" of their patients would disappear not by treatment from doctors or by the use of drugs but by *"stopping the free rations and distribution of compensation money".*

The basic aim of the training was to enhance the sensitivity of the medical officers to the emotional needs of individuals and to provide the skills to recognize, diagnose, treat and refer (when required) the mental health problems[11]. The period of initial training was six working days. It was decided that the training should be as practical as possible and should be imparted to groups not exceeding 20 persons. The methodology of training took into account principles of 'adult learning' viz., an open learning environment in which participants were free to share their needs and experiences, with greater stress on interactive learning. The predominantly lecture approach was changed to case studies and group discussions facilitated by audio-visual, audio taped material of affected population with maximum learner involvement.

The actual training was carried out in two batches by two consultant psychiatrists (i.e. the authors). A manual was prepared for this training on the basis of our experience of training on the basis of experience of training primary care physicians medical officers at National Institute of Mental Health and Neurosciences (NIMHANS), Bangalore. (Issac, Chandrasekar & Srinivasa Murthy, 1984). Additional sections on 'emotional reactions to sudden severe stress'; 'emotional reactions of children to stress and emotional reactions to physical problems' were written and incorporated in the manual. The manual in its draft form was used for the training. A revised manual incorporating the experience of the training and the needs of the medical officers was prepared subsequently and distributed to all the doctors working with the gas affected population (Srinivasa Murthy et al, 1987). For the purpose of the evaluation of the existing pre-training psychiatric knowledge, video presentation of 10 cases was utilized. These included video interviews of the gas-affected population and standard interviews with those having different psychiatric problems.

Each day in the morning, the two faculty members visited the different health facilities and worked with the medical officers to help them learn the interview techniques and counseling methods. This 'live' experience was considered to be very useful by the medical officers. Post-training evaluation of the training was carried out by a simple questionnaire. A total of 38 medical officers took part in the training.

Some of the comments of the participants in the post-training evaluation supported the usefulness of the training. Most of them felt that with the training, they could be of much more capable of treating psychiatric illness and other patients having medical problems as well. Some doctors expressed that earlier, they used to give the patients only symptomatic treatment, but after the training they were able to think and diagnose the condition in terms of a psychological approach. Some doctors mentioned that earlier to the training, they were not aware of any psychiatric problems and were of the opinion that the patients were malingering and giving vague symptoms to evoke sympathetic response and get more medicines. All the doctors who took part in the training agreed that there was need for privacy for interviews support from psychiatrists for difficult cases and there should be a regular supply of psychotropic drugs.

UNRESOLVED ISSUES:

There are a number of unresolved issues of the Bhopal disaster. Bhopal disaster continues to occupy the public space and the people cry out for relief and rehabilitation.

Three of them are of importance.

Firstly, there is an international level debate about the right to know. The Bhopal disaster jolted activist groups around the world into renewing their demands for right-to-know legislation granting broader access to information about hazardous technologies[12].

Secondly, the need for continuing study of the health effects on the population. This need has been voiced by a number of researchers and human rights activists. However, except for limited efforts, large-scale systematic studies are not forthcoming. Long –term monitoring of the affected community has to be done for at least the next 50 years. Formal studies of ocular, respiratory, reproductive, immunologic, genetic and psychological health must be continued to elucidate the extent and severity of long-term effects[13].

Thirdly, the need to provide appropriate medical services to the affected population. 17 years after the disaster, thousands and thousands of men, women and children are still suffering from respiratory illnesses, precocious blindness, cancers and so many other related ailments for which they receive no treatment[14].

The efforts to date are to set up specialized centers[15] without a clear link to community services. It has been repeatedly emphasized that a health-care-pyramid approach be adopted to deal with health problems resulting from the gas leak. Community-level health units should be developed to serve only a maximum of 5000 people. Local hospitals with specialised departments may be used provide secondary care. A specialised medical centre should be established, dedicated to treatment of research into the more serious problems arising from the gas leak. There is clearly an urgent need to develop standard protocols of treatment for the unique problems of the gas-affected population.

(The International Medical Commission on Bhopal, 1990, Srinivasa Murthy, 2001).

Lessons from Bhopal Disaster

1. *Importance Of Mental Health:*

One of the big challenges for a mental health professional is the low priority given to mental health. This is mainly because it is thought of as marginal affecting a small proportion of people without any voice. However, the recognition of mental health of disaster affected populations' switches the value of mental health, from a deviant model to a normalcy model. The recognition that each and every person has a potential risk for mental health problems, following severe stress, makes mental health important to everyone both in terms of its importance as well as community level interventions. For example, in India in the state of Madhya Pradesh, with a population of over 60 million, there were less than a handful of psychiatrists at the time of the disaster. Following the disaster, there was greater awareness of mental health. There has been a significant improvement in the mental health infrastructure; most of it created as a consequence of the disaster. Currently all the medical colleges have psychiatrist in their faculty.

This innovative approaches to utilize study the mental health effects of disasters and to utilize the existing health personnel provide mental health care, initiated at Bhopal, has become the accepted pattern in the country to meet the mental health needs of the subsequent disaster-affected populations[16]. The populations affected by the Orissa supercyclone and the Gujarat earthquake have received attention to mental health and psychosocial needs more promptly than in the earlier disasters[17].

2. ***Integration Of Mental Health With Other Services:***

It is important to recognize the mental health needs and interventions as part of the other needs of the disaster population. The integration has significant advantages in terms of utilizing the available resources, providing psychiatric care without stigma, and as well as harmonizing the physical, social and psychological services. This requires training of all personnel who are working with disaster populations in mental health care.

3. ***Simplification Of Knowledge And Skills:***

The mental health professionals have the challenge of simplifying the information as well as the intervention skills suitable to the affected population, community level helpers, school, teachers, primary care health workers, primary care doctors and other developmental personnel. These programs have to be short, focused and practical rather than theoretical. In addition, they have to be routed in the local cultural ethos of the affected population. Already a number of examples are available in this area.

4. ***Training Of Non-Professionals:***

As noted above non-professionals particularly from the local area should be the primary care providers. In this approach the professionals will have to accept this partnership with the people so that there is no conflict between professionals and nonprofessionals. The training should be located in the field area, should include lot of practical work and the professionals should be able to demonstrate the interventions in the actual community situation.

5. ***Evaluation:***

Mental health professionals have a very important role in evaluating interventions. Currently most of the interventions are based on face validity. Short term and long term evaluations have not been done beyond evaluation of the training programs. Such evaluation should not only look at clinical symptoms but the quality of life of the affected population. There is also need for developing simple tools for evaluation that can be used by non-professionals.

6. ***Research:***

There is a need to study various aspects of the psychiatric problems in disaster-affected populations. Recent reviews of literature in this area have identified the variables like family support, kinship help, and subsequent events in the affected populations as being important in the long-term outcome[18]. The cross-cultural aspect of disaster is only recognized as being important[19].

CONCLUSIONS

Disasters are a challenge everywhere for the affected populations as well as the professionals. However, they represent special challenges and opportunities in India. Bhopal disaster is a milestone in understanding the mental health aspects of disasters. The research has shown the high physical and mental morbidity in the general population and the continuing need for longitudinal health studies. Using a public health approach in priority setting, identification of interventions and training of existing personnel, utilizing the community resources the needs of the population can be addressed. Such situations offer mental health professionals both challenges and opportunities for innovation.

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b. **Write to the Indian Ambassador in your respective countries about the unresolved issues of the Bhopal disaster and ask why the Indian government is neglecting the task of extraditing Anderson.**
c. **Publicize the issues of Bhopal through the media.**
d. **Support the work of the Sambhavna Clinic through financial contribution, donation of equipment and voluntary work.**

For more information please visit: www.bhopal.net and www.bhopal.org

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BHOPAL GAS DISASTER AND MENTAL DISORDER: NARRATIVES FROM THE SURVIVORS

by

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BHOPAL GAS DISASTER AND MENTAL DISORDER: NARRATIVES FROM THE SURVIVORS

"As time passed, Sunil became more and more withdrawn and uncommunicative. Slowly, almost imperceptibility, he found something cracking up within him. He was frequently depressed, and became obsessed by thoughts of suicide. He heard voices call out to him. He would not stir out of his home, would not wash himself or talk to people. The neighbours took care of his brother and sister and fed Sunil.... There were times when he ran out of the house without clothes, feverishly roaming the streets night and day, running for kilometers on the railway track into the forest."

(**'After Bhopal'** by Harsh Mander in *Unheard voices: Stories of forgotten times*, Penguin, 2001, p. 10-11)

Sunil -who was eleven- on 3rd December 1984, was left with his younger brother and sister to cut across his path of survival. He did cut through, but the cost it took on a growing child's mind, was heavy. What I would like to say at this moment is, there are many such stories in Bhopal when we moved around in the city and collected some.

We wanted to listen to stories from the individuals and their families who, according to the popular motion are known to have suffered or are still suffering from mental distress, problems or say disorders, after the gas disaster. Our investigations relied on what people in locality talked about such an individual or individuals, whom they considered to become 'mad' (*paagal ho gaya*) after the disaster.

Let me not get into the discourses on qualitative research methods and its validity, as this is not a forum for methodology workshops. However, curious and interested readers may consult these materials (Bogdan & Taylor 1975, Clifford & Marcus 1986, Denzin & Lincoln 1995, Filstead 1970, Geertz 1973, Johnson 1987, Kapur 1999, Kleinman 1988, Strauss & Corbin 1990,Williams 1984). Rather, this is a forum where we express our serious concern on various aspects of Bhopal gas disaster through our engagement with a systematic study from our area of expertise/ activity. "Fact Finding Mission (FFM)", as we have named it, made us aware that our report must reflect 'facts' about what had been happening at the time our enquiry. However, there are many 'facts' though sometimes 'fictions' such as the one quoted from Harsh Mander's book are stronger than many everyday facts that try to dissolve or dispute crucial experiences.

For me, in search of narratives of mental illness in Bhopal led me to this assertion that my 'fact finding mission' acknowledged 'fiction' in a sense that, mental illness was *not an object* of my study. It was an *engagement*, a pro active one perhaps, with the discourse of mental disorders as mediated by the survivors and their families, which tries to recover a narrative that seriously question whatever happening in the realm of mental health for Bhopal gas Victims. So the facts I present, is consciously coloured subjectivity acknowledging its contribution in the construction of *any form* of knowledge.

Let me share from our research process, which will outline the methods of our data collection. First we organised an orientation workshop to train up investigations on the techniques of open-ended interviews, the basic distinction between major and mental disorders, and knowledge on some problems, which are more common. This was a full day workshop and the next day they were asked to visit the field and comeback with a recording sample. The day next we found many people have dropped and we discussed with the rest on refining the techniques of interview. Finally, six investigators and two volunteers, total eight persons fanned out in those areas of Bhopal, which were known as moderate to severely affected. Though we provided a list to them from the larger survey that was done, but we relied more on popular information and checked them out. Most of the twenty-six people we have interviewed were reached through their community teashops, *paan-dukaan* etc.

The investigators were asked to get the individual's life-stories in two hours. They were instructed *not to ask any diagnostic question* but to elaborate on illness narratives and to see what are the storyteller's concepts of linking gas tragedy to mental illnesses. Many times family members helped when the person concerned could not or would not speak. Three interviews were done with professionals, one Clinical Psychologist, one Psychiatrist and an Ayurvedic practitioner. Both the psychologist and psychiatrist worked in an NGO besides their private clinics. The Ayurvedic practitioner worked in a Govt. hospital and in her private clinic.

From the Hindi transcriptions a processed and translated material was filtered through. This was an important step, where translations were done from the transcripts according to the questions I wanted to focus on, which acted as filters. Thus the voluminous transcriptions were reduced to narratives, crucial to our research question/s.

Gas Disaster and Mental Disorder:

R. Srinivasa Murthy's review research, which one can see is not an exhaustive one on mental health studies that has gone through since the disaster. Yet, it still brings out the major observations that make sense my data. His paper shows clearly that in the early post-disaster phase, studies indicated how gas disaster is linked with mental disorders. This is the reason for which I avoid writing a 'literature review' and this paper should be seen as a complimentary one to Prof. Murthy's review.

Also, the common questionnaire conducted during FFM had some questions on mental health. Out of 3881 respondents 21.2% showed symptoms of anxiety, 21.8% suffered from 'sleeplessness', 10.2% from 'lack of concentration' and 16.8% from 'lack of motivation'. 58.8% of them showed problems of memory in 1984-85, which still remains among 3.5% after 1996. 9.5% of them describe themselves as 'depressed' after the incident.

Veena Das, in her through study (1995) on the suffering of the Bhopal gas victims conceptualized two orientations of suffering, *internal* and *external*. First one, constructs on elaborate discourse on the meaning of suffering, essentially in order to legitimize the producer of the discourse rather than the victim. For the Bhopal case she has noticed how this internal orientation was embodied in the judicial and medical discourse and provided legitimacy to the producers (The scientific profession, the law court) of the discourse.

The second orientation, termed external, did not make the sufferer internalize his/her suffering, neither it posited a meaningful world or a just god or a comprehensive scientific discourse within which suffering can be made comprehensible.

A recent study on disaster mental health (Juvva & Rajendran 2000:532) also comments that, 'at the individual level, post-disaster psychosocial trauma can be manifested in the form of psychiatric disorders such as, major depression, generalized anxiety disorder, substance abuse disturbances, family violence, acute stress disorder and post traumatic stress disorder.'

Our survivors' narratives also show the same pattern with addition of cases of major mental disorders and some mental retardation cases. However, though important, and knowing that alcoholism has increased significantly in Bhopal with liquor-shops and bars everywhere, we did not look for cases of substance-abuse.

Satish (this one and all the names used in case studies are pseudonyms), in his fifties, despite managing job in the state police wanders around and collects junks like old battery cells and takes it to his home and hides it in different places. One of his family members said: *when we got him admitted in the hospital he used to collect clothes women use for their menstruation and talked in a language to the doctors without showing any respect to him.*

Before the disaster he was a responsible person and got his sisters married off, put his brother into a job and took care of the family. After the disaster, his behavior changed. He became more religious and kept referring to morals and ethics of life in a language, which was not so coherent. However, during interview he said: *people who has made the gas-kaand have flourished when [victims] are still asking for death from god... those who are neither living or dead... logon ne Kursi ka gaand maar diya (people have fucked up the arse of the chair)!*

It is not clear from his narrative whether he had ever visited a psychiatrist apart from the usual symptomatic treatments for the effects of MIC, which many people received. But this is clear from his interview (and also from his brother's and wife's comments) that he showed symptoms of flight of ideas with grandiosity and loss of self-care. The family felt that he has lost the understanding of social obligations and the normal association a person normally has with his family.

Naveen is a twenty eight year old young man studied upto the matriculation level. He helps his brother to run a flour-mill (*aata chakki*); his father is in his sixties and mother in late forties. It appeared to the interviewer that the whole family is suffering from the trauma, which is manifested with milder psychological problems. Naveen was a teenager when the gas leak happened. According to him:

" I used to live in Ibrahimganj and my childhood went off very well... but since the gas-kand I have been facing so many problems and will continue to face these problems... there is no surity in my mind... I say anything to anyone. Earlier my memory was good but since the gas tragedy my memory has become weak, I can't recollect events two days old! I have no concentration or interest. I get angry and irritated by small, little things.... I lie down but cannot sleep whether its day or night. I keep forgetting things... I have to leave my studies because of this. I abuse and I myself do not remember what I said... once I had been in a [police] lockup because of this. It seems my present living is not living... but this problem hasn't just happened to me... it has happened to everyone... everyone has mind related problems... many people see my behaviour and say that this person is a little loose... what to do with him?"

It is not very difficult to see that Naveen suffers from a problem of neurosis with perceived memory dysfunction. One can also presume that growing young was not psychologically smooth for him and he tries his best to rationalize with the thought that 'every one is suffering from psychological problems after the *gas-kaand.*'

Let us now listen to the tale of **Amina** who was only an adolescent during the gas leak. Her father died later due to a gas related illness. Her mother is old and brother is married and suffers from a health problem. Amina, at present in her early thirties suffers from a major mental disorder. She was married but deserted first and then divorced. This family belongs to a lower income group and barely manages to survive by selling various things. Amina's mother told us that:

"She was fine in her childhood and studied till fifth standard and passed each year... but after the gas tragedy she started showing abnormality. She abused, did not take her food properly and got into fights. She started having fits initially then her speech became incoherent, she used to tear up clothes and we started her keeping locked up and tied".

When the interviewer tried to talk to her Amina said:

[My name is] *Hema Malini- Hema Malini... people say I am paagal, I look like a paagal... if you have come to befriend me will you tear clothes with me? What have you come for? You look like awara, you look like a slut... I don't want to be friends with you... have you got anything to eat like apple, grapes, I like those.*

Throughout the interview she carried on talking like this and at times threatening the interviewer to throw her out of the room. Her brother said that initially she responded to the treatment and she was married off but soon the problem started at her in laws place and she was brought to our house and later divorced. He said, doctors have said it has happened because of the gas. She was taken to shamans many times and perhaps to a psychiatrist once without any improvement. One can suspect that, due to their low socio-economic status psychiatric treatment could not be continued.

Vimala, now in her mid forties is otherwise a strong person who is fighting out her anxiety and mild, episodic depression through her social commitments as an *Anganwadi* worker. For her, it was not a straightforward case of psychological disorder linked to the gas disaster. And may be, this point out to another fact that many like her must be suffering out of a complex problem where the impact of disaster played an indirect but critical role.

She was born in a place near Itarsi and came to Bhopal after her marriage. She was nostalgic while remembering her childhood and adolescence, particularly about her paternal uncle who still remains an ideal man for her. He was a freedom fighter and died as a bachelor. It was he, who induced her into social work in and a love for poetry. She studied till graduation but her marriage was with a man who was interested in cultivation (*kheti-baadi*). However, it was she who persuaded him to come to Bhopal and start some business. She was energetic too and managed a work in *Anganwaadi* and ran a centre for women where training on literacy and sewing etc. were given.

Somehow her relationship with husband was not good and he kept going to his village and she also had a miscarriage. After the gas tragedy, she saw all kinds of problems started accumulating altogether. Her husband became sick and could hardly do much and their relationship never became better. The family grew bigger as they started living with her elder sister, her husband and their children . She had a boy by this time and her uncle also lived with them. Apart from meeting all the ends in the family becoming difficult, her worries and anxiety about future become intense. She said:

"now... the moment I think something seriously my mind becomes restless.... I am surrounded by problems... life has become a tough struggle, big crises keep coming up".

She also lost her speech for a short time (functional aphonia) years back and recalls with panic that:

"I wonder whether I will become deaf and dumb one day... at times I have pain in stomach which carries on...headache...I get anxious and feel tingling sensations all over my body... sleep gets disturbed. I can't wok half the amount I used to do before the gas tragedy".

Throughout her interview her mood fluctuates, sometimes she is in tears and at times she is exasperated when she fishes out plenty of papers related to claims for compensation. The ideals she had set in her late adolescence seems to be shattered with a fatalistic hope represented in one of many of her poetries:

Who will come to burn my pyre?
Who will come?
Who will come?
Who will come?
The one who has love in his heart?
He will come
He will come
He will come

Vimala's story would attract any psychoanalyst with her strong identification with bachelor uncle as the ideal man and a father figure who virtually brought her up, which explains the indifferent attitude towards her husband. The gas disaster has become more a metaphor than an actual event, which turned her life into a bundle of problems. She is not a *paagal* in the popular sense, neither her doctor could interpret that much of her physical problems were psychosomatic. Yet she represents one of those few, who cope with her mental maladies by engaging herself in social work and also by writing poetries.

Leela, according to her elder sister:

"Was very fine. She could do all the work at home and was regular at school. She was eventually married and started doing well at her in-law's house. Then the gas-kaand happened and she lost her mental balance. The in-laws left her in our house and never took back saying she is a paagal and what will we do with her?"

Leela told the interviewer that, she went for nursing training after her graduation and was enjoying her work in the villages. But this was not true according to her sister and other family members. After the gas disaster she become withdrawn, spoke less and did not show any interest in work. If someone pursued her to do something she starts ---screaming. When situation became worse, she was taken to the Hamidia Hospital but nothing changed much. But the doctors tried ECT (Electro Convulsive Therapy), which did not improve her condition. Sometimes she went out of the house and disappeared for few days. Neighbours complained that she comes out in the mid night and starts knocking at their doors. Once she returned home naked. Her sister does not know how a proper mental health care can be taken of Leela as treatment is expensive and there is hardly any recognition by any Govt. agency that all this happened due to the impact of gas disaster.

If psychiatric researchers are looking for a late onset psychotic disorder, then, **Hasina**_can be an excellent material for them:

Hey girl (to the interviewer)... go away from here...get up and go away...why did you come here? If my husband sees you he will scream.... I have twelve children; they are all in America.... I am very beautiful, more beautiful than you are ... I am not mad.

Hasina's husband said, before the gas (when she was in her mid thirties) she was absolutely okay talking charge of the domestic work and care of their children. It all started after the gas disaster and even after admission to the hospital twice. She never attained her premorbid personality.

Hasina intervenes and starts talking that she is a heroine of Hindi films and she has to rush off to Bombay for shooting and again express her anger toward the interviewer. Her husband said:

"I feel much troubled... she throws stones or anything that is handy... talks incoherently and all the burden of family care is on me... I wanted to get her treated but there is no proper treatment for this".

In addition to these five cases, rest of the twenty-one cases (including two mental retardations) told us the stories how the disaster had torn up their mental world, sometimes into a split and sometimes into a painful path of coping with minor psychological disorders. This otherwise small number of twenty-six mentally distressed individuals came from an age group of 23-56 years and ten of them are women formed the representative world of our study. They belong to the lower socio economic strata to the middle class and accessing psychiatric treatment and continuing them was not possible.

Another interesting feature is that there is a range of mix up with typical physical complaints like fatigue, weakness, breathlessness, watering of the eyes that has been repeatedly shown in various medical studies. One can (if one wishes to) listen to each of the narratives and arrive at a psychiatric diagnosis, which *can* be categorized under schizophrenia, bipolar disorder, depression, generalized anxiety disorder and somatoform disorders. However, none of our stories give us a single classical case of part traumatic stress disorder or PTSD. Or I would say that when you listen to the narratives of mental trauma unhinged with a diagnostic code, you can experience how the balance is broken when all the elements that constitute a 'sane' world, gets badly complicated with the gas disaster playing the central role.

In many interviews we were told with a punch of sarcasms that why now, after so many years, our interest grew to listen to their talks of mental suffering when we have no power to either fight for their claims or to provide better treatments? It is obvious that we had no answers. However, each interview also provided a therapeutic space to let out their repressed negative emotions, perhaps for some cases for the first time. This relates to two issues. One is with the treatment facilities for psychological disorders. None has given us a story where treatment had been proper and continuous. Not a single narrative informed us that despite the continuity of the problems they were heard with empathy and care, which probably were more needed from the viewpoint of their expectations. The second issue relates to the psychosocial care and each family appears to be suffering from some sort of isolation or the other. Listening through all the recordings one wouldn't be making an overstatement that as if the whole of Bhopal is suffering from a kind of emotional bluntness toward the survivors affected with mental illnesses! So let us now look at what the professionals told us.

Professional's Narratives:

"Sorry I can't share anything on gas disaster and mental illness to you"

This is what Dr. Bhiman, a Govt. psychiatrist working in a hospital, said to me when I reached his plush private clinic after setting an appointment! I tried to argue that when today mental health professionals are urging to recognize mental health problems as an important public health agenda, then this silence will contribute to only vested interests! But he only offered me a mysterious smile. I felt, his silence voiced many things that had already been hinted upon by the survivors.

However, responses from mental health professionals working in the NGOs were very different. They shared openly and eagerly their experiences with gas-affected mental patients.

Dr. Samit Ray worked both in a private clinic and in a NGO called *Sambhavna*, which is providing health care services to the survivors who stay in and around J.P. Nagar, which is close to the Union Carbide factory. *Sambhavna* is unique in the sense that they provide both traditional and modern health care services. Dr. Ray helps to run a weekly psychiatry clinic for the survivors. He found a difference between the clients he treats in his private chamber at new-Bhopal and at *Sambhavna*:

"The difference basically is that in my other practice [in new-Bhopal] – what I call my normal practice, I see a whole range of mental illness ... but whereas, when I go to Sambhavna, *a very stereotyped pattern of symptoms are seen over there... And I think, in the last two years, I have seen only two cases of psychosis... not that they are not there, but somehow, they are not coming to me. And the people who are coming, they are coming with minor psychiatric disorders, by that I mean these dysthymias and anxiety disorders and somatoform disorders. So that is the difference".*

For Dr. Ray the key word for this difference is *Ghabrahat,* which he thinks he has encountered only here. It appeared to him as a very peculiar term.

For instance everybody uses the term and when they really go into it, people have different meanings. Now, what they actually mean by Ghabrahat? *Some people use this for anxiety, like* bechainy, darr. *Some people use it for peculiar feelings-say somatic feelings, physical feelings... including nausea, including palpitation and all that. So it seems to be like an umbrella term, which encompasses lot of different, other problems. But usually, it seems to deal with a feeling of restlessness, anxiety, and tension. I think most people feel that when they say* Ghabrahat.

Given the chance to use the American classificatory system called the Diagnostic & Statistical Manual (DSM), he categorized his cases under anxiety disorder, mild depressive disorder, and a lot of somatoform disorders. He finds it difficult to relate the disaster with this stereotypical pattern of mental illness as many years have passed. Looking at it from an objectivist, 'scientific' angle he faces problems of methodology to separate and isolate the present problem from many adhesions that grew up from the 'past' to show that it has a direct link with the disaster. But when he takes up the disaster as a complex process, which plays the role of a crucial metaphor that destabilized many peoples mental world, this link becomes a possible reality.

Kakoli Ray, a clinical psychologist, provides mental health services with her husband Sumit Ray (also a clinical psychologist) through their NGO called *Digdarshika*, shared similar viewpoints while linking the gas tragedy with mental disorders. But she recognized that as far as mental retardation is concerned, there are strong correlations. As most of her clinical work is with disabled children, she has found that lot of mothers who were pregnant during the time of disaster or just had delivered, their children presented with development disorders. Particularly mothers who came from Muslim community and from the old city showed this pattern of brain damage, which led to mental retardation. It would be relevant to note have that her husband, who once worked in an I.C.M.R. (Indian Council for Medical Research) project that studied gas-affected children, saw in the initial phase that a strong relationship was emerging with brain damage and gas disaster. However, for strange and unknown reasons this study was taken off mid way!

She talks in detail about cases where the causes of disability were ascertained through routine assessment procedures to be the gas leak. She observes a strong lack of awareness on this issue in Bhopal and feels that for better rehabilitation programme for such children community based programmes can be an effective intervention. She also laments that resources on mental health (both human and other) is poor in a state capital like Bhopal and that too after such an unparallel disaster.

Dr. Rashmi Jha is an ayurvedic practitioner and also does acupuncture therapy apart from her job in the Govt. Ayurvedic Hospital. She came to Bhopal in 1984 March. She said:
"No one can forget the tragedy. I got many patients affected with that – mainly women, who have lost their children, husbands – could not forget those deadly memories... in the days they

remain occupied with their work but in the night the memories start haunting as if someone has started a film on".

She talked about a different kind of mental stress in women linked with the problems of menstruation, particularly those who had miscarriages after the disaster. They constantly suffer from an anxiety that whether the same sort of gynecological problem will happen to their children or not.

She has observed another interesting phenomena among her women clients that, they complained of their husbands becoming more irritated and violent after the gas tragedy, which made their mental distress more complex to copc with. Despite her explanation that, men are like that in a patriarchal society who are potentially violent, her clients repeatedly said that:

[No] didi, mian (husband) was more loving and caring before the gas-kaand, but now he has become different, always irritated and without any reason get violent.

She interprets this as a kind of generalized social psychopathology that has occurred in Bhopal but also says: 'I have not collected data on this systematically and analyzed, so my statement is more experiential and impressionistic that scientific.'

She herself has suffered from the disaster both physically and mentally and gives a classical description of episodes that we call posttraumatic stress disorder. It even happened to her in China when she was taking an advanced training in acupuncture. Perhaps, this has made her more empathetic to her women clients and also led her to think strongly that much of her patients who came with mental complaints have a link with the impact of disaster. In her therapy for that she combines counselling with acupuncture therapy and some relaxation exercises. She has repeatedly said in the interview that: *because we make our diagnosis mostly based on our patient's history so it is necessary to believe in those which correlates the gas tragedy with their psychosomatic illness. Also I have gone myself through similar processes, so I never thought that my patients were talking me lies.*

Rashmi Jha's opinion is both crucial and unique in the sense that, she did not formulate from an objectivist view point by giving subject hood to her patients and drew on her own subjectivity. Her narrative brilliantly shows the spilt in a professional discourse where reality does not lie only on verifiable positivistic 'facts.'

Our Realisation:

It is now possible to argue based on the synoptic representations of brief life story narratives of those twenty-six individuals from Bhopal and also from the interviews of professionals that, the Bhopal gas disaster had indeed, made an impact on the mental health which still carries on after seventeen years. Despite the problems of a well designed, thorough, and so called scientific research with finer and sensitive tools that may prove in one way that the disaster has caused mental illnesses among the population, our brief cultural anthropological endeavour is a major eye opener to a forgotten reality.

The disaster, as it appear from our exploration is not constructed with the centrality of MIC. The 'gas' has been transformed into a collective metaphor. As described in a recent text (Mehta, 2000:164-165):

Bhopalis have very personal relationships with the 'gas'...People know the gas like a member of their family-they know its smell, its colour, its favourite foods, its predictions.

It has percolated into words, symbols and narratives, which makes and breaks the mental world of the survivors. So, it is necessary to question the relevant authorities and agencies with their singular, omnipotent views of the scientific fact, which does not allow the survivors to fight with their narratives that point out the quality of their survival.

As I have commented before, that some of 'fictions' on the gas disaster are more real than many bland, stereotype, objective facts. I can not resist my temptations to pick up a few sentences by Suketu Mehta who, while his remarkable narrative on 'Bhopal lives' said (Mehta, 2000:163):

A lot has been written about the bare facts of the Bhopal gas disaster: how it night have happened, how many died, how many were injured. What has rarely been portrayed is the complexity of people's individual responses to disaster. Not all in Bhopal passively accepted their victim hood. Many fought, and continue to fight, alone or in groups. And not all the people working for the giant corporation that caused this disaster erased the incident from their consciences. Ultimately, Bhopal is a tragic story, bitter and bloody, a tragedy that has *brought out the worst in some people, yet offered the possibility of redemptions for others.*

Suketu tells us with his 'stories' how the pain of survival repeatedly point out to a reality that asks for a radical reconstruction of 'facts' that is gathering dusts in the cabinets of the scientist and policy makers.

The most crucial realisation we have richer through there narratives that, in spite of major surveys and training on mental Health for doctors and even the recent lessons drawn by Prof. Murthy, the mental health aspect of the survivors of Bhopal remains a neglected area. One wonders what happened to the trained doctors and why the responsible Govt. psychiatrists take a happy refuge in their plush chambers and bypass their tall claims on community mental health? Why mental health services remain limited to few outdoor clinics and some hospital beds where dispassionate clinicians keep swiftly writing the names of innumerable anti-psychotics, anti-depressives and anxiolytics (that too not available free of cost!) without looking into what actually this happens in the lives of these faceless clients? Isn't it relevant to ask, when endless meetings have happened in the chambers placed at the end of Govt. corridors on the urgency to develop mental health services, which those quantitative researches indicated? Since mid 1980's why no mental health social work could be initiated? Why self-help groups could not be developed?

We also realise that with a strong apprehension, when this small qualitative study points out to the fact that, without intervention-research made on emergency footing the mental health scenario will remain unchanged. If figures and tables with sophisticated statistical tools are for some esoteric exercises to be built on survivor's mental trauma, then the scientific community needs to be hit hard with narratives, which has been termed by them as 'fiction' or non-science. As Veena Das has said aptly while working on Bhopal that (Das, 1995:196):
The healing force of social anthropology can come if the experiences of suffering we have encountered.... do not become cause of consolidating the authority of the discipline, but rather an occasion for forming one body, providing voice, and touching victims, so that their pain may be experienced in other bodies well.

Post-Script:

Is it at all possible to make a closure of this text that I have constructed? If not, then the future research activities on mental health of Bhopal survivors is needed to be done on the line of what we call participatory action research, which will change not only the mental distress of the survivors but also (and more crucially) the lives of the researchers.

Acknowledgement:

This study would not have been possible without the warm, energetic, friendly and active support from Tarnjit Birdi (popularly known as TJ) who stood beside strongly during moments of despair and frustration that were put forward by different individuals and agencies. Thanking formally would minimise the quality of comradeship she provided.

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OH-1A.

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BHOPAL GAS DISASTER AND MENTAL DISORDER: NARRATIVES FROM THE SURVIVORS

Executive Summary:

This is a qualitative study on the impact of the Bhopal gas disaster on the mental health of survivors. twentysix people were identified by the investigators from the community by asking a key question "tell us who are the people you think have gone mad after the disaster?" These people lived in areas which were moderate to severely affected by the gas.

Investigators, recorded the brief life-histories of the affected individuals, which described in detail, how the disaster has brought mental suffering in their lives ranging from major to minor mental disorders. These narratives also tell us the pathetic state of mental health services generally in Bhopal and particularly for the disaster survivors.

To suppliment the findings, interviews of a clinical psychologist,a psychiatrist and an ayurvedic practitioner were also conducted.

Together with the review research done by Prof. Srinivasa Murthy, this report exemplifies the severity of the situation and the pain, suffering and trauma of the survivors that are still waiting to be healed. It proposes for intervention research on mental services for the survivors on an urgent footing.

30th/31st Afternoon: Presentation. 2:30 - 4:30pm.
: Morning.

: Rajamohan : meeting (Last Year)
Pesticide residue. from } look for his guy.
Agriculture College.

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Surviving Bhopal

Toxic Present - Toxic Future

A Report on Human and Environmental Chemical Contamination around the Bhopal disaster site

by

Srishti

January 2002

For the Fact Finding Mission on Bhopal

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The Bhopal Fact Finding Mission was set up to investigate the current state of the people and environment at the Bhopal disaster site. The mission focused on different aspects namely medical and mental health, environmental, economic, legal and social status of the people living in and around the UCIL plant. Specialist coordinators working on a voluntary basis headed each area of work. This report relates to the environmental aspect of the work.

Environmental Coordinator : ***Ravi Agarwal***, Chief Coordinator, Srishti.
Environmental Investigation : ***Dr. Amit Nair***
Inputs by : ***Kishore Wankhade***, Toxics Link.

Period of Study 1999-2000

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CONTENTS **Page Nos.**

1. Bhopal - The Toxic Noose

What should one do if the food, the soil, the water, and ones own body is contaminated with toxics? Where does one turn, how does one cleanse oneself, just to be able to live healthily and support a livelihood? Where does one turn if there is no access to any resources, and no one is prepared to even believe in your suffering? Can human rights be more violated, than through the slow everyday creeping of poison in ones body, through processes unleashed by a powerful corporate, which is now nowhere to be seen? To protect the citizen is not the reason why we have a Constitution, laws, to be able to have a Right to Life and a healthy one? Should not any environmental and health policy basically attempt to ensure just this? The ongoing saga of the Bhopal tragedy and this report confirms that this is exactly what is not happening.

As the following report once again evidences, Bhopal did not just happen on December 3rd, 1984, it is continuing to happen to those who were unfortunate to live in its vicinity on that fateful day. Not only this generation but the next generations too stands to be contaminated and poisoned by the disaster. Not only is the soil, but also groundwater, vegetables as well as mother's breast milk has found to be contaminated.

1.1 Toxics Entrenched

All media, soil, ground water, vegetables, breast milk investigated were found contaminated by heavy metals, and organochlorines to various degrees. The evidence suggests that the toxics had not only moved across various mediums but had also become part of body burdens. As is well known, some of these toxics accumulate in human fat, and are passed onto the next generation through mother's breast milk. The effects on the infant are traumatic, not only in terms of the amount of toxics, which it receives, and it can exceed a lifetime supply, but also in their nature. Current toxicological knowledge shows that there may be no acceptable level, which can lead to health effects. In children this is especially true since low dosage toxicity can lead to endocrine disruption and hormonal malfunctions, effects of which may only emerge at puberty in some cases.

1.2 Cleanup?

Post contamination clean up is often used as a safety valve when a toxic hotspot has been created through corporate misendemours. However the reality is very different. Can these sites ever be cleaned up? The polluter pays principle is cited in this case. However, more often than not polluters do not pay, and resist attempts to make them do so. Or the amount the polluter may have to pay to clean up the soil and groundwater, even if it were possible, of all the multiple types of toxics there may be, the cost could threaten the existence of the polluter itself. It is hardly likely that such a drastic annihilation for the sake of a mere toxic site would be allowed, or if State laws would push enough to make this happen.

In the US, where clean up has been legislated through their superfund provisions, already there are more than 85,000 known or suspected hazardous waste sites across the country, and the worst 1,300 are listed as Superfund sites. According to the US based NGO PIRG, "Ever since Superfund was created, insurance companies, polluters like DuPont, General Electric, and Union Carbide, and industry trade associations including the Chemical Manufacturers Association (CMA) and the American Petroleum Institute (API), have lobbied Congress to roll back the polluter pays principle and weaken cleanup standards at the nation's worst toxic waste sites. In addition, these groups have fought efforts to expand the public's right to know about toxic chemicals used in the workplace, consumer products and communities."

" Companies seeking to roll back Superfund, the nation's toxic waste cleanup law, gave nearly $100 million dollars to congressional candidates between 1991 and 1997, according to a report released today by U.S. PIRG. The report, Polluter Pay-Off: The Multi-million Dollar Campaign to Roll Back Superfund, details the money given to congressional candidates by 188 political action committees (PACs) of some of the nation's largest oil, chemical and insurance companies as well as trade associations for their industries."

1.3 Corporate responsibility

The post Bhopal era saw the industry coin new terms: Responsible Care is one of them. However, as can be seen time and again Responsible Care or similar corporate responsibility statements are lip service. How does one explain then the dumping of mercury in South India by one of India's largest corporate, Hindustan Lever, also an arm of the international giant Unilever? Or the fudging of EIAs by some of the best known consultants in the world? It increasingly seems that corporates will be as responsible as will be permitted by the community. An unaware disempowered community cannot negotiate a corporate to be responsible.

2. Policy and Legislation

The Bhopal disaster was a watershed in the area of environmental policy and legislation worldwide. Suddenly the horror of the industrial model of development became very stark and real. How and where industries were sited, how they dealt with the dangers which they posed to the communities around them became real questions. After the Love Canal saga, Bhopal probably was one incident, which led to worldwide regulation on chemicals and toxicity. Intertwined with all the information was the fact that communities needed to know and be provided information, besides being participants in industry siting decision making.

Later in 1990, an EPA analysis compared U.S. chemical incidents in the early to mid-1980s to the Bhopal incident. Of the 29 incidents considered, 17 U.S. incidents released sufficient volumes of chemicals with such toxicity that the potential consequences (depending on weather conditions and plant location) could have been more severe than in Bhopal. As a result of this, the *Occupational Safety and Health Administration* (OSHA) was asked to develop programs to prevent chemical incidents, and the US Congress authorized EPA to promulgate the *Risk Management Program Rule (40 CFR 68)* for protection of the public, and OSHA to promulgate the *Process Safety Management Standard (29 CFR 1910.119)* to protect workers. The

Amendments also established the independent U.S. Chemical Safety and Hazard Investigation Board.

While in India too, the post Bhopal scenario realigned thinking on the impacts of chemicals on human health and the environment is in many way, however this it has not translated into practice. The Bhopal disaster led to a political environment where the State had to act, or at least seen to act against such a horror story being repeated. India enacted the wide seeping Environment Protection Agency in 1996, which became the basis of the various laws over time, which deal with toxics effects of chemicals. On the face this Act led to a new framework of legislation to ensure that Bhopal is not repeated.

Yet the focus on all the laws was to manage the toxicity and the waste. The titles of the Rules enacted under the Act, also said as much. Management and Handling became the key words for environmental and human health protection in their intentions. Even though the first Indian policy statement on pollution abatement clearly marked out pollution prevention as the primary intent of the State, this has never translated into practice. The laws lead automatically to the technical path of regulation, and end-of-pipe solutions, without examining the processes, which led to the generation of these hazards themselves.

The inefficacy of this approach was revealed when the Supreme Court started investigating the matter of hazardous waste, prompted by a PIL. The ground situation was disastorous. There were probably many more Bhopal's waiting to happen. In some senses the laws have provided a sense of security, and legitimized the continuance of a toxic legacy. There has been a reluctance to take stern action on a non-complying industry, and the matter of reporting becomes a private affair between the polluter and the regulator since there is no provision for any public disclosure of information. Not only is the regulator incapable of regulating but also in many cases, owing to political interferences or just mere corruption is unwilling to do so.

The common person has little rescourse in such a situation. People are not only alienated through the language of science but also not allowed access to any documents, which may threaten their safety. Industrial siting too has not improved. Industries continue to come up in urban centres and lead to concentrations of large communities around their periphery. Accident preparedness in non existent and the designated local officers entrusted with the tasks of responding in an Bhopal like emergency often are not even aware that they have this responsibility leave alone how to react.

Also the State refuses to act on the basic requirement of better environmental governance that of public information and disclosures, which are almost non-existent in our laws. While the world moved onto legislation such as Toxics Release Inventories (TRI), forcing industry to release data on its emissions, the Indian citizen does not even have the right to know what is going on in next door. In fact there is very little pressure on the corporate to comply with any emission law. Industry siting too has been garbed in ineffective processes such as the Public Hearing processes where Environment Impact Assessments (EIAs) are routinely put up for public comments, and cleared despite any objection that may have been received. The process of information, and public involvement has been totally obfuscated and made mockery of. Consultants are known to ensure that their corporate clients will not only receive an EIA for a proposed project but will also get clearance for them. Industry at any cost is the State line, and anything which stands in the way is quickly overcome, either through a perfunctory and meaningless process, geared to rubber stamp approvals, or through even enacting amendments to existing laws. For example this has recently happened in the new EIA laws, which remove the need for an assesment to be carried out if the project is a small scale one. It is open to question how the scale of operation changes the possible environmental impact of a process, especially if it my entail highly toxic chemicals and wastes.

Recognising the impact of such chemicals on human health then is a far cry. In fact there is such a dearth of data on health impacts, which has been made public, that one would assume that there is no harm being done. The truth is of course far from that. Human health concerns have driven environmental policy round the world, and is the basis of the rejection of the risk assessment approach by many environmental groups worldwide in favour of a precautionary approach.

Such is the state of affairs more than 15 years after the worst industrial accident took place. One can only place the blame on a complete lack of will of the State to act in favour of the citizen. Instead of venturing down a path of clean development and attract the best process in the world, we have set our minds to development at any cost. People have become mere statistics, especially if they are marginalised, poor and voiceless. The Bhopal disaster, and its ongoing human tragedy have not taught us any lessons. In fact we have just not wanted to learn.

2.1 Legislative framework

There are various legislation pertaining to the prevention and control of pollution in India. Even Constitution's 42nd amendment under the Article 48 A, the provision which deals with the protection and improvement of environment reads: "The State shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country". The Courts through various judgements (*Kinkri Devi, L.K. Koolwal*) have also taken a note of provisions of Article 21 and held that environmental degradation violates the fundamental right to life.

There are various laws governing the environment and labour protection and set reasonably good standards, but the implementing machinery is weak and funding of facilities poor. There is too much emphasis on government and its machinery but little or no scope for workers or the community to intervene effectively. The various related laws are:

- *Water (Prevention and Control of Pollution) Act of 1972;*
- *Air (Prevention and Control of Pollution) Act of 1981;*
- *The Environment (Protection) Act, 1986,*

This Act was enacted to implement the decisions taken at the UN Conference on the Human Environment held at the Stockholm in June 1972. This is the first comprehensive law, which covers air, water and noise pollution as also other matters relating to industrial and environmental hazards, including the handling of hazardous material. But this gives a very little right for workers or the community to take action against the polluting units. There is no provision for right to information, no right to take samples, monitor and sue the industry under EPA, unless the government and its authorities co-operate.

- *Hazardous Processes & the Factories Act, 1948:*

The Bhopal Gas Tragedy and the Oleum gas leakage from Shriram Foods and Fertilisers, lead to the amendment in the 1987 to the Factories Act, 1948. The amendment has introduced special provisions related to the hazardous industrial processes in an effort to tackle the risks and dangers not only to the workers but also to the general public residing in the in the vicinity of the factory.

- *The right to information:*

The law makes it compulsory for the occupier of the factory to disclose all the information regarding dangers, health hazards and the measures to overcome such hazards, in case of hazardous processes to the workers, Chief Inspector of factories, the local authority and the general public.

- *Worker's Right:*

Under the Sec. III- A of the factories Act, the workers have a right to:

- Obtain from their Employer information relating to their health and safety at work;
- Get trained within the factory or get sponsored by the employer for getting such training.
- Represent to the Inspector directly or through union representatives in the matter of inadequate provision for the protection of their health or safety in the factory.

- *Manufacture, Storage and Import of Hazardous Chemicals Rules of 1989:*

The main purpose of this rule is to regulate handling and storage of hazardous chemicals and to prevent and contain accidents from the industrial activities and storage involving such hazardous chemicals. Rule 14 requires the Authority specified under the under the column 2 of the schedule 5 to prepare and keep up-to-date an adequate off-site management plan detailing how emergencies relating to a possible major hazard on the site would be dealt with.

- *Public Liability Insurance Act, 1991:*

The Act was passed to provide public liability insurance for the purpose of providing immediate relief to the person affected by an accident occurring while handling any hazardous substance and for matters connected therewith or incidental thereto. It also provides for liability to give relief in certain cases on principle of no fault. It will be the duty of the owner to take out insurance policies.

The Rules provide the list of chemicals with quantities for application of public liability insurance act.

Authority (ies) with legal backing	Duties and corresponding rule
1. MoEF under the EPA –1986	Notification of the hazardous chemicals as per rule 2(e) (i), 2(e) (ii) and 2 (e) (iii)
2. Chief Controller of Imports and Exports under the Import and Export (Control Act), 1947	Import of Hazardous chemicals as per rule 18
3. CPCB and State Pollution Control Board under EPA- 1986.	Enforcement of directions and procedures in respect of isolated storage of hazardous chemicals like: - • Notification of major accidents as per rule 5(1) and 5(2) • Notifications of site as per rules 7 and 9 • Safety reports in respect of isolated storages as per rules 10 and 12 • Preparation of on-site emergency plans as per rule 13
Chief inspector of Factories appointed under the Factories Act, 1948	Enforcement of directions and procedures in respect of industrial installations and isolated storages covered under the Factories Act, 1948, dealing with hazardous chemicals and pipelines • Notification of sites as per rules 7 to 9 • Safety reports as per rules 10 and 12 • Preparation of of-site emergency plans as per rule 13 • Preparation of off-site emergency plans in consultation with District Collector or District Emergency Authority.
District Collector or District Emergency Authority designated by the State Government.	Preparation of off-site emergency plans as per rule 14

- *The Emergency Planning, Preparedness and Response to Chemical Accident Rules (EPPRCA)*

The rule notified in August 1999 provide specific focus on the management of chemical accident emergencies. The regulation requires the management of chemical accident and the key requirements/provisions are.

- Formation of a Central Crisis Group and Crisis Alert system (by the Central Government) with defined functions and roles.
- Formation of State Level, District Level and Local Level crisis groups by State Governments with defined roles and responsibilities in the planning.

Under the Environment Protection Act (1986), *"The Manufacture, Storage and Import of Hazardous Chemicals"*, rules were passed in 1989 to ensure that chemical handlers appropriately warn employees, maintain a safe workplace and are prepared if an emergency situation should occur. The rules also places responsibility in the

hands of different government bodies, called Authorities. These laws are applicable depending on the type and quantity of chemical that one is handling.
Some basic responsibilities of Authorities include[i]:

- Inspect the industrial activity at least once in a calendar year (Rule 3a).
- Prepare and keep current an adequate off-site plan containing details of how emergencies relating to a possible major accident on that site will be dealt with (Rule 14).
- Ensure that a rehearsal of the off-site emergency plan is conducted at least once a year (Rule 14).
- Make a full analysis of accident reports and channel them appropriately (Rule 5).

Some basic responsibilities of handlers include[ii]:

- Gain approval from the appropriate authority before undertaking any activity. This information must include data on the chemicals that will be handled and the maximum that may be found on site at any given time (Rule 7).
- Notify the appropriate authority if there are any applicable changes in the operation such as the quantity or type of chemicals handled (Rule 8).
- Prepare and update annually, a safety report containing information on the industrial activity, identification of all possible hazards and description of how an emergency will be handled, at least 90 days before commencing that activity (Rule 10).
- Identify the major accident hazards (Rule 2a).
- Take adequate steps to prevent such major accidents and to limit their consequences to persons and the environment (Rule 2b-i).
- Provide to the persons working on the site with the information, training and equipment including antidotes necessary to ensure their safety (Rule 2b-ii)
- Take appropriate steps to inform persons outside the site who are likely to be affected about the nature of the major accident and the actions, which should be taken in the event of an accident (Rule 15).
- Prepare and maintain a safety data-sheet to be accessible upon request. This should identify characteristics, health hazards and safety precautions for each chemical (Rule 17).
- Properly label every container of a hazardous chemical clearly. This should identify the contents of the container, the manufacturer and the physical, chemical and toxicological characteristics of the chemical (Rule 17).
- Prepare and maintain an on-site emergency plan containing details on how major accidents will be dealt with and conduct a mock drill of the plan every six months (Rule 13).
- Notify the concerned authority within 48 hours should a major accident occur and furnish a report to the concerned authority with required information (Rule 5).

3. Industrial Siting

Siting is another key issue from an environmental perspective. Siting has many dimensions in India, and has been a key reason for conflict. Often siting is not given adequate importance, as can be seen in the haphazard growth of urban centres in India, as well as the distribution of industry in and around towns. Till date there are no siting laws, only guidelines, though there is now a proposed law.

Siting problems have also been the reason for very active Supreme Court action in the recent past. Some of the key judgments have related to relocating industry or pushing it to use cleaner fuel, such as natural gas. For example, industry has been asked to shift from Delhi as well as the Taj Trapezium, leading to immense human trauma to those working in it.

Poor siting has also led to the growth of cities such as Delhi, Mumbai and Kanpur, owing to the location of Industry here. Such cities are now centers of industry and commerce, leading to high level of pollution. The Bhopal gas disaster of 1984, was an outcome of poor siting, leading to a high death toll following to the high population density adjoining it. Such a trend is being increasing observed in the growing towns of India, and is a worrying feature, since industrial areas have not been clearly defined or located.

There have been numerous responses to decongest such cities from such industrial activity in the recent past. Amongst them is the massive proposed location of over 90,000 industrial units in Delhi, and the relocation of polluting industry near the Taj Mahal. Such relocation has a high human cost, further leading to strife and conflict.

It was in response to one such trend in the capital city of Delhi, that in a case filed by NGOs to prevent an infrastructure hotel's complex form being built in the city, the Supreme Court of India set up a special Environmental Impact Assessment Authority in October 1996, to examine all infrastructure projects in the National Capital Region Delhi, and which has not been transformed into the Environment Protection and Prevention of Pollution Protection Authority since January 1998. This Authority has the powers to reject any infrastructure project in the area on the basis of its environmental impact, which includes siting.

3.1 EIAs

All industrial projects involving an investment amount of Rs 50 crores need to carry out an environmental impact assessment. The Assessment, which is mandated in law under the EIA notification, has a strong component of siting, guided by the Industrial Siting guidelines of 1985. However, of late many projects have been proposed in hitherto inviolate zones such as protected areas, coastal zones, and there is a general pressure on previously agricultural land to be converted to industrial zones. In fact some of the hazardous industry asked by the SC to shift out of Delhi has relocated in the periphery nearby town of Alwar, on agricultural land.

The location of industry is hence slowly changing the face of cities as well as what was earlier rural and agricultural India. There are also local demands from those residing in rural areas to locate industry since these provide jobs and livelihood, to those who were earlier agriculturally based, or were hitherto landless. In Gujarat for example, sugarcane factories are dispersed amongst agricultural land, and share water and air resources with them. In many senses the rural economy is becoming industrialized, since both the crops being grown as well as those employed have either urban market linkages or are part of the extended industrial resource base, such as sugarcane for sugar factories.

Expectedly then, industrial siting is a very political issue. Both the Industry as well as various state governments, see industrialization as key to prosperity, and do not wish to be hampered by any environmental constraint such as siting.

3.2 Siting Process

The first emphasis on industry siting was brought about by the publication of the `guidelines for industry siting' almost fifteen years ago in 1985. Subsequent to these guidelines the Environmental Impact Assessment (EIA) Notification in 1995 lay down the basic procedures to be adopted for the siting of Industry. However the guidelines were not mandatory, and only served, as inputs to the EIAs which were required for certain Industries for obtaining Central clearance for siting.

There have been a number of related efforts to make industry siting a more scientific and ecologically sound process. Amongst these are sections of the CRZ Act (Coastal Regulatory Zone), which prohibits the setting up of industry (amongst other activity) from within 500 m of the high tide line, the Zoning Atlas for Industries project of the CPCB wherein a detailed district wise plan for industry siting based on GIS systems is being developed, and the inadequate Public Hearing Notification April 1997, which makes it mandatory for any EIA presented to the Government to be publicly debated in the area of siting before it is finally cleared.

An experts committee evaluates all EIAs submitted to the Centre. However the experts advice is not taken seriously. Projects are often cleared with recommended changes, which are not implemented especially if the project proponent is a State Body. In the case to the TEHRI dam the experts committee recommended the dropping of the large dam project owing to it not meeting environmental requirements. However a subsequent Committee of secretaries cleared the project irrespective of the advice, and even though it had no environmental expertise. The decision was a political one.

The new proposed Environmental Siting Rules had a series of reactions to the proposal, before they were notified. The Industry felt that those areas with low pollution potential should be taken off the list, as also the 25 Km band should be reduced to 10 Km, stating that the `maximum ground level of pollutants rarely occur beyond 7 Km form their sources.... And that 10 Km would provide adequate safety"[1] It also felt that these restrictions should only be applied to mega-cities of population more than 2.5 million, and that pushing a 25 Km band law would locate industries in rural areas per force.

The Government of Gujarat reacted particularly strongly. In a letter to the Secretary MOEF, the Chief Minister declared the draft as "rigid and draconian,' stating that the "circle approach" to protecting the "so-called" ecologically sensitive area as not

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[1] Nivedita Prabhu, Industry protests against siting norms, The Economic Times, New Delhi, August 29, 1999.

acceptable, since it would seriously "hamper industrial growth, virtually placing the development on a procrustean growth." Citing specific instances the letter says that it would adversely affect investment plans such as the new Indian Oil Corporation's refinery project, the Indian Petroleum Corporation's petrochemical complex, the Gujarat State Fertilizer and Chemical Complex, the Surat based KRIBHCO fertilizer plant, the Reliance Petrochemical complex and Essar Steel plant and the National Thermal Power Corporation's thermal power plant being amongst them

The new law will tend to shift the focus of Industry to rural and small town areas, which will have the potential to have a greater impact on agriculture. However, this has not been considered. Unfortunately, there is no specific focus on agriculture for the purposes of Industrial siting.

3.3 Public Participation

Public participation in industry siting is inadequately facilitated. Though all EIAs before they are cleared, need a public hearing through the *Public Hearing Notification* of April 1997, public information on siting is hard to access. Documents relating to EIAs and siting, as well, as the existing public hearing process does not require that decision reasons be made public, or that issues raised in the public hearing be addressed and made public.

In practice the public hearing process does not involve participatory decision making. The EIA is presented `after the fact' and does not call for participation, till it is too late. Often at this stage there is tremendous pressure and lobbying form the industrial group to have the project cleared irrespective.

Access to information is denied through various means. The law only provides for the availability of a summary of the EIA, but not the EIA itself and it has to be obtained at the State Pollution Control Board office, and even then cannot be photocopied. Often is too technical and not in a local language for the community to make much sense of it.

Information, even if available, is often too technical for it to be used by the community. Often those whose areas the project is slated to come up in are illiterate or unaware of the real impact that the projects might cause. Hence the questions which are posed at the public hearings, often relate to employment opportunities and the ability of the project to provide schooling for children, rather than on other impacts such as on their livelihoods, agriculture, waste dumping etc.

The law itself is silent on the mechanism of redressal of the questions raised in the public hearing. There is no mechanism to ensure that the questions raised are taken account of or the decision of siting changed. The proceeding of the hearing itself are not made public, and the addressal of the queries not documented. Often the Public Hearing is attended by middle of low level functionaries in the State Pollution Control Board, and other local bodies and the process is often perfunctory.

Very rarely have projects been relocated as an outcome of this process, though in more high profile and visible siting, there is an effect. (See EIAA in Urban Planning and Land Use chapter). Some NGOs such as Toxics Link in Delhi are producing information, which can help community groups to evaluate complex projects and to aid them in making the public hearing exercise more effective.

However public hearing implies a people's power to influence a decision. Even though the formal notification came only recently, and that too in a very incomplete way, there has been a tradition of `peoples tribunals' being held on environmental issues in India.

One such series of IPTs which were held recently in end 1998 and early 1999, were by the Human Right's Law Network a Mumbai based NGO which is legally oriented. Normally such tribunals have a public hearing by a panel consisting of lawyers and retired judges. The report is then published, and is used by the media as well as the community as a testimony to their grievances. These also result in public interest litigation.

Another IPT was held by the Mazdoor Kisan Shakti Sangathan a landless agricultural labourers group for outsees of the Bilaspur dam in Tonk district, Rajasthan, in February 1999.

4. The Reality of Implementation of Laws in India

4.1 *The case of India's hazardous waste – Bhopals in waiting*

The High Powered Committee (HPC) on hazardous wastes constituted by the Supreme Court of India in 1997 under the Public Interest Litigation filed by the Research Foundation for Science, Technology and Ecology (1995) recently submitted its report to the apex body, highlighting the state of India's hazardous waste management. In the Chairman's foreword, Prof MGK Menon noted that the "*situation in regard to hazardous wastes in the country is grim. It particularly affects the groundwater systems of the country and remediation is very difficult and expensive. It affects a large numbers of innocent people, workers as well as community, who have to pay for the sins of others.*"

Government apathy towards managing hazardous wastes is apparent from the fact that there is no reliable data available on the quantum and nature of hazardous wastes generated in the country. In the last three years, the Ministry of Environment and Forests have reported four different figures on the quantum of hazardous wastes generated - 0.7 million tones (MT)/ annum in 1997, 9 MT/annum in Jan'2000, 8 MT/annum in Feb'2000 and 4.4 MT/annum in May 2000.

Though the figure is incomplete, the approximate number of hazardous waste generating units in the country is 13,011, out of which 11,138 are authorised and 1873 are illegal according to the HPC report.

4.2 Disposal of hazardous wastes

The situation is alarming as far as the disposal of these wastes is concerned, to say the least. Due to lack of any infrastructure, both due to government's negligence and industry's lack of concern, hazardous wastes is finding its way:

- Along the roadside
- In low lying areas
- Along with the municipal refuse
- On river/canal beds
- In empty spaces within industrial estates[2]

The HPC found hazardous waste being dumped along with municipal wastes. The leachates from such areas may be toxic or infectious, seriously contaminating both agricultural land and groundwater aquifer.

As per the HW Rules, 1989, and the MoEF's 'Guidelines' (1991), hazardous waste generated by industries has to be disposed of in Secured landfill Facilities. The responsibility for identification of sites under the HW Rules, 1989, for the disposal of hazardous waste rests with the respective State Department of Environment. The sites must be located after carrying out EIA's.

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[2] Report of the HPC on Management of Hazardous Wastes, vol.1, page: 97, 2001.

The MoEF, in 1992, formulated a scheme, and thereafter provided financial assistance of Rs 5-15 lakhs to15 states for identification of disposal sites conducting EIA studies. Despite this, till 1997, there was not a single Secured Landfill Facility (SLF) available in the country to dispose of hazardous waste. Only recently three common disposal facilities have come up in the state of Gujarat and one in Andhra Pradesh.

Infact, State Pollution Control Boards of Gujarat and Andhra Pradesh, on a preliminary listing, have reported that they have "more than 40 illegal hazardous wastes dump sites in each state". The cost of remediation of these sites, which have severely contaminated the ground water and soil, will run into millions of rupees, which will be borne by innocent citizens in the form of taxes. As a case in point, the rehabilitation of 350 hectares of contaminated area from toxic effluents in Bichhri, Rajasthan is expected to cost Rs 44 crores.

Table (1) State-Wise (Available) Hazardous Waste Disposal Options[3]

State	Disposal Options	
	No. of Incinerators	No. of eng. Landfills
Andhra Pradesh	20 In Ida	2 TSDFS are planned
Assam	Nil	All units have their own on-site disposal sites
Bihar	Nil	2 proposed
Chandigarh	Nil	Nil
Delhi	-	-
Goa	1	Nil
Gujarat	30	12 are operational
Haryana	7	1(Faridabad site notified)
Himachal Pradesh	-	-
Karnataka	6	4 (On-Site)
Kerala	5	16 (On-Site)
Maharashtra	16	8 sites are being
Madhya Pradesh	8	16 sites identified & 3 notified
Orissa	Nil	3
Jammu & Kashmir	-	-
Pondicherry	1	-
Punjab	9	-
Rajasthan	6	23
Tamil Nadu	10	23+2 under construction
Uttar Pradesh	9	11 identified, 1 acquired, EIA for 8 districts done
West Bengal	Nil	Nil
Total	116	

As indicated in the above tables there are about 116 industrial incinerators in the country, mostly in Maharashtra, Gujarat, Tamilnadu and Andhra Pradesh. According

[3] Report of the HPC on Management of Hazardous Wastes, Vol.1, page: 103.

to the HPC, most of these are merely "combustion chambers or industrial boilers where the maximum temperature is around 500-550° C". This is of particular concern since dioxins and furans, two most deadly toxins produced during burning of chlorinated compounds, ideally form between the ranges of 400-600° C. The type of wastes being burnt in these incinerators includes wastes from oil refineries, pesticides, drugs, petrochemical. All of these wastes contain chlorine.

4.3 Present situation in Bhopal

According to the newspaper reports, people living in the vicinity of the Union Carbide Ltd in Bhopal are scared of the 'Hazardous Waste' lying in the factory compound. There is a growth of high grass and bushes in the compound, if it catches fire then the toxic fumes and gases will be emitted out of the waste.

There is also probability of Toxic Waste leaching to the ground and polluting the groundwater acquifers.

According to Shri Chauhan, a former employee of Union Carbide and currently with District's Industrial Area Depts. says that in the compound of the UCL about 25 chemicals and 'hazardous wastes' lying in there. They are Methyl Isocyanate, Methyl Chloride, Carbon Tetra chloride, Methanol, Phosgene, Chlorine, Tar coal, Mercury, Naphthalene etc and many more.

There is thus an urgent need for a right to information and citizen's action: Citizen action is one of the most effective ways of ensuing long-term change. In order to adequately act however, people must be able to access information in an efficient manner. The Bhopal tragedy spurred the passage of several community right-to-know laws in several countries in the mid 1980's. The idea behind the right-to-know is that if someone is being exposed to a chemical, he has the right-to-know about it. As a result, community members can now access information about contaminated sites and about pollutants being emitted into their neighbourhoods. In India, however, community struggles have had little success in winning the "right-to-know" for ourselves. People should be able to identify any contaminated sites in their area and chemical emissions to the air and water. Giving individuals the resources with which to fight will help keep industry in line and will produce a better-informed citizenry.

5. Summary of Findings

5.1 SOIL SAMPLES

Heavy metals

Among the four heavy metals analysed in the soil samples in residential areas around UCIL, nickel was the most prevalent one. Five of the six soil samples showed nickel contamination, while chromium, mercury and lead were present in three each and two samples, respectively.

The soil samples in the UCIL factory were analysed from four different sites, as different types of chemical reactions were confined to different areas within the factory. Soil samples mostly showed the presence of chromium and nickel.

Mercury was detected in higher levels in the samples collected from the alpha-napthol site and below the Pan filter site. Nickel was present in four of the five sites within the factory premises, while mercury was present in two sites at almost similar quantities, but their levels were comparatively high.

Pesticide HCH (BHC)

The total HCH (BHC) pesticide concentrations in the six soil samples were 9 mg/Kg. The average value of its concentration was 1.60 ppm. Among the six residential areas, J.P Nagar had the highest level of the pesticides HCH with a level of 5.038 mg/Kg, while Nawab Colony, Atul Ayub Nagar had almost similar levels, exceeding slightly over 1 ppm. Among the HCH isomers, the proportion of gamma- HCH exceeded those of beta- HCH.

Among the four sites in the factory premises, the HCH levels were highest at the Sevin Shed. The total HCH in this area was slightly over 8 mg/Kg, which was five times more than those were present in Sevin plant site-I. The Solar Evaporation Pond, which was dumping site outside the premise, showed very low levels of the HCH isomers.

Volatile Organic Compounds (VOC's)

Among the residential areas, J.P. Nagar showed the highest contamination of Volatile Organic Compounds (VOC's) followed by Kanchi Chola, which showed 7.5 times lower than that of J.P. Nagar. Dichlorobenzene was the predominant contaminant in most of the cases. The total VOC level found in the soil samples were 5.86 mg/Kg while their average was slightly lower than 1 mg/Kg. Among the six soil samples, Dichlorobenzene, 1,3,5-Trichlorobenzene and Tetrachlorobenzene were present in all the samples.

All the soils tested for VOC's in the UCIL factory showed positive results. All the soils from the factory site showed Dichlorobenzenes, 1,3,5-Trichlorobenzenes, 1,2,4-Trichlorobenzenes and Tetrachlorobenzenes. Among the four sample sites, the Sevin Shed showed the highest concentration of VOC's. The amounts of VOC's at the other three sites were more or less similar. The total VOC content in the samples was 1.855 mg/Kg while the mean levels in the factory premises was 0.463 mg/Kg. The total VOC content in soils from the Solar Evaporation Pond was found to be 0.268 mg/Kg.

Halo-organics: Dichloromethane and Chloroform

Among the six soil samples from the residential area, Dichloromethane was present in all the samples. The levels ranged from 0.082 to 0.170 mg/Kg with an average amounting to 0.103 mg/Kg. The soil samples from Kanchi Chola showed maximum concentration of Dichloromethane, which was almost twice as compared to the other areas. The other residential areas showed more or less similar amounts of this contaminant.

Chloroform was present in all samples and most of the soil samples contained this compound at fairly similar levels. The average chloroform level in the soil sample was found to be 6.55 mg/L. The highest concentration of chloroform found at Atal Ayub Nagar was 6.77 mg/L, while the minimum found at Kanchi Chola was around 6.27 mg/L.

Soil samples within the factory premises showed both dichloromethane and chloroform. The chloroform in the samples in the factory exceeded those of dichloromethane. The chloroform and dichloromethane levels were almost similar at all soil sampling sites in the factory. The average level of chloroform in the soil was 6.40 mg/Kg, which was 50 times more than dichloromethane.

5.2 GROUND WATER

Heavy metals

Among the ten ground water samples collected from the residential areas around UCIL, all samples contained chromium and nickel, while mercury was present in six and lead in eight water samples. Nickel was the predominant contaminant in water, with an average of 1.0990 ppm, followed by mercury, chromium and lead whose average levels were, 0.567, 0.026 and 0.122 ppm, respectively.

Pesticide HCH (BHC)

The total concentration of the pesticide HCH in the ground water samples from the residential areas was 0.0898 mg/L. The mean level detected in water was 0.011 ppm. Water samples from Anu Nagar and Shakti Nagar were most contaminated with the pesticide HCH, while the other areas had almost similar levels.

The water tested from the factory premises showed 0.115 mg/Kg of the pesticide HCH. This level is ten times more than those present are in the residential areas around the factory.

VOC's (Volatile Organic Compounds)

The concentration of VOC's was highest in Kanchi Chola, while a marginally lower level was found in Anu Nagar. In the other areas, it was almost two to ten times lower than these areas. The mean concentrations of VOC's in the ground water samples of the residential areas were found to be 0.050 mg/Kg. Table 21 indicates the VOC's in ground water samples from the UCIL factory premises.

Water samples from the factory premises contained 0.0331 mg/L VOC's while those from a water pond adjacent to the Solar Evaporation Pond contained 0.008 mg/L VOC's.

Halo-organics: Dichloromethane and Chloroform
All the eight ground water samples contained both dichloromethane and chloroform. However, the dichloromethane levels in water were almost 2 times more than chloroform. Water samples from Rajgarh colony had the highest level of dichloromethane. The average concentration of dichloromethane was 1.63 mg/L. The water samples from Atal Ayub Nagar showed maximum concentration of chloroform. The average concentration of chloroform in water was 0.85 mg/L.

5.3 VEGETABLES

Heavy metals
All the three vegetable samples grown at J.P. Nagar, showed chromium and nickel, while palak showed chromium, nickel, mercury and lead. The levels of heavy metals were found highest in palak than any other vegetables.

Pesticide HCH (BHC)
The total levels of HCH isomers in Brinjal and Palak were almost similar. The gamma-HCH isomer exceeded those of beta-HCH isomer.

VOC's (Volatile Organic Compounds)
Both the vegetables were found to contain VOCs. The dichlorobenzene was the predominant contaminant in the samples. The mean concentration of VOCs in the vegetable samples was found to be 0.132 mg/Kg. The concentration of VOC's was almost similar in both the vegetable samples analysed.

Halo-organics: Dichloromethane and Chloroform
All the three vegetable samples analysed showed the presence of both Dichloromethane and Chloroform. In palak, the dichloromethane levels were almost 30 times more than those present in either radish or brinjal. The average levels in the vegetable samples were 0.0284 mg/Kg.

Chloroform content was more in radish and brinjal when compared to palak. The average chloroform content in the vegetables was 7.51 mg/Kg, which was 264 times more than the mean levels of dichloromethane.

5.4 BREAST MILK

Heavy metals
The predominant metal detected in the breast milk samples was lead, which was found in seven of the eight samples analysed. Chromium was absent in the breast milk, while nickel and mercury were present in two and three samples, respectively. The mean levels of lead were marginally higher than mercury, although mercury was detected in fewer samples compared to lead.

Pesticide HCH (BHC)

All samples of breast milk showed the presence of pesticide HCH. The average level of the pesticide in the breast milk was 2.39 mg/Kg while the levels ranged from 0.179 to 11.44 mg/Kg. The breast milk sample from Shakti Nagar had highest levels for both beta and gamma – HCH when compared to the other samples.

VOC's (Volatile Organic Compounds)

All samples of breast milk contained VOC's. The total VOC content in breast milk samples was 17.12 mg/Kg. The 1,3,5 Trichlorobenzene was the predorninant VOC and was present in all the samples. The sample from Shakti Nagar contained 9.52 mg/L and VOC was highest when compared to other samples. The average level of the VOC in the breast milk was 2.85 mg/Kg while the levels ranged from 0.588 to 9.52 mg/Kg.

Halo-organics: Dichloromethane and Chloroform

All the breast milk samples contained dichloromethane and chloroform. The amounts of chloroform were 3.2 times more than those of dichloromethane levels. The breast milk samples from J.P. Nagar showed highest levels of dichloromethane, while maximum concentration of chloroform in breast milk samples, were from New Arif Nagar. The average concentrations of dichloromethane and chloroform in breast milk were 0.359 and 1.154 mg/L.

6. Discussion

The objective of the present study was to establish the:

1. Presence of toxic contaminants in the factory premises and at dumping sites of the factory away from premises.
2. Quantitative estimations of the toxic chemicals.
3. Mobility of the chemicals.
4. Ascertain the presence of the chemicals in areas adjoining residential areas.
5. Trophic transfer of these chemicals, which essentially is through food chain to humans.
6. Exposure of human infants through breast milk.

The study clearly indicates that the factory is a source of chemical contamination since most of the chemicals used in the factory, are still present in factory and its adjoining residential areas.

The heavy metal nickel constituted up to 35% contamination, while mercury contamination was 21%. The heavy metal distribution was not uniform in different areas in the factory. Mercury was found at very high levels near the Pan filter area, Chromium was present at the Solar Evaporation pond and it constituted 7% of the various toxic chemicals detected at this site. The factory samples still showed almost 4% contamination of volatile organic compounds. The pesticide HCH constituted 40% of contamination near the Sevin Shed, was a point for the formulation of the pesticide Sevin with Lindane (gamma-HCH). Among the halo-organics, the Dichloromethane was fairly consistent amounting to 1% in all the factory samples. The most significant contaminant was chloroform amounted as high as 85% at SEP site, while at the factory it constituted 73% among the various contaminants at the alpha-napthol site, 65% at Pan filter site, 59% near the Sevin plant and 32% near the Sevin Shed.

The samples from the residential areas showed all the toxic chemicals present in the factory and its acquired premises. Among the toxic chemicals analysed in the soil, 56% constituted chloroform, 14% HCH isomers, 8% VOC's and 20% heavy metals. Among the heavy metals nickel constitutes 9%, while mercury and chromium amounted to 5 and 6%, respectively. The groundwater samples showed the highest concentration of dichloromethane, which amounted to 44% of the total toxic chemicals. The water also contained 23% chloroform and 30% nickel. In the vegetable samples, 77% comprised chloroform, while 20% constituted heavy metals. Mercury accounted to 9% while nickel and chromium amounted to 5 and 6%, respectively. The major contaminant in the breast milk was VOC's, which accounted to 40% of the total toxic chemicals detected. The pesticide, HCH formed 34% of the total toxicants, while chloroform constituted 16% of the contamination.

Results of the survey clearly indicate mobility of the toxic chemicals from the emanating source, the UCIL factory to the adjoining residential areas. Further there are no other chemical industries within the radius of 3-5 km from the factory, which have used the chemicals mentioned in UCIL inventory.

Chloroform, HCH, chlorobenzene, nickel and lead are the major contaminant in the residential areas. The UCIL factory was the source for presence of these chemicals in these areas. Chloroform was used as a solvent in the manufacture of methyl carbomyl chloride, an intermediate in Sevin production. Mercury was used s a sealant, while chromium and nickel were from corroded processing equipments and storage facilities. The pesticide, Lindane (gamma-HCH), was used in making a formulation with Sevin. The plant stored chlorinated benzenes; dichlorobenzenes and it had also manufactured these compounds on a small scale, before beginning with Sevin production. The trichlorobenzenes may have produced from isomers, produced during the manufacture of HCH.

The results clearly establish that there has been a serious environmental contamination due to UCIL factory. Although, it has been 16 years since it ceased to function, still, a number of chemicals are present and are making its way to other areas. It is evident, that many of organisms normally thriving in soil would have been wiped out from the contaminated areas. The vegetables grown in the interior of a residential area opposite to the front gate of the factory had the ability to absorb these toxic chemicals and transfer to the next trophic level of a food chain, which may be either herbivore or an omnivore, like human beings. Another very significant aspect is that the human breast milk showed maximum concentrations for VOC's and a higher concentration of the pesticide HCH. It is evident that these carcinogenic toxics are bio-concentrated in the breast milk. Hence, this poses a serious concern to infants, as it is the easiest and shortest route of exposure of number of these suspected carcinogenic chemicals.

No studies were conducted to see MIC in environmental and human samples, since MIC has a very short-life, although extremely toxic. In human autopsy tissues, MIC trimer was found in blood samples (Heeresh Chandra et al., 1991)

7. Toxicology of Chemicals found in the Residential Areas, Drinking water, Vegetables and Breast Milk.

7.1 *Chloroform*

It is a heavy colourless liquid with a pleasant odour. It had been extensively used in the past as an anesthetic. It evaporates into air where it breaks down to phosgene and hydrogen chloride; both of these products are toxic. It does not remain tightly bound to soil, hence easily percolates to the ground water, where it can persist for years.

Toxicological effects: Chloroform has specified as a Group 2B as a possible human carcinogen. Animal studies have shown that liver, kidney and intestines are the main target organs that could be induced to cancerous growth by chloroform exposure. Also, chloroform is known to cause reproductive and birth defects in rats and mice.

According to EPA, the Maximum Contaminant Level of 100 μg/L in drinking water is considered safe for total trihalomethane (THM) content in water (chloroform is one of the THM)

7.2 *Chlorobenzenes*

1. *Dichlorobenzenes-* these are colourless liquids. These are used as intermediates for rubber chemicals, antioxidants, dyes, pigments, pharmaceuticals and agricultural chemicals. It enters the environment, while it is used as a solvent. The major route of human exposure is through inhalation. Dichlorobenzenes causes depression of central nervous system, respiratory tract and eye irritation, anemia, skin lesions, vomiting, headaches, anorexia, weight loss, atrophy of the liver, blood dyscrasias, porphyria and chromosomal disorders in blood samples.

2. *Truchlorobenzenes-*1, 2,3 and 1,2,4- Trichlorobenzenes. Human exposure to this group of chlorobenzenes is mainly through inhalation while other routes include drinking water, food and breast milk. These compounds have the ability to damage the thyroid, liver and kidney.

3. *Tetrachlorobenzenes-* Exposure of the general population is thought to be through food. The group has the ability to damage the thyroid, lungs, liver and kidneys. Workers exposed to tetrachlorobenzenes have shown an increase in chromosomal aberrations. There is large difference in the behaviour of tetrachlorobenzene isomers. 1,2,4,5- tetrachlorobenzenes tend to remain in water and evaporates very little from it. Hence, many aquatic organisms bio-accumulate this isomer, when it is present in water.

4. *Hexachlorocyclohexane (HCH):* A pesticide still widely used in many developing countries. The technical grade comprises of five isomers-alpha, beta, gamma, delta and epsilon. The gamma-HCH referred to as Lindane has the insecticidal activity. Alpha, beta and gamma-HCHs have serious environmental impact. These isomers are very stable, persistent and lipophillic. Once introduced in the environment, they persist for years, which is more especially for the beta-isomer. Human consumption is through food, particularly dairy products, oils and cereals. The HCH moves through the food chain and gets progressively magnified while passing from one trophic level to the other. Human beings, which occupy the

highest trophic level, are the sinks for these toxic chemicals. The chemical gets bio-concentrated in the human milk and infants are exposed to concentrated amounts of the HCH pesticides.

Chronic exposure leads to liver, lung, endocrine and other types of cancer in animals. In addition, toxic effects include shortened lifespan, lower fertility, and behavioral and reproductive changes.

7.3 *Heavy Metals*

Nickel: the metal is one of the essential metals required in extremely small quantities for normal growth and reproduction in plants and animals, including human being. However, a few nickel compounds, especially, oxides, carbonate, acetate and few more, are well known carcinogens. Metallic nickel and its alloys are listed as Group 2B- possible human carcinogens.

It has been observed that workers in nickel refining plants show higher incidence of respiratory tract cancers compared to normal populations. In nickel exposed women workers, pregnancy complication have been observed which include spontaneous abortions, higher incidence of birth malformations, musculo-skeletal and cardiovascular defects. Long-term chronic exposure to nickel has associated with chronic bronchitis and impaired lung functions.

The European Council Directive sets a maximum permissible limit of 50 μg/L nickel for human consumption.

Mercury: It is the only metal that can exist as both liquid and vapor from at ambient temperatures. Mercury is an extremely toxic with no biological functions. There are no mechanisms in the body to remove mercury once it enters the living system. Hence, the metal gets bio-concentrated and biomagnified within the food chain.

Chronic exposure of mercury affects the nervous system, causing tremors, spasms and loss of memory, severe depression, and increased excitability, delirium, hallucination and personality changes. Renal damages have been observed in chronically exposed workers.

The European Council Directive sets the maximum permissible limit of 1 μg/L mercury for human consumption.

Chromium: It is present in two chemical states. Chromium (III) is an essential trace micronutrient required for carbohydrate, protein and fat metabolism. The other, Chromium (IV) is the non-essential and the toxic form. These are corrosive and allergic to the skin. Long-term exposure, particularly air-borne chromium is associated with lung cancers. Chromium (IV) compounds are enlisted as carcinogens by the International Agency for Research on Cancer (IARC).

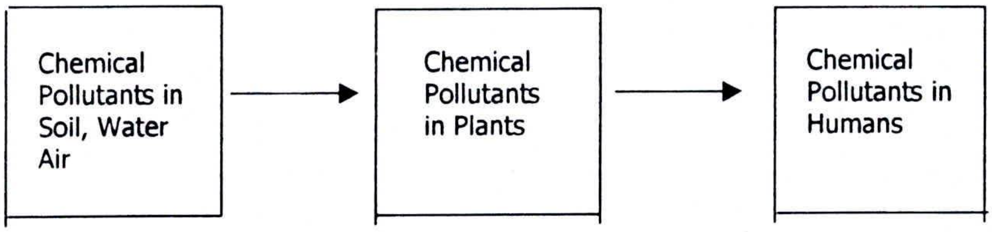
The European Council Directive sets a maximum permissible limit of 50 μg/L chromium for human consumption.

Lead: The elevated presence of Lead in our environment has been issue for decades chiefly because of lead based gasoline products. It is ubiquitous in the environment as a result, in many parts of the world, a significant level of lead turns into human body.

Ingestion of lead may pose great risks to human health. Once free in the eco-system, lead may cause nephorotoxicity, neurotoxocity and hypertension.

8. Understanding the dynamics of chemicals in the environment

When chemicals enter water and air, they are transported thousands of miles from their point of application. In places where there has been no history of chemical use, still chemicals have been detected in soil, water, animals and human. In the North Pole penguins and seals contained chemicals like DDT, Hexachlorobenzene (HCB), Persistent Organic Pollutants (POPs) and heavy metals. It is quite obvious that Eskimos would also be exposed to these xenobiotics. Similarly, water and animal samples collected from Antarctica showed a wide spectrum of chemicals that were never used in these continents.



In the Union Carbide Plant at Bhopal, the manufacture of few pesticides in addition to carbaryl (Sevin) involves the use of a wide range of chemicals followed by the release of intermediates and its final products. All these at some point of time would get released into the environment form where it would move into the three environmental sinks viz. soil, water and air and would eventually find itself entering into terrestrial ecosystems that include plants, herbivores, carnivores and omnivores (humans) or in aquatic chains.

In the manufacture of Sevin, the Union Carbide Plant at Bhopal used chloroform, carbon tetrachloride, chlorine, phosgene and a number of catalysts. In addition the UCIL manufactured formulations of sevin and aldicarb as well. The manufacture of a wide spectrum of chemicals would involve the use of a wide range of chemicals as well. The Table 6 lists the chemicals that were found in the factory premises.

Hence it is quite evident that chemicals and its intermediates depending upon its chemical structure, stability, mobility, half-life, and degradability would contaminate soil, water, air vegetation and humans.

8.1 Process of Contamination of the Ecosystem

The fate of a chemical depends upon its inherent chemical structure and its ability to react in the various environmental compartments. The three environmental compartments include soil, water and air. Chemicals once released enter either of the compartments and further movements to other compartments depend upon its chemical interaction within these compartments.

Chemicals are differentiated into persistent and non-persistent chemicals. Persistent chemicals are those that tend to remain for extremely long periods without further degradation. Hence, once such a group of chemicals are released they pose a lot of problems since these have the ability to enter from any of the other compartments to plants, animals and finally human bodies.

The non-persistent chemicals are those that biodegrade once they are released into the environment. Soil microorganisms degrade these chemicals through a process of co-metabolism into products that may or may not be toxic.

Hence, most chemicals once released into environment are dynamic and move from one compartment to the other from where these enter trophic chains and finally end up in human bodies. If chemicals are present in soil they may undergo the process of biotransformation reactions depending upon their chemical stability. The parent, terrestrial and aquatic animals and finally into human beings. Further, most chemicals undergo bio-magnification as it moves from one trophic level to the other level. Also, within the body they store and get bio-concentrated.

8.2 Waste treatment in the factory

The Union Carbide factory was in the heart of Bhopal and residential areas adjoining the factory was exposed to emissions or effluents released from the factory. All though the Air Act and Water Act existed prior to the disaster, the UCIL did not comply, as the enforcements were not taken seriously. If the factory had complied with safety norms the disaster would never have occurred. Further, after the post disaster era, chemical monitoring both by the Government and independent agencies indicated contamination within the factory premises. It is quite clear that mechanisms such as Effluent Treatment Plants (ETP) to minimize water pollution due to chemical waste were not installed.

Although evaporation ponds were present to collect chemical wastes, the possibility of overflowing during rainfall and contaminating surrounding areas was high.

8.3 Health Implications of chemical pollutants

It is extremely difficult to pinpoint the effect of a single toxic chemical since we are exposed to a wide range of chemical toxins simultaneously. Studies indicate that exposure to chemicals pollutants would show multiple effects that include fever, dairrhoea, respiratory and nervous disorders and cancer.

However, there chemical structure could be used as an invaluable tool to suggest the type of response it would elicit once it is present in the human body.

The health implications of chemicals depend entirely upon its toxicities. A few chemicals are extremely toxic and a single exposure leads to the death or exhibits toxic symptoms to an individual. The exposure of Methyl isocyanate is an example of acute toxicity. In the case of few other chemicals toxicity symptoms are exhibited due to exposure over a period of time. This happens when individuals consume food and food products or is occupationally exposed to chemicals above certain tolerance limits. Although, humans are continually exposed to a wide spectrum of toxic chemicals through food, water and air, it is only when the levels exceed Acceptable Daily Intake (ADI) create health problems.

Chemicals act upon the following systems and alter the normal physiological and biological process in the human bodies: -

1. ***Reproductive system:*** A few chemicals mimic hormones and elicit those reactions that result in the onset of female cycles. The group of chemicals is referred to as Endocrine Disruptors. The pesticide DDT mimics the estrogen hormone and results in altering the timing of female cycles. Many chemical pollutants reduce sperm count in males.

2. ***Immune System:*** A number of chemicals alter the immune system rendering the individuals vulnerable to a host of infections. Most of the pesticides affect the immune systems. Infants and children are the most affected lot since their immune systems are still in developmental stages and most chemical pollutants inhibit immune system generating an immuno-compromised state.

3. ***Nervous System:*** Most chemical pollutants have a significant impact on the nervous system. The pollutants bring about neuro-behavioral changes. Long-term exposures result in motor neuron defects that would result in trembling of fingers, numbness, irritability and loss of memory.

4. Other effect of chemical pollutants includes genotoxicity, tertatogenicity, mutagenicity, and carcinogenicity resulting in disorders in the fetuses.

In India, the Central government had sanctioned major projects to study various aspects of the disaster. The Indian Council of Medical Research (ICMR), report was not made public. Those who had managed to get their hands to the report, found it an extremely poor designed, inferior quality research output, meant more to somehow use the grant rather than see the whole issue for the benefit of the existing survivors (see Table 2).

9. Some Previous Studies

The Indian Council of Medical Research conducted major research projects to study the impact of the gas disaster on human health (ICMR, Report – 1990,92). A total of 25 projects on human health impacts were initiated from 1985. In 1991, sixteen of these were being continued and the remaining concluded.

Table (2) A few of the projects undertaken by ICMR after the Bhopal disaster

S.No.	Name of the projects	Budget (Rupees)	Time frame	Outcome	Status
1.	Long term epidemiological studies on the health effects of toxic gas exposure through community health clinics	65,23,000.	Feb1985, and completion March 1994.	Abortion rates are still higher in exposed areas; Morbidity is still on the rise.	
2.	Studies on clinical and forensic toxicology of Bhopal Gas Disaster.	26,57,632.77	Feb 1985, till Sept 1991.	Project has been stalled because of problems between Principal Investigator and Administrative head	Recommended for continuation till March 1992 review committee.
3.	Establishment of population based cancer registry at Bhopal.	14,52,553	Oct 1985 for rupees till 1991	No evidence to suggest or rule out role of gas exposure in causation of cancer.	Recommended for continuation till March 1992 by review committee.
4	Follow up to see Corneal opacity in gas-affected areas.	22,39,167.00	March 1986 to Sept 1991.	Corneal opacity was more in affected areas.	Staff gone to court.
5	Studies on lens proteins in cataract.	9,55,566	Nov 1986 to Sept 1991	Methods not sensitive enough for studies	Extension requested
6	Studies on Broncho Alveolar lavage	2,04,110	Feb1985 to Sept 1991	Macrophagic alveolitis after 3 years of gas exposure. Cases of Chronic	Review committee terminated work

				bronchitis is on the rise	
7	Radiological spectrum of lung chambers	17,02,539	Feb 1985 to Sept 1991	Pathogenic abnormalities observed	Review recommends termination
8	Chromosomal aberrations in Individuals exposed to MIC	60,67,680	April 1986 to Sept 1991	No results as frequent changes in Principal investigator.	Review committee recommends termination
9	Immunological parameters	31 lacs	June 1985	Most work contributed from outside the country	Review committee recommends termination
10	Mental health studies in MIC exposed population	15,44,800.00	Aug1985	Recovery with passage of time	Review committee recommends termination
11	Organic brain damage - a pilot study	1,49,140.00	Dec1989 to Sept 1990	Localisation of brain damage observed	Review committee recommends termination
12.	Genetic risk evaluation on pregnancy outcomes.	35,98,226.00	Feb 1985 to June 1991	Sample size was too small for interpretation	Review committee terminated the work
13.	Oral, mucosal, gingival and orodental anomalies in children whose mothers were exposed	5,16,210.00	Nov 1986 to June 1991.		Review committee asked the team to submit fresh proposal.
14	Study of pulmonary effects of toxic gases to children	23 lakhs	Sept 1985 to June 1991	Obstructive lung diseases in 15.4% in affected children as compared 8.3% control.	Review committee terminated the work

A few institutes under the Council of Scientific and Industrial Research (CSIR), for instance National Environmental Engineering Research Institute (NEERI), Nagpur and Indian Institute of Toxicological Research (ITRC), Lucknow, carried out environmental and human health. ITRC dispatched a team of experts immediately after the gas disaster as a relief team to treat the gas exposed victims. NEERI conducted environmental surveys around the UCIL premises (NEERI-Report, 1995). NEERI investigated the impact of indiscriminate disposal of wastes by UCIL on the land and water environments. The work was initiated in 1993 and the NEERI executive summary which was available on Nov. 1995, focused upon contamination in the UCIL premises and had no mention on contamination at the residential areas around the UCIL. This was only the first phase of the work, while the second phase could only begin after the Madhya Pradesh Pollution Control Board get legal permission from the court.

It is well known that Madhya Pradesh Government, had licensed the Union Carbide India Limited, and permitted it to be located within a crowded neighborhood.

In 1999, Greenpeace International carried out surveys in order to gain an insight into the nature and severity of chemical contamination (Greenpeace, 1999). Greenpeace analysed samples of solid wastes, soils and groundwater within UCIL and its surrounding areas. Greenpeace found samples to be contaminated with volatile organic compounds and heavy metals. However, the survey did not include human samples.

There is paucity of data on environmental monitoring around the areas within the factory premises of the UCIL.

Most studies focused upon health impacts and were conducted by Indian Council of Medical Research (Table 2). The Post Exposure Mortality Rates were studied by Andersen et al (1985), Patel et al, Banerji et al (1985) and Sathyamala et al (1985). In addition, studies by International Medical Commission (R. Bertell and G. Tognoni, 1996) and Long-term morbidity in survivors in the 1984 Bhopal gas survivors by P. Cullinam (1996) were published in The National Medical Journal of India.

Environmental monitoring studies included those of NEERI and IICT were done to investigate a few pollutants in the premises, contain and remediation measures to prevent further problems. However, these studies lacked follow-up studies. In addition studies by Gary Cohen, The Greenpeace studies were done to estimate levels of a few contaminant in tube-wells around the areas adjoining the factory premises and in soils within factory premise. The Industrial Toxicology Research Centre (ITRC), Lucknow has studied the impact of MIC on plants. However, no other studies were reported since then.

An organisation by the name of Bhopal Group for Information and Action (BGIA), contacted different research organisations to test the water samples, but their request was turned down since, the testing of sample, required clearance from the State government.

The Citizens Environmental Laboratory, Boston, USA agreed to test the water and soil samples from J.P. Nagar. The report indicated high levels of dichlorobenzene and phthalates in the samples. The toxicological effects of dichlorobenzene include damage to liver, kidney and respiratory system while phthalates are toxic to liver. The studies clearly indicate that there is a definite contamination problem around the residential areas surrounding the factory.

10. Current Study

The objective of the present study was to assess the extent of chemical contamination of environmental and breast milk samples around residential areas adjoining the Union Carbide Factory. The focus is on movement of chemicals from soil, water, vegetable and finally to human beings. The study would be useful indicator of chemical contamination of infants.

In the present study a few selected chemicals were chosen primarily on the basis of its extensive use in the factory and its toxic effects. For instance, chloroform a carbon tetrachloride were used in the process of manufacture of carbaryl. The heavy metal mercury was considered since it was used extensively as a sealent. Other heavy metals like chromium, nickel and lead were identified in the survey conducted by IICT. A few other chemicals were considered for analysis after running a mass-spectrum and identifying the presence of few compounds in the spectra.

None of the previous studies including those by Greenpeace have shown the movement of chemical pollutants from one level to another, through the food chain. The present study shows build-up of pollutants i.e. bioaccumulations of toxicants move from one level to another level of the food chain.

Hence, the study around residential UCIL is first of its kind to show the transfer of chemical pollutants through food chain i.e. drinking water and vegetables till it reaches the human infants via the breast milk.

There are three sinks in the environment through which chemical contaminants enter into living forms. These are soil, water and air. The soil is the major sink, followed by water that transfers contaminants through different continents while the air is responsible for a rapid long distance transmission of most of these chemicals. Further, chemical contaminants present in the different compartments can easily migrate from one compartment into another;

The soil is a niche for a diverse type of living forms from microbes to plant parts and animals. When the soil is contaminated with chemicals, it is very likely that chemical toxins transfer into the living components of the soil system. All types of living organisms that thrive in the soil, such as earthworms; plant parts such as root, tuber, bulbs, etc and further reptiles, birds and human beings are exposed to these chemicals through the food chain transfer. In case of water contamination, aquatic living forms such as mollusks (snails), fishes, amphibians, reptiles and water mammals show different levels of contaminants. Similarly, living organisms receive contaminants from atmosphere too, due to absorption, adsorption and inhalation. In the present survey, emphasis is placed tracing the links between contamination of environmental components and human being. With this in view, a pilot study was undertaken to assess the type and level of contamination in soil, water, food and human milk around UCIL factory.

A suitable indicator for human exposure to chemical contamination is to analyse the contaminants in breast milk. The survey would not only indicate the type and levels of toxins within mothers but also show the immediate exposure of toxins to infants through breast-feed.

What exactly poisoned so many lives is still a matter of conjecture. The plant was undoubtedly manufacturing carbaryl (Sevin), a formulation of it with lindane (gamma HCH), small quantities of aldicarb (Temic) and butaphenyl methyl carbamate, all destined for use in the Indian market. However, there has been confusion surrounding the nature of the poisonous gas that took so many lives. Was the gas MIC or phosgene, or a mixture of both or some other deadly toxic gas? The examination of the residues from the faulty tank, revealed twelve compounds. These were MIC, its timer called MICT, Dimethyl urea, Trimethylurea, Trimethylbiuret, Dimethyl isocyanurate, Cyclicdione, Monomethyl amine, Dimethylamine and Trimethyl amine, HCN and Nickel salts. Interestingly, the parent carbide factory is still tight lipped about the nature of the gas.

UCIL had a large stockpile of phosgene when the disaster had occurred.

10.1 UCIL Production Process

The parent Union Carbide Corporation (UCC), West Virginia, USA, proposed the design for the plant at Bhopal, India. The UCIL manufactured the pesticide carabaryl (Sevin), (Union Carbide, Oct, 1978). In the manufacture of Sevin, two lethal compounds available- Methyl Isocyanate (MIC) and Carbonyl Chloride (Phosgene) are required. Initially, MIC was imported to manufacture Sevin, but in 1977, the UCIL plant obtained the technology for the production of MIC from the parent UCC, and by 1980 the UCIL commenced the production of MIC.

Manufacture of the carbamate pesticide, Sevin (Carbaryl).
To manufacture Sevin, there is a need to initially use three ingredients.
They are: -
1. Phosgene - ($COCl_2$)
2. Monomethylamine (MMA) - CH_3-NH
3. Methyl Isocyanate (MIC)- $CH_3N=C=O$

Phosgene also known as carbonyl chloride is manufactured by reacting chlorine with carbon monoxide. The chlorine for this reaction is brought to the plant in a tanker while carbon monoxide was produced from petroleum coke when it was made to react with oxygen. The UCIL had a facility to produce carbon monoxide.
The monomethyl amine was also brought in by a tanker, and was allowed to react with phosgene in the presence of chloroform to produce methyl carbamoyl chloride (MCC) and hydrogen chloride gas. The process is called phosgenatation.
The methyl isocynate (MIC) is produced when Monomethylamine (MMA) is heated.
An Overview of the chemical reactions are: -

1). $COCl_2$ + CH_3NH_2 ------------ $CH_3NHCOCl$ + HCl + Heat
Phosgene MMA MCC Hydrogen Chloride
In step 1, the reaction proceeded in the presence of chloroform ($CHCl_3$).

2). $CH_3NHCOCl$ ----------------- $CH_3N=C=O$ + HCl
MCC MIC
The MIC was collected and stored in stainless steel tank while the remaining HCl, Chloroform were collected recycled for use once again.

3). $CH_3N=C=O$ + alpha napthol --------------- * $OCONHCH_3$ Carbaryl (Sevin)
In step 3, the reaction proceeded in the presence of carbon tetrachloride (CCl_4).

Note: The MMA and chlorine gas was brought in by tank truck from other parts of India and stored in tanks and used whenever MIC was needed to produce Sevin

Other pesticides: Although Sevin was the major pesticide; smaller amounts of other carbamate pesticides were also manufactured using MIC. These were aldicarb (Temic) and butyl phenyl methylcarbamate and a formulation of Sevin-lindane was also made at UCIL.

10.2 Limitation of the present study

The environment survey around adjoining residential areas around UCIL shows substantial evidence of chemical contamination. The present study although undoubtedly indicates extensive chemical pollution, however increasing sample size and sample types could highlight chemical pollution by showing translocation at various levels of the food chain. For instance a link between soil – earthworm – birds (including chickens) could establish how birds were getting poisoned and its possible linkage to humans; similarly aquatic food chains involving water and aquatic organisms like Daphania, mussels and fish and humans could have given transfer in a more sequential pathway. Here, the link between soil, ground water, vegetables and human breast milk has been established. The increase in sample size would also enable incorporation in statistical analysis to show correlation between different pollutants with respect to different sample types. Hence the present study lacks diverse sample types and sample numbers. The paucity of funds in the present study in responsible for reducing sample size and types.

10.3 Future study for assessment

The present study has indicated without any doubt the chemical contamination of human samples. It would be essential now to continue studies on epidemiological surveys and chromosome analysis. It would be worthwhile to study the chromosome aberration in children born after the Bhopal gas tragedy.

11. Survey on Human and Environmental Contamination around UCIL.

The most important task prior to assessment of human and environmental contamination would to be scrutinise the UCIL's inventory for toxic chemicals. Ascertain if, few of these chemicals they would still exist in the environment.

The fate and behaviour of a chemical in an environment is its intrinsic property. It depends upon the constituting elements and the bonds that exist between them and the nature. The physical property like solubility, volatility, boiling point, melting point as well as chemical properties such as reactions in air, water and in different environmental factors depends upon the intrinsic property, characteristic to it.

The UCIL inventory indicates a wide spectrum of compounds that were reactants, catalysts, byproducts or the end products. It would be a futile task to test for each of them since; many would not be present because of their short half-lives or would be transformed into other harmless products by natural environmental conditions. It would be worthwhile to consider those chemicals, which are toxic and also persistent i.e., remain over long periods of time in the environment.

In the present environmental and human contamination survey, the presence of a few Heavy metals, Pesticides and Volatile Organic Carbons (VOC's) in samples were investigated.

1. Heavy metals: A total of four heavy metals were tested in the samples. These are
a). Mercury (Hg)
b). Lead (Pb)
c). Chromium (Cr)
d). Nickel (Ni)

2. Pesticides: HCH (BHC) isomers, like gamma-HCH (Lindane), alpha- HCH, beta-HCH were considered.
Note: Sevin (carbaryl) and Temic (aldicarb) were not considered because of their short half-lives in the environment.
3. VOC's: Dichiorobenzene, 1,3,5-trichlorobenzene, 1,2,4-trichlorobenzene, 1,2,3-trichlorobenzene and tetrachlorobenzene.
4. Halo-organics: Chloroform and Dichloromethane

The factory started operating from 1969 and till 1977 it used dump all effluents in an open pit near the eastern wall of the factory. Then onwards most but not all, effluents used to be discharged into the two solar evaporation ponds (SEP), behind and outside of the factory. The solar evaporation ponds were spread in an approximate area of 22 acres. The lime pit effluents and other organic wastes were discharged into the evaporation ponds. The evaporation ponds were lined with a film of polythene to prevent seepage. However, one should not overlook the fact that polythene sheet are not corrosive proof and a wide spectrum of chemicals present in the effluents, like acids can easily destroy their structure.

The UCIL had two lime pits 28 feet in length X 12 feet breath X 12 feet D* each having two compartments. The primary neutralisation pit of a size 22 feet X 12 feet X 12 feet and the secondary neutralization pit of 6 feet X 12 feet X 12 feet were separated by a concrete wall. Hydrochloric acid is pumped to the lime pit for neutralisation and the effluents from here go to the evaporation pond. Although, the UCIL management insists that the spent lime is replenished, that after every time acid is neutralised, some lime is used up in the process, this cannot be ascertained. In rainy season, these effluents used to overflow and enter into sewages that used to pass through J.P. Nagar, a slum cluster opposite the main gate of the factory. It has been 17 years since the closure of the factory, but still the hand pump and the community water have a strong stench of organic solvents.

11.1 Chemicals dumped within the factory premises.

The UCIL workers with more than 10 years experience of working in the factory reported that the following chemicals (Table 3) have been dumped within the factory premises by the factory management.

Table 3: Chemicals dumped in the factory site.

Chemical	Use	Dumped amount in MT
Alpha-napthol	As slurry and dust	50.00
Chloroform	Solvent in MIC plant	100.00
Carbon tetrachloride	Solvent in Sevin plant	200.00
Methanol	Solvent in Temic plant	10.00
Methylene chloride	Solvent in Temic plant	50.00
Mercury	Sealant in Pan filter	1.0
Ortho-dichlorobenzene	Solvent in Napthol plant	250.00
Sevin	As slurry and dust	50.00

In April, 1996, the Indian Institute of Chemical Technology (IICT), Hydria and National Environmental Engineering Research Institute (NEERI), Nagpur, presented their report on the basis of analysis of 2.5 kg sample collected from drums, bags and trolleys near cycle stand godown and soap stone godown.

Table 4: Metals detected in Sevin and alpha-napthol waste*

Metals	Sevin waste (mg/Kg)	Alpha-napthol waste (mg/Kg)
Cadmium	1.247	Below detection limit
Chromium	26.8	42.3
Copper	40.64	7.35
Lead	22.26	4.88
Manganese	487.25	67.66
Nickel	20.85	31.44
Zinc	28.73	17.05

Table 5: Organic chemicals detected in sevin and napthol tar*

Organic chemicals	Sevin tar (mg/Kg)	Napthol tar (mg/Kg)
Volatile matter	3.07	2.83
Napthol content	12.1	23.18

* Analyses conducted by Indian Institute of Chemical Technology (IICT), Hyderabad.

It is worthwhile to mention that none of the analytical surveys conducted post Bhopal disaster, have shown the presence of the pesticides like Sevin and aldicarb were the final products of the factory. Both, carbaryl and aldicarb is non-persistent compound, unlike organochlorines such as DDT and BHC (HCH), and have short half-lives in the environment. Hence, testing for these chemicals would be a futile exercise unless data for this and a few other chemicals had been made available before the disaster (see Table 6).

Table 6: Chemicals dumped by Union Carbide Management around the factory from 1969-84.

S.No.	Chemicals	Quantity (MT)	Use in factory	Nature of pollution
1.	Aldicarb	2.0	Product	Air, water & soil
2.	Alpha-napthol	50.0	Ingredient	Air & Soil
3.	Benzene Hexachloride	5.0	Ingredient	Air, water & soil
4.	Carbaryl	50.00	Product	Air, water & soil
5.	Carbon tetrachloride	500.00	Solvent	Air & water
6.	Chemical waste tar	50.00	Waste	Water & soil
7.	Chlorobenzoyl chloride	10.00	Ingredient	Air, water & soil
8.	Chloroform	300.00	Solvent	Air & water
9.	Chlorine	20.00	Ingredient	Air
10.	Chlorosulphonic acid	50.00	Ingredient	Air & soil
11.	Hydrochlroic acid	50.00	Ingredient	Air & soil
12.	Methanol	50.00	Solvent	Air & water
13.	Methylene chloride	100.00	Solvent	Air & water
14.	Methyl Isocyanate	5.0	Ingredient	Air, water and soil
15.	Mercury	1.0	Sealant pan filter	Water and soil
16.	Monochloro toluene	10.00	Ingredient	Air, water and soil
17.	Monomethyl amine	25.00	Ingredient	Air
18.	Naphthalene	50.00	Ingredient	Air
19.	Ortho dichlorobenzene	500.00	Solvent	Air
20.	Phosgene	5.0	Ingredient	Air
21.	Tri methylamine	50.00	Catalyst	Air
22.	Toluene	20.00	Ingredient	Air, water & soil

Source: Satinath Sarangi, Sambhavana Clinic, Bhopal

The factory became operative in December 1969 and since then till 1984, a major amount of chemical substances like pesticides formulated in the factory, initial reactants, byproducts, catalysts and other substances used, were dumped in and around factory premises. These toxic contaminants in the form of solid, liquid and gaseous products caused pollution in the soil, water and air in and around the factory. Till date, the soil and water around the factory are polluted.

11.2 Dumping of chemicals.

Many toxic chemicals are still remained dumped within the UCIL factory site (see photograph) while others are dumped at the solar evaporation pond (see photograph) that is across the railway track. The UCIL had acquired land for the purpose of a landfill that lay across the railway track. It is understood that toxic wastes were pumped from the factory to this landfill. In fact, this waste dump is present in the other side of the railway track, across the factory. To pump the effluents, it would require pipes to be laid under the railway track, which means it has to be done with prior permission of the railway ministry and technically unfeasible to put anything under the railway track.

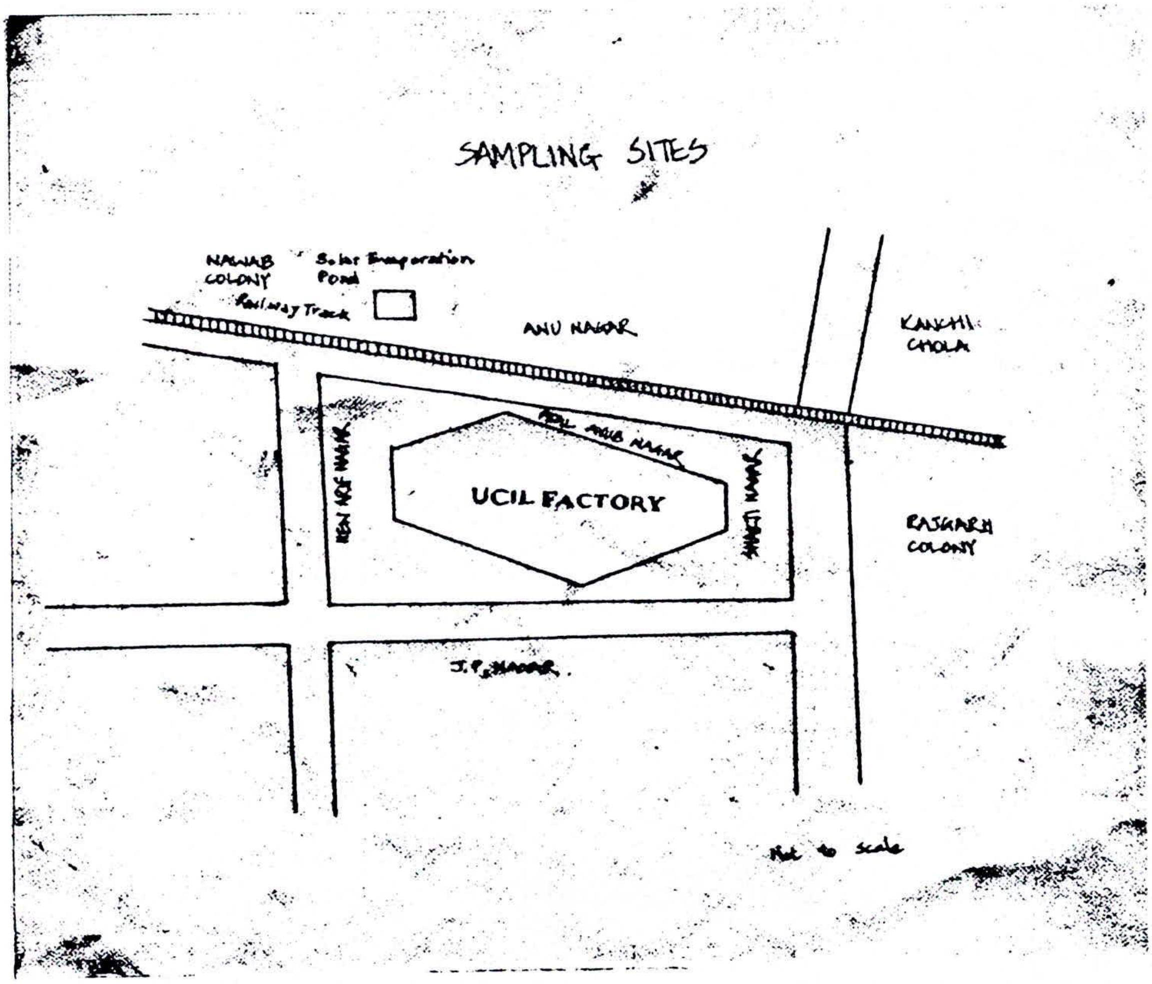
12. Materials, Methods and Results

12.1 *Sampling sites.*

The sampling sites were selected on the basis of their proximity to the UCIL factory and the dumpsites near the factory. In addition, different directions were also selected for sample collection to know the spatial variations in contamination (see figure - 2).

The following sites were selected in the residential areas:

1). J.P. Nagar. 2). Kanchi. 3). Nawab colony. 4). Atal Ayub Nagar
5). Anu Nagar.6). Arif Nagar. 7). Ramgarh Colony. 8). Factory premises



12.2 *Samples.*

In order to investigate the environmental transfer of a chemical toxin, it would be imperative to first detect and quantitate a few of these suspected chemical toxins in the environment and then ascertain if there is a route for human exposure.
In this study, the following samples were tested for contamination: -

1). Soil: The levels in the soil would indicate availability of chemical toxins for living forms of the soil.
2). Water: Its contamination further indicates the easy transfer of chemical toxins to life forms, depending upon the particular water.
3). Food samples: Chemical toxins are absorbed from soil in to vegetables grown in contaminated areas and thus becomes a contaminated link in the food chain.
4). Breast milk: - Contaminant levels indicating toxins present, which can pose danger to next generation.

12.3 *Sample Collection.*

Soil samples: A total of 14 samples were collected for the analyses, out of which 5 samples were from the factory site, while the remaining from the residential areas surrounding the factory site.

The residential areas include Anu Nagar and Nawab colony at the northern side of the factory, Atal Ayub Nagar at the northwest; Kanchi at the northeastern side; J.P. Nagar at the southern side; Rajagarh colony at the eastern side and Shakti Nagar at the south eastern side.

The soil samples from the factory premises include two samples very close to the Sevin plant side, one from the cycle stand site, one close to the alpha napthol plant site and one from the solar evaporation tank which lies across the railway track.
The collections were based on random sampling method where five core sub-samples i.e. from four corners and a central point of a selected site represented a sample for a given area. An auger was introduced 3 inches deep from the surface of the soil to collect the soil sample from each sampling point. All soil samples were collected in transparent polythene bags, labeled and sent to the place of analyses. These samples were stored at -20° C, until extraction for contaminant was done.

Water samples: A total of eleven water samples were collected from the same areas of soil collection. In residential areas, water sample were collected from hand pumps used by the local population for drinking, bathing and washing purposes. The water samples were collected in Teflon capped 2.5 L brown bottles, to minimize the photolyis of light sensitive compounds in the water samples. In addition, water samples were also collected within the factory premises i.e. within the Sevin plant area and from an open pond adjacent to the solar evaporation pond. Samples were transported to the laboratory, and stored in a deep freezer maintained at -20° C.

Food samples: In one of the residential areas, local population grows seasonal vegetables for their consumption. These include radish, brinjal and palak and methi (spinachs). Samples of vegetables were wrapped in foil and sent to the laboratory, where it was stored at -20° C.

Breast milk: A total of eleven milk samples were collected from residential areas adjoining the UCIL factory. All relevant details of the donor like age, number of previous deliveries, socio-economic conditions, etc were collected prior to collection of the samples.

Samples of breast milk were manually collected in 5ml Teflon screw cap Borosil vials and stored immediately at 0° C and transported in an ice box to the laboratory to keep at -20° C until extraction of contaminants was done.

Note: The most difficult part of the survey was the collection of breast milk samples. All efforts at three major government hospitals to acquire breast milk samples proved futile, since, according to the medical superintendent, the government had given strict instructions not to permit any individual/s or from private institutions, other than government agencies, to collect samples related to Bhopal gas disaster. Mr. Sathyu Sarangi, from the Sambhavana Trust provided the milk samples with help of his staff.

13. Chemical Analysis of Samples

13.1 Metals

The sample preparation depends to a large extent on the sample, its matrix and sample treatment which finally determines the accuracy of the procedure. All the samples were thawed prior to extraction. The analysis of metals from the sample, involves sample drying, digestion, extraction and finally the analysis.

Sample drying: Soil samples were dried prior to weighing and dissolution. Air-drying at room temperature was done for soil as substantial loss of volatile elements, such as mercury can occur at elevated temperatures. The water samples (10 ml.) were taken as such without further processing. The plant materials were dried at 80°C till the complete drying as per standard recommended procedures for plant materials.

Digestion and Extraction: The total element in the sample requires complete and vigorous digestion with acids (Aqua regia a mixture of Nitric acid and Hydrochloric acid at a ratio of 3:1) for soil samples. For the soil difestion and extraction of metals 0.1 gm of the sample was mixed 5 ml Aqua regia. The mixture was heated on a hotplate for 30 minutes, and later cooled and filtered. This final volume is made up to 100 ml in a standard flask.

In the case of plant materials, the most satisfactory and universal digestion procedure adopted is the use of concentrated HNO_3 for digestion.

The breast milk samples were totally dried, using a lyophilizer (this process milk is totally dried) used to make infant formulae and later 0.2 gm of the sample was dissolved in 5 ml of dilute HCl and the mixture was heated for 20 minutes and filtered through Whatman no 42 filter paper. This 2000 ppm solution was used for actual analysis. The results are reported for 1000 ppm.

Analysis: The analysis was carried out in a Perkin Elmer model Inductively Coupled Plasma Spectrometer (ICP-OES).

In the present survey, Inductively Coupled Plasma Spectrometer (ICP-OES) carried out the analysis of Chromium (Cr), Nickel (Ni), Mercury (Hg) and Lead (Pb) directly from the extract solution.

Standard preparation: Commercial standards of 10000 ppm concentration from Perkin Elmer were purchased. Multi element standards for ICP-OES analysis were freshly prepared keeping in mind that the elements to be analysed are compatible and are grouped together to avoid precipitation in the mixed solution.
Operating conditions for aqueous solutions: Machine used Integra XL single and dual monochromator. The Integra XL is a fully computerized Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES).

Table 7: The operating conditions of ICP-OES.

ICP - OES.	Specifications
Power	1000 Watts
Nebulizer type	Concentric
Plasma gas flow	10 l/min
Auxiliary gas flow (Argon)	0.7 l/min
Sample gas flow	0.4 l/min
Viewing height	8.0 mm
Pump speed	9.0 rpm

Results
Among the four heavy metals analysed in the soil samples, nickel was the most prevalent one. Five of the six soil samples showed nickel contamination, while chromium, mercury and lead were present in three each and two samples, respectively. The table 8 indicates the concentration of heavy metals in the soil samples collected from residential localities.

Table 8: Concentration (mg/L) of heavy metals in soil samples in residential samples around UCIL factory, Bhopal.

Location	Chromium	Nickel	Mercury	Lead
Anu Nagar	-	1.628	0.9798	-
Atal Ayub Nagar	-	-	2.429	-
J.P. Nagar	1.131	0.2143	-	0.4667
Kanchi Chola	0.7845	0.5779	-	-
Nawab Colony	1.958	2.3700	-	-
New Arif Nagar	-	1.3990	1.2650	0.3533

The soil samples in the UCIL factory were analysed from four different sites, as different types of chemicals reactions were confined to different areas within the factory. Soil samples mostly showed the presence of chromium and nickel.
Mercury was detected in higher levels in the samples collected from the alpha-napthol site and below the Pan filter site. Nickel was present in four of the five sites within the factory premises, while mercury was present in two sites at almost similar quantities, but their levels were comparatively high. The table 9 indicates the

concentration of heavy metals in the soil samples collected from the premises of the factory.

Table 9: Concentration (mg/L) of heavy metals in soil sample within the UCIL factory.

Location	Chromium	Nickel	Mercury	Lead
Pan filter area	-	1.1090	1.8160	-
Sevin Cycle shed	0.0206	4.7660	-	-
Sevin Plant - Outside - 1	0.1520	3.9350	-	-
Sevin Plant - Outside - II	-	4.6820	-	-
Alpha-napthol plant site	-	-	1.8980	-
Solar Evaporation Pond	0.5269	0.0065	-	0.2767

Among the ten ground water samples collected from the residential areas, all samples contained chromium and nickel, while mercury was present in six and lead in eight water samples. Nickel was the predominant contaminant in water, with an average of 1.0990 ppm, followed by mercury, chromium and lead whose average levels were, 0.567, 0.026 and 0.122 ppm, respectively. The table 10 indicates the concentration of heavy metals in the ground water samples.

Table10: Concentration (mg/L) of heavy metals in hand pump water

Location	Chromium	Nickel	Mercury	Lead
Anu Nagar Hand pump - 1	0.0056	0.9036	0.2576	-
Anu Nagar Hand pump - 2	0.0107	0.7804	0.2939	0.0013
Atal Ayub Nagar	0.0117	1.8750	-	-
J.P. Nagar Hand pump - 2	0.0149	0.7447	-	0.0497
Kanchi Chola	0.0210	0.9417	-	0.0548
Nawab Colony	0.0095	1.8000	-	0.0117
New Arif Nagar	0.0057	1.0800	0.1197	0.0398
Rajgarh Colony	0.0143	0.7932	0.0264	0.0413
Solar Evaporation Pond- Pond Water	0.0116	0.1861	0.0343	0.0321
Shakti Nagar	0.0126	0.7155	0.0317	0.0113

All the three vegetable samples grown at J.P. Nagar, showed chromium and nickel, while palak showed chromium, nickel, mercury and lead. The levels of heavy metals were found highest in palak than any other vegetables. The table 11 indicates the concentration of heavy metals in the vegetable samples collected from J.P. Nagar site.

Table11: Concentration (mg/Kg) of heavy metals in a few vegetable samples grown at a residential area opposite to the UCIL factory (J.P. Nagar)

Vegetables	Chromium	Nickel	Mercury	Lead
Brinjal	0.1541	0.3869	-	-
Radish	0.1130	0.1169	-	-
Palak	1.1370	1.2840	2.5100	0.5733

The predominant metal detected in the breast milk samples was lead, which was found in seven of the eight samples analysed. Chromium was absent in the breast milk, while nickel and mercury were present in two and three samples, respectively. The mean levels of lead were marginally higher than mercury, although mercury was detected in fewer samples compared to lead. The table 12 indicates the concentration of heavy metals in the breast milk samples.

Table 12: Concentration (mg/L) of heavy metals in breast samples collected from residential areas adjoining UCIL factory.

Location	Chromium	Nickel	Mercury	Lead
Atal Ayub Nagar	-	-	-	0.0380
J.P. Nagar	-	0.0581	0.0550	-
J.P.Nagar	-	-	-	0.0454
J.P. Nagar	-	-		0.0801
Kanchi Chola	-	-	0.0550	0.3135
New Arif Nagar	-	-	-	0.1517
Rajgarh colony	-	-	0.6665	0.0643
Shakti Nagar	-	0.5235	-	0.2830

13.2 Chlorinated Compounds.

Pesticide analysis was carried out through a Gas-Chromatograph (GC), (Perkin Elmer Autosystem XL). Each sample was analysed twice and the reproducibility of results was almost 90% by the above methods. Recovery studies were performed separately for two soil samples and the results showed recoveries exceeding 90% for all the twelve pesticides. Recovery percentage for HCH was around 87-90%.
The pesticides chosen for study were obtained from RDH Laborchemikalien GmbH & Co. KG D-30918 Seelze via Promochem India Pvt. Ltd, Bangalore India. β-BHC was 99% pure and all the other pesticides were above 99.6% purity level.

The following organochlorine pesticides were analysed.

1. Beta- BHC (1,2,3,4,5,6-hexachlorocyclohexane)
2. Gamma- BHC (1,2,3,4,5,6-hexachlorocyclohexane)
3. Dichlorobenzene
4. Trichlorobenzenes 1,2,3-, 1,2,4-, & 1,3,5- Trichlorobenzenes.
5. Tetrachlorobenzenes
6. Chloroform
7. Dichloromethane

Temperature programming of GC:
1. BHC: 220 to 270°C at a ramp of 2°C per minute
2. Chlorinated compounds: 40 to 70°C at a ramp of 2°C per minute,

Soil
For the pesticide analysis, each soil sample size taken was approximately 500g, out of which representative sub-samples in triplicate (35g) were randomly taken for the analysis. The pesticides were extracted for 8-10 hrs at the rate of 4-5 cycles per hour, in 150 ml of 50%(v/v) acetone in hexane in a Soxhlet extractor (Thao et al.1993b, EPA method 3540). The extract obtained was cooled, filtered and concentrated in a rotary evaporator. The concentrate was again extracted in hexane/water with the help of a separating funnel and dehydrated by passing through sodium sulphate. The solution thus obtained was filtered and concentrated to approximately 5ml. The fractions obtained on with 20%(v/v) dichloromethane in hexane were analysed for the presence of twelve pesticides by GC equipped with a split – split less injection port and selective electron-capture detector (ECD). This detector allows the detection of contaminants at trace level concentrations in the lower ppb range in the presence of a multitude of compounds extracted from the matrix to which these detectors do not respond. The column used was PE-17, length 30m, ID 0.25mm, and film 0.25mm with a 2ml/min flow. The carrier gas and the makeup gas was nitrogen employing the split mode. The oven temperature was kept at 190°C to 280°C with a ramp of 5°C/min. The samples were calibrated (retention time, area count) against 1 to 10 ppm standard solutions of all twelve pesticides. Each peak is characterised by its retention time and the response factors in ECD. Sample results were quantitated in ppm automatically by the GC software. The detection limit was 0.001 mg/Kg for organochlorine and 0.01 mg/Kg for organophosphate pesticides.

Recovery studies were performed separately for three original sample types by spiking the samples with known quantities of different pesticides and subjecting them to similar analytical procedures. The average recovery was almost 92.8% for organochlorines and 89.1% for organophosphates. The reproducibility of results for all the pesticides was 95.8% and above for all the samples. However, the mean average reading of a particular type of sample analysed in duplicate, was considered. One GC injection (30 min) of 5μl covered all twelve pesticides included in the analysis. Hamilton micro syringe injection of the pesticide dissolved in hexane as solvent were made directly onto the coated silanized column solid support, thereby eliminating the possibility of catalytic degradation by metallic surfaces. Pesticides were identified according to their retention times. The actual relative retention times for the different pesticides were compared with unknown samples. The multi-residue method that can detect twelve pesticides in one analytical run was preferred. This method is characterised by a broad scope of application, good recoveries and sensitivity and low solvent consumption, coupled with good analytical quality control.

Milk, Water and Vegetable extraction
Weighed milk sample was extracted with 5-6 drops of 10% Sodium chloride solution and 15% Dichloromethane (DCM) in hexane. Organic layer was collected and the aqueous layer was extracted twice. The three organic layers were mixed and sodium sulphate was added to it, filtered and evaporated the solvent. In order to evaporate the residual DCM, some hexane in the RB was added and evaporated twice. Finally

the volume was made to 5 ml with n-hexane. Pesticides in milk and vegetable were extracted by the method followed by Kumari and Kathpal, 1995; Nair et al, 1996 and Madan et al, 1996.

Results

The total HCH (BHC) pesticide concentrations in the six soil samples were 9 mg/Kg. The average value of its concentration was 1.60 ppm. Among the six residential areas, J.P Nagar had the highest level of the pesticides HCH with a level of 5.038 mg/Kg, while Nawab Colony, Atul Ayub Nagar had almost similar levels, exceeding slightly over 1 ppm. Among the HCH isomers, the proportion of gamma- HCH exceeded those of beta- HCH. The table 13 indicates the concentration of pesticides in residential areas around the factory.

Table13: Pesticide HCH (BHC) in soil samples (mg/Kg) around residential areas adjoining UCIL factory premises.

Location	Beta – HCH	Gamma –HCH
J.P. Nagar	0.2263	4.812
Kanchi	0.3697	0.2208
Nawab Colony	0.0555	1.7181
Atal Ayub Nagar	0.0014	1.0633
Anu Nagar	0.0180	0.0770
New Arif Nagar	0.0404	1.0265

Among the four sites in the factory premises, the HCH levels were highest at the Sevin Shed. The total HCH in this area was slightly over 8 mg/Kg, which was five times more than those present in Sevin plant site-I. The Solar Evaporation Pond, which was dumping site outside the premise showed very low levels of the HCH isomers. Table 14 indicates the concentration of pesticide HCH in the factory premises.

Table 14: Pesticide HCH (BHC) in soil samples (mg/Kg) within UCIL factory premises.

Location	Beta – HCH	Gamma -HCH
Sevin Shed	0.0035	8.2814
Sevin Plant - I	0.3101	1.3777
Sevin Plant - II	0.0897	0.0359
Alpha-Napthol Site	0.0041	0.0663
Solar Evaporation Pond *	Nil	0.0358

* Acquired by the UCIL factory outside the premises of the factory

The total levels of HCH isomers in Brinjal and Palak were almost similar. The gamma-HCH isomer exceeded those of beta-HCH isomer. Table 15 indicates the pesticide HCH in vegetable samples grown close to the UCIL premises.

Table15: Pesticide HCH (BHC) in vegetable samples (mg/Kg) around residential areas adjoining UCIL factory premises.

Vegetables	Beta- HCH	Gamma- HCH
Brinjal	0.0033	0.0294
Palak	Nil	0.0215

The total concentration of the pesticide HCH in the ground water samples from the residential areas was 0.0898 mg/L. The mean level detected in water was 0.011 ppm. Water samples from Anu Nagar and Shakti Nagar were most contaminated with the pesticide HCH, while the other areas had almost similar levels. Table 16 indicates the pesticide HCH in ground water samples adjoining the UCIL factory premises.

Table 16: Pesticide HCH (BHC) in groundwater samples (mg/Kg) around residential areas adjoining UCIL factory.

Location	Beta – HCH	Gamma -HCH
Anu Nagar - II	0.0256	0.0146
Atal Ayub Nagar	0.0016	0.0011
J.P. Nagar	0.0003	0.0015
Kanchi Chola	0.0005	0.0027
Nawab Colony	0.0001	0.0012
New Arif Nagar	0.0016	0.0014
Rajgarh Colony	0.0005	0.0004
Shakti Nagar.	0.0336	0.0031

The water tested from the factory premises showed 0.115 mg/Kg of the pesticide HCH. This level is ten times more than those present in the residential areas around the factory. Table 17 indicates the pesticide HCH (BHC) in water samples within the UCIL premises.

Table 17: Pesticide HCH (BHC) in water samples (mg/L) from the UCIL factory premises.

Location	Beta – HCH	Gamma -HCH
Sevin Plant Site	0.1050	0.0104
Solar Evaporation Pond – Water*	0.0010	0.0175

* Acquired by the UCIL factory outside the premises of the factory

All samples of breast milk showed the presence of pesticide HCH. The average level of the pesticide in the breast milk was 2.39 mg/Kg while the levels ranged from 0.179 to 11.44 mg/Kg. The breast milk sample from Shakti Nagar had highest levels for both beta and gamma – HCH when compared to the other samples. Table 18 indicates the level of pesticide in breast milk samples from the UCIL factory premises.

Table 18: Pesticide HCH (BHC) in breast milk samples (mg/L) in residential areas around the UCIL Factory.

Location	Beta - HCH	Gamma -HCH
Shakti Nagar	5.1367	6.3345
Kanchi Chola	0.0376	0.1414
Rajgarh Colony	0.1912	0.0915
J.P.Nagar	0.6947	0.0154
New Arif Nagar	0.0684	1.3580
J.P.Nagar	0.3271	0.6388
J.P.Nagar	0.0232	0.2343
Atal Ayub Nagar	0.2317	0.1160

13.3 Volatile Organic Compounds (VOC's)

Among the residential areas, J.P. Nagar showed the highest contamination of Volatile Organic Compounds (VOC's) followed by Kanchi Chola, which showed 7.5 times lower than that of J.P. Nagar. Dichlorobenzene was the predominant contaminant in most of the cases. The total VOC level found in the soil samples were 5.86 mg/Kg while their average was slightly lower than 1 mg/Kg. Among the six soil samples, Dichlorobenzene, 1,3,5-Trichlorobenzene and Tetrachlorobenzene were present in all the samples. Table 19 indicates the VOC's in soil samples adjoining the UCIL factory premises.

Table 19: Volatile Organic Compounds (VOC's) in soil samples (mg/Kg) in residential areas around UCIL.

Location	Dichloro-benzene	Trichloro-benzene (1,3,5)	Trichloro-benzene (1,2,4)	Trichloro-benzene (1,2,3)	Tetrachloro-benzene
J.P. Nagar	2.4961	0.7447	0.6070	0.1701	0.1073
Kanchi	0.1096	0.4149	0.0156	Nil	0.0053
Nawab Colony	0.1304	0.1678	0.0063	Nil	0.0060
Atal Ayub Nagar	0.1294	0.0102	0.0127	0.0117	0.0339
Anu Nagar	0.1419	0.0135	Nil	Nil	0.0161
New Arif Nagar	0.1637	0.0140	0.0150	Nil	0.0463

Both the vegetables were found to contain VOCs. The dichlorobenzene was the predominant contaminant in the samples. The mean concentration of VOCs in the vegetable samples was found to be 0.132 mg/Kg. The concentration of VOC's was almost similar in both the vegetable samples analysed. Table 20 indicates the VOC's in vegetable samples collected adjoining the UCIL factory premises.

Table 20: Volatile Organic Compounds (VOC's) in vegetable samples (mg/Kg) in residential areas around UCIL.

Location	Dichloro-benzene	Trichloro-benzene (1,3,5)	Trichloro-benzene (1,2,4)	Trichloro-benzene (1,2,3)	Tetrachloro-benzene
Brinjal	0.2653	0	0.0082	Nil	0.0124
Palak	0.2354	0	0.0073	Nil	Nil

All the soils tested for VOC's in the UCIL factory showed positive results. All the soils from the factory site showed Dichlorobenzenes, 1,3,5-Trichlorobenzenes, 1,2,4-Trichlorobenzenes and Tetrachlorobenzenes. Among the four sample sites, the Sevin Shed showed the highest concentration of VOC's. The amounts of VOC's at the other three sites were more or less similar. The total VOC content in the samples were 1.855 mg/Kg while the mean levels in the factory premises was 0.463 mg/Kg. The total VOC content in soils from the Solar Evaporation Pond was found to be 0.268 mg/Kg. Table 21 indicates the VOC's in soil samples from the UCIL factory premises.

Table 21: Volatile Organic Compounds (VOC's) in soil samples (mg/Kg) in the UCIL

Location	Dichloro-benzene	Trichloro-benzene (1,3,5)	Trichloro-benzene (1,2,4)	Trichloro-benzene (1,2,3)	Tetrachloro-benzene
Sevin Shed	0.1613	0.1974	0.0065	Nil	0.4711
Sevin Plant-I	0.1292	0.1883	0.0044	Nil	0.0233
Sevin Plant –II	0.1124	0.2143	0.0073	Nil	0.0046
Alpha Napthol Site	0.1212	0.2081	0.0056	Nil	Nil
SEP –Soil	0.1215	0.1389	0.0074	0.0006	Nil

The concentration of VOC's was highest in Kanchi Chola, while a marginally lower level was found in Anu Nagar. In the other areas, it was almost two to ten times lower than these areas. The mean concentrations of VOC's in the ground water samples of the residential areas were found to be 0.050 mg/Kg. Table 22 indicates the VOC's in ground water samples from the UCIL factory premises.

Table 22: Volatile Organic Compounds (VOC's) in groundwater samples (mg/Kg) in residential areas around UCIL.

Location	Dichloro-benzene	Trichloro-benzene (1,3,5)	Trichloro-benzene (1,2,4)	Trichloro-benzene (1,2,3)	Tetrachloro-benzene
Anu Nagar	0.0104	Nil	Nil	Nil	0.0007
Atal Ayub	0.0008	Nil	Nil	Nil	0.0007

Nagar					
J.P.Nagar	0.0094	Nil	Nil	Nil	0.0002
Kanchi Chola	0.0147	Nil	Nil	0.0002	Nil
Nawab Colony	0.0012	Nil	Nil	0.0003	0.0006
New Arif Nagar	Nil	Nil	0.0029	Nil	Nil
Rajgarh Colony	Nil	Nil	0.0015	Nil	0.0002
Shakti Nagar	Nil	Nil	0.0060	0.0001	0.0005

Water samples from the factory premises contained 0.0331 mg/L VOC's while those from a water pond adjacent to the Solar Evaporation Pond contained 0.008 mg/L VOC's.

Table 23: Volatile Organic Compounds (VOC's) in water samples (mg/L) from the UCIL factory premise.

Location	Dichloro-benzene	Trichloro-benzene (1,3,5)	Trichloro-benzene (1,2,4)	Trichloro-benzene (1,2,3)	Tetrachloro-benzene
Sevin Plant-ditch	Nil	Nil	0.0025	0.0008	0.0298
S.E.P	Nil	Nil	0.0058	0.0002	0.0007

All samples of breast milk contained VOC's. The total VOC content in breast milk samples was 17.12 mg/Kg. The 1,3,5 Trichlorobenzene was the predominant VOC and was present in all the samples. The sample from Shakti Nagar contained 9.52 mg/L and VOC was highest when compared to other samples. The average level of the VOC in the breast milk was 2.85 mg/Kg while the levels ranged from 0.588 to 9.52 mg/Kg. Table 24 indicates the VOC's in breast milk samples from the UCIL factory premises.

Table 24: Volatile Organic Compounds (VOC's) in breast milk samples (mg/L) in residential areas around UCIL.

Location	Dichloro-benzene	Trichloro-benzene (1,3,5)	Trichloro-benzene (1,2,4)	Trichloro-benzene (1,2,3)	Tetrachloro-benzene
Shakti Nagar	2.2693	0.6226	5.8984	0.4690	02573
Kanchi Chola	Nil	1.5986	0.4120	Nil	0.0386
Rajgarh Colony	0.4580	0.2041	Nil	0.1354	0.0601
J.P.Nagar	0.3380	0.1993	Nil	Nil	Nil
New Arif	Nil	2.1718	0.7450	Nil	0.1094

Nagar					
J.P.Nagar	0.5221	0.1800	Nil	Nil	0.0473
J.P.Nagar	0.3514	0.0369	Nil	0.0327	0.0574
Atal Ayub Nagar	0.7016	0.3826	Nil	Nil	Nil

13.4 Halo-organics: Dichloromethane and Chloroform.

Among the six soil samples from the residential area, Dichloromethane was present in all the samples. The levels ranged from 0.082 to 0.170 mg/Kg with an average amounting to 0.103 mg/Kg. The soil samples from Kanchi Chola showed maximum concentration of Dichloromethane which was almost twice as compared to the other areas. The other residential areas showed more or less similar amounts of this contaminant.

Chloroform was present in all samples and most of the soil samples contained this compound at fairly similar levels. The average chloroform level in the soil sample was found to be 6.55 mg/L. The highest concentration of chloroform found at Atal Ayub Nagar was 6.77 mg/L, while the minimum found at Kanchi Chola was around 6.27 mg/L. Table 25 indicates the Halo-organics in soil samples from the UCIL factory premises.

Table 25: Dichloromethane and Chloroform in soil samples (mg/Kg) around residential areas adjoining UCIL factory premises.

Location	Dichloromethane	Chloroform
J.P.Nagar	0.0901	6.5129
Kanchi Chola	0.1700	6.2668
Nawab Colony	0.0909	6.5327
Sevin Cycle Shed	0.1790	6.6593
Atal Ayub Nagar	0.0815	6.7204
Anu Nagar	0.0995	6.6237
New Arif Nagar	0.0877	6.6174

Soil samples within the factory premises showed both dichloromethane and chloroform. The chloroform in the samples in the factory exceeded those of dichloromethane. The chloroform and dichloromethane levels were almost similar at all soil sampling sites in the factory. The average level of chloroform in the soil was 6.40 mg/Kg, which was 50 times more than dichloromethane.

Table 26: Dichloromethane and Chloroform in soil samples (mg/Kg) collected from UCIL factory premises.

Location	Dichloromethane	Chloroform
Sevin Cycle Shed	0.1790	6.6593
Sevin Plant-1	0.0809	6.6299
Sevin Plant-2	0.1595	6.4971
Alpha Naphthol	0.1177	6.6826
Pan filter area	0.1023	5.5204

All the three vegetable samples analysed showed the presence of both Dichloromethane and Chloroform. In palak, the dichloromethane levels were almost 30 times more than those present in either radish or brinjal. The average levels in the vegetable samples were 0.0284 mg/Kg.

Chloroform content was more in radish and brinjal when compared to palak. The average chloroform content in the vegetables was 7.51 mg/Kg, which was 264 times more than the mean levels of dichloromethane. Table 27 indicates the Halo-organics in vegetable samples from the UCIL factory premises.

Table 27: Dichloromethane and Chloroform in vegetable samples (mg/Kg) around residential areas adjoining UCIL factory premises.

Sample	Dichloromethane	Chloroform
Spinach	0.0797	6.1843
Radish	0.0027	8.2929
Brinjal	0.0027	8.0403

All the eight ground water samples contained both dichloromethane and chloroform. However, the dichloromethane levels in water were almost 2 times more than chloroform. Water samples from Rajgarh colony had the highest level of dichloromethane. The average concentration of dichloromethane was 1.63 mg/L. The water samples from Atal Ayub Nagar showed maximum concentration of chloroform. The average concentration of chloroform in water was 0.85 mg/L.
Table 28 indicates the Halo-organics in water samples from the UCIL factory premises.

Table 28: Dichloromethane and Chloroform in water samples (mg/L) around residential areas adjoining UCIL factory premises.

Location	Dichloromethane	Chloroform
Anu Nagar	0.2580	0.9901
Atal Ayub Nagar	0.1065	1.3591
J.P. Nagar	0.1235	0.8013
Kanchi Chola	1.7250	0.3792
Nawab Colony	0.3377	0.8544
New Arif Nagar	4.2690	0.8673
Rajgarh Colony	4.6035	0.8650
Shakti Nagar	1.6660	0.6710

All the breast milk samples contained dichloromethane and chloroform. The amounts of chloroform were 3.2 times more than those of dichloromethane levels. The breast milk samples from J.P. Nagar showed highest levels of dichloromethane, while maximum concentration of chloroform in breast milk samples, were from New Arif Nagar. The average concentrations of dichloromethane and chloroform in breast milk were 0.359 and 1.154 mg/L. Table 29 indicates the Halo-organics in breast milk samples from the UCIL factory premises.

Table 29: Dichloromethane and Chloroform in breast milk samples (mg/L) around residential areas adjoining UCIL factory premises.

Location	Dichloromethane	Chloroform
Shakti Nagar	0.4109	0.9598
Kanchi Chola	0.0928	1.3965
Rajgarh Colony	1.0896	1.1541
J.P. Nagar	0.1631	1.1337
New Arif Nagar	0.0864	1.4005
Atal Ayub Nagar	0.3080	0.8785

The soil from the Solar Evaporation Pond, a dumping site for UCIL factory, showed both dichloromethane and chloroform. The chloroform levels were almost similar to those present within the factory premises. The pond water samples adjacent to the Solar Evaporation Pond, showed dichloromethane and chloroform and their average concentration were 0.714 mg/L and 0.917 mg/L, respectively.

Table 30: Dichloromethane and Chloroform in SEP dumping site samples (mg/Kg) around residential areas adjoining UCIL factory premises.

Location	Dichloromethane	Chloroform
Solar Evaporation Pond - Soil	0.0972	6.6141
Solar Evaporation Pond - Water	0.7140	0.9165

Table 31: Summary of the analysis of chemical contamination (ppm) around UCIL Factory and adjoining residential areas in Bhopal.

	Heavy Metals				VOC	Halo-organics		Pesticides-
Samples	Chromium	Nickel	Mercury	Lead	Chlorobenzenes	Dichloromethane	Chloroform	HCH isomer
Soil - Residential Areas	0.647 (0.021 to 1.96)	1.032 (0.007- 4.77)	0.568 (0.980 - 2.43)	0.137 0.277 - 0.467)	0.932 (0.1715 – 4.1252)	0.103 (0.0815 - 0.1700)	6.546 (6.2688 to 6.7204)	1.605 (0.095 –5.0383)
Soil-Factory	0.233	2.90	1.857	0.277	0.425	0.128 (0.0809 –0.179)	6.4 (5.5204 – 6.6826)	2.041
Ground water-Residential	0.012 (0.0057 to 0.021)	1.099 (0.7155 - 1.875)	0.057 (0.0264 to 0.2758)	0.026 (0.0013 to 0.0548)	0.006 (0.0015 – 0.0149)	1.636 (0.1065 to 4.6035)	0.849 (0.3792 to 1.3591)	0.011 (0.0009 – 0.0402)
Vegetables	0.475 (0 to 1.137)	0.596 (0.9721 to 1.284)	0.837 (0 to 2.510)	0.191 (0 to 0.5733)	0.132	0.028 (0.0027 to 0.0890)	7.506 (6.1114 to 8.2929)	0.021
Breast milk	ND	0.097 (0.0581 to 0.5235)	0.129 (0.0550 to 0.6665)	0.149 (0.0380 to 0.3135)	2.854 (0.5883 – 9.5166)	0.359 (0.0772 to 1.0896)	1.594 (0.8755 to 1.4005)	2.392 (0.179 – 11.471)

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Annexure

Some Available Standards

Heavy metals	Drinking Water (mg/L) (UAEPA)	Ground Water (µg/L) (USEPA)	Soil (maximum acceptable level) mg/Kg (EU Std)	Vegetables (maximum residue limit)	Breast milk (USFDA) mg/Kg
Chromium	0.1	0.05	100		
Nickel	0.1	0.02	50		
Mercury	0.002	0.001	1	1.0 ppm (USFDA)	
Lead	0.015	0.01	100	5.0 ppm (USFDA)	
Pesticides					
Beta HCH				0.02 mg/Kg EEC legislation	0.1
Gamma HCH	0.004	0.2	0.1 mg/Kg USSR	0.5 to 3 mg/Kg (FAO, WHO)	1.0
VOC's					
Dichlorebenzene	0.6	5			2.5
Trichlorobenzene (1,3,5)					
Trichlorobenzene (1,2,4)	0.07				
Trichlorobenzene (1,2,3)					
tetrachlorobenzene					
Halo-Organics	µg/L (USEPA)				
Chloroform	80				
Dichloromethane	5	5			

OMIA.

THE REPORT ON UNION CARBIDE CORPORATION (UCC)

Union Carbide Corporation (UCC) was formed by the merger of 5 separate US companies in 1917, one of a wave of mergers that consolidated the US chemical industry. In the 1920s and 1930s it became a world leader in research on and production of petrochemicals, becoming the leading producer of basic chemicals such as ethylene and polymers such as PVC. UCC received a great stimulus to growth from World War 2, emerging from the war as the largest US petrochemical producer, while also running major industrial gas and metal alloys operations. By 1963 UCC had become the world's second largest chemical company. In the 1960s UCC diversified into new areas, but it failed miserably as a conglomerate and in the mid-1970s returned to its core products, by 1979 still ranking as the seventh largest chemical company in the world and the third largest in the US. That year UCC also began licensing production technology, which was to become a nice little earner.

UCC internationalised early, moving into Canada in 1924 and England in 1939. In the 1950s UCC set up polyethylene plants in countries as diverse as Brazil, Holland, India and Sweden, by 1957 operating in 27 countries. By 1975 a quarter of UCC's sales were foreign. In 1985 of a worldwide salaried workforce of 50,000, 23,000 worked outside North America.

UCC's involvement in India grew out of its internationalisation strategy, becoming India's first petrochemical proder. In 1974 it announced plans to set up a pesticides factory in Bhopal, intending to pick up on markets created by the Green Revolution.

After the Bhopal massacre, UCC responded by attempting to distance itself from the Bhopal operation, thereby insulating the US parent company from liability. Following an attack from US corporate raider Samuel Heyman, UCC undertook a major restructuring operation which vastly increased debt and slashed its asset base. Following this UCC entered a period of decline, epitomised by its continued slide down the Fortune 500, dropping from 65 in 1990 to 284 in 2000.

Despite this decline, UCC is still a considerable venture, operating factories throughout the US and internationally in Argentine, Belgium, Brazil, Canada, England, Indonesia, malaysia, PRC, Philippines, Thailand and the United Arab Emirates, while also participating in joint ventures in France, Germany, Italy, Japan, Malaysia and South Korea.

UCC has a long history of responsibility for various toxic outrages, including involvement in two of the greatest industrial disasters of the twentieth century. While its responsibility for the Bhopal massacre is well-known, its involvement in the death of hundreds of workers and injury to hundreds more from silicosis on the Gauley Bridge tunnelling project in West Virginia in the 1920s is much less well-known. Throughout its history UCC has shown a consistent disregard for the health of the environment and human beings. Acccording to the US Public Interest Research Group (PIRG) UCC is in the top four of companies responsible for toxic waste dumps in the

US, being responsible for waste at 51 sites on the Superfund National Priority List of toxic dumps requiring clean-up. UCC's involvement in the Manhattan Project and continued nuclear weapons production for the US government has also led to the creation of radioactively contaminated wastelands.

As well as these outrages, UCC's ordinary day-to-day operations represent a hazard to safety and the environment. The company's factories suffer fires and explosions, some resulting in death and injury, others resulting in releases of toxic chemicals.In a recent example over a thousand people sought hospital treatment after a leak from a UCC plant in Sri Lanka in October 2000.

As well as these accidents, UCC's day-to-day operations release large amounts of various toxic chemicals to the environment. The following information is confined to the US, where freedom of information regulations (introduced in response to Bhopal) make this information available. In 1987 UCC's factories in the US emitted some 69,556,343 lbs. of various toxic chemicals into air, water and the ground. By 1999 that figure had dropped to 6,063,839 lbs. The amount of waste generated by UCC in the US has not seen such a significant decrease: in 1991 UCC generated 185,494,608 lbs. of waste, in 1999, 164,247,503lbs.

UCC ceased to operate as a separate corporation in 2001 when it was taken over by Dow, creating the largest chemical corporation in the world. The merger is expected to decimate UCC's workforce and will increase Dow's annual sales to $24.4 bn. The new company will operate in 168 countries and employ 49,000 people. Dow has a long record of criminal behaviour, including supplying napalm and other chemical warfare agents (such as defoliants) to the US war in Vietnam, as well as a long history of involvement in environmental controversies and outrages. The company now claims however to operate to a new philosophy, 'the triple bottom line of sustainability -economic, social and environemntal needs', according to its CEO. It is time for the international community to call on Dow in the strongest manner possible and by all means neccessary to adhere to this philosophy by taking responsibility for Bhopal.

Tomas Mac Sheoin

Summary

During the night of December 2-3, 1984 the world's worst industrial disaster took place in the city of Bhopal in Central India. Large amount of toxic gas leaked from the plant into the surrounding area, which was densely populated. More than 2,000 died immediately and over 200,000 populations were directly affected in a city of 700,000 population. The disaster-affected population have been investigated for the effect of the disaster on their physical and psychological health. Community level studies carried within one month of the disaster to 10 years after the disaster report higher levels of physical and mental health morbidity. Though efforts to provide psychological support to the affected population were initiated using the primary care personnel by focussed training programmes, a system of comprehensive community based health care in general and mental health care in particular, is still not in place. In addition there is need for continuing the research studies into the long-term effects of the disaster and the morbidity in the affected population. The magnitude of the Bhopal disaster and the research efforts to understand the health effects have resulted in greater awareness in India of the psychological aspects of disasters and to include psychological support as part of relief and rehabilitation activities following all disasters.

OH-1A.

SURVIVING BHOPAL: 17 YEARS ON

A FACT FINDING MISSION

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January 15, 2002

To: All Coordinators of FFM

Sub: REPORT ON THE ONE DAY SEMINAR ON ENVIRONMENT, MENTAL HEALTH AND UNION CARBIDE CORPORATION

Dear Friends,

This note is with regard to a day long seminar conducted at the Constitution Club, New Delhi on the 12th January 2002 where The Fact Finding Mission on Bhopal presented its findings on environment, Mental health and Union Carbide Corporation. The findings focused on the continuing damage to physical, mental health and the environment of the survivors along with rising profile of corporation involved.

At the first session on Environment, Mr. Ravi Agarwal of Srishti and Dr. Amit Nair a Toxicologist specialising in pesticide contamination who did the survey and the study presented their report. The report focussed on the evidence of contamination of soil, ground water and mothers' milk by a range of toxic chemicals in alarming concentrations. The findings were based on samples collected by Dr. Amit Nair and analysed at the Laboratory of the Indian Institute of Technology, Kanpur. The study was coordinated by Srishti, a Delhi based NGO specialising in Industrial Wastes issues. This report is likely to have a significant impact on the ongoing class action suit on Bhopal in the U.S. court. We are also hoping that this report would trigger off discussions and debates on the continuing environmental impact of the 1984 gas disaster and the need for urgent action and monitoring of the situation. One of the recommendation of the group is to demand from both state as well the concerned corporation, clean water supply to the affected people in Bhopal as an immediate measure and demand clean up of the toxic site in Bhopal.

The second report was on Mental Health by Prof. Srinivasa Murthy of International repute of the National Institute of Mental Health and Neurosciences, (NIMHANS), Bangalore and Dr. Amit Basu of Jawaharlal Nehru University. Both the reports underlined and reconfrmed that the long term damage done to the psyche of the survivors of the disaster is yet to be dealt with by the state. The report based on both qualitative and quantitative studies carried out in Bhopal found a pattern of mental illness specific to the survivors of the disaster. Both of them lamented the discontinuation of monitoring of the situation as well as periodic assessment and study on the mental health problems on Bhopal. They were also shocked about the lack of concern and mechanisms in health care programmes of the state to deal with the mental health situation in Bhopal. Their report emphasised an urgent need to set in place monitoring mechanisms and systematic long term care for the people mentally affected by the gas disaster.

To Rajkumar & Praveen
for CHESS collection on Bhopal
RN
25/1/02

The report on the Union Carbide Corporation was compiled by Tomas Mac Sheoin, Ireland, internationally acclaimed writer of one of the best books on the Bhopal gas tragedy. His report was based on the study and research on the company's records and its filings to the US Environmental Protection Agencies, Security rxchange commission and other regulatory agencies. The findings indicate that the Corporation remains unscathed and in fact in the subsequent years of the disaster grew in its assets and had world wide access through a series of mergers and spin offs. The report also documents Union Carbide's unhealthy track record in terms of occupational and environmental safety worldwide.

These three reports form part in a series of reports on the aftermath of 1984 Union Carbide gas disaster, envisaged by the Fact Finding Mission on Bhopal after 17 years which was launched in the 14th year of the disaster (1998) with survivors groups and their supporters.

Though the survivors and support organisations have for years demanded for a National Commission on Bhopal there was absolutely no response from the government. Hence initially, it was decided to constitute a "People's Commission on Bhopal" composed of experts, eminent people, survivors and supporters to assess, monitor and respond to the issues concretely. However, it was realised that this proposal would be premature if an analysis of the current situation on different aspects was not comprehensively investigated. Hence, it resulted in identification of 15 themes that would be investigated to evaluate the full impact of the disaster through inter disciplinary research that would reconstruct the history and assess the current situation in Bhopal. The 15 groups which were constituted while launching the FFM on 30th November 1998 in Delhi were as follows:

(1) Medical care (2) Medical Research (3) Mental Health consequences and cultural impact (4) Legal issues (5) Economic rehabilitation (6) Labour (7) Social Rehabilitation (8) Environment (9) Union Carbide (10) Scientific Institutions (11) Role of state and Central Governments (12) Non Government organisations and People's organisations (13) Memorial on the Disaster and its people (14) Disaster Management (15) Media's Response.

The basic objectives of the FFM through study and investigation on the 15 areas was to provide :

i) a reconstruction of facts 'lost or forgotten', Analysis of the continuing impact of the disaster on different aspects of the lives of survivors, Assess the work of the many agencies involved over the years and Outline larger policy changes as a result of the disaster. Explore future, long term, self sustaining critical interventions that directly work with and for the people of Bhopal to implement the recommendations of the FFM.

2. To compile documentation on all the various aspects related to the Bhopal gas disaster.
3. To compel an otherwise indifferent government/s and corporations to remain accountable to the continuing sufferings of the people of Bhopal while simultaneously taking responsibilities for setting up a national commission on Bhopal towards implementation of the recommendations of the mission jointly with the survivors organisations and their national and international supporters.

FFM has drawn up resources and research of more than 30 experts and professionals around the world. The plan is to release 10 other reports dealing with legal, economic, medical, social and other aspects of the continuing disaster in Bhopal by June this year.

You will find along with this note the first part of the report of the FFM which consists of the following:

1. Report on Environment, (2) Report on Mental Health & (3) Report on Union Carbide Corporation.

You will also find Executive Summaries of these 3 reports. We would appreciate if you could use these material either to write articles in newspapers and journals or to dessiminate the information as widely as possible. Kindly inform us as to what you are doing with the reports at the following address:

Surviving Bhopal - 17 years on
A Fact Finding Mission
B-14 (second floor),
Gulmohar Park
New Delhi 110 048
E-mail othermedia@vsnl.com

E. Deenadayalan & D. Leena
On behalf of the Fact Finding Mission

Encl: 3 Reports, Executive Summaries

OH-1A.

OH-1A.

A Summary of the Report on Human and Environmental Chemical Contamination around the Bhopal disaster site

More than 17 years, and the toxic legacy of Bhopal continues like a noose around those who were exposed on the fateful day.

As the following report once again evidence, Bhopal did not just happen on December 3rd,1984. It is continuing to happen to those who were unfortunate to live in its vicinity on that fateful day. Not only this generation but the next generations too stands to be contaminated and poisoned by the disaster. Not only is the soil, but also groundwater, vegetables as well as mother" breast milk has found to be contaminated.

All media, soil, ground water, vegetables, breast milk investigated were found contaminated by heavy metals, pesticide- HCH and organochlorines to various degrees. The evidence suggests that the toxics had not only moved across various mediums but had also become part of body burdens. As is well known, some of these toxics accumulate in human fat, and are passed onto the next generation through mother's breast milk.

Though the Bhopal disaster was a watershed in the area of environmental policy and legislation worldwide yet today in India, the common person has tittle rescourse in such a situation. People are not only alienated through the language of science but also not allowed access to any documents, which may threaten their safety. Industrial siting has not improved too. Industries continue to come up in urban centres and lead to concentrations of large communities around their periphery. Accident preparedness in non existent and the designated local officers entrusted with the tasks of responding in an Bhopal like emergency often are not even aware that they have this responsibility leave alone how to react.

Such is the state of affairs more than 15 years after the worst industrial accident took place. One can only place the blame on a complete lack of will of the State to act in favor of the citizen. Instead of venturing down a path of clean development and attract the best process in the world, we have set our minds to development at any cost. People have become mere statistics, especially if they are marginalised, poor and voiceless. The Bhopal disaster, and its ongoing human tragedy have not taught us any lessons. In fact we have just no wanted to learn.

Findings

The objective of the present study was to establish the:

1. Presence of toxic contaminants in the factory premises and at dumping sites of the factory away from premises.
2. Quantitative estimations of the toxic chemicals.

3. Mobility of the chemicals.
4. Ascertain the presence of the chemicals in areas adjoining residential areas.
5. Trophic transfer of these chemicals, which essentially is through food chain to humans.
6. Exposure of human infants through breast milk.

The study clearly indicates that the factory is a source of chemical contamination since most of the chemicals used in the factory, are still present in factory and its adjoining residential areas.

The heavy metal nickel constituted up to 35% contamination, while mercury contamination was 21%. The heavy metal distribution was not uniform in different areas in the factory. Mercury was found at very high levels near the Pan filter area, Chromium was present at the Solar Evaporation pond and it constituted 7% of the various toxic chemicals detected at this site. The factory samples still showed almost 4% contamination of volatile organic compounds. The pesticide HCH constituted 40% of contamination near the Sevin Shed, was a point for the formulation of the pesticide Sevin with Lindane (gamma_HCH). Among the halo-organics, the Dichloromethane was fairly consistent amounting to 1% in all the factory samples. The most significant contaminant was chloroform amounted as high as 85% at SEP site, while at the factory it constituted 73% among the various contaminants at the alpha-napthol site, 65% at Pan filter site, 59% near the Sevin plant and 32% near the Sevin Shed.

The samples from the residential areas showed all the toxic chemicals present in the factory and its acquired premises. Among the toxic chemicals analysed in the soil, 56% constituted chloroform, 14% HCH isomers, 8% VOC's and 20% heavy metals. Among the heavy metals nickel constitutes 9%, while mercury and chromium amounted to 5 and 6%, respectively. The groundwater samples showed the highest concentration of dichloromethane, which amou9nted to 44% of the total toxic chemicals. The water also contained 23% chloroform and 30% nickel. In the vegetable samples, 77% comprised chloroform, while 20% constituted heavy metals. Mercury accounted to 9% while nickel and chromium amounted to 5 and 6%, respectively. The major contaminant in the breast milk was VOC's, which accounted to 40% of the total toxic chemicals detected. The pesticide, HCH formed 34% of the total toxicants, while chloroform constituted 16% of the contamination.

Results of the survey clearly indicate mobility of the toxic chemicals from the emanating source, the UCIL factory to the adjoining residential areas. Further there are no other chemical industries within the radius of 3.5 km from the factory, which have used the chemicals mentioned in UCIL inventory.

Chloroform, HCH, chlorobenzene, nickel and lead are the major contaminant in the residential areas. The UCIL factory was the source for presence of these chemicals in these areas. Chloroform was used as a solvent in the manufacture of methy| carbomy|

chloride, an intermediate in Sevin production. Mercury was used as a sealant, while chromium and nickel were from corroded processing equipments and storage facilities. The pesticide, Lindane (gamma-HCH), was used in making a formulation with Sevin. The plant stored chlorinated benzenes; dichlorobenzenes and it had also manufactured these compounds on a small scale, before beginning with Sevin production. The trichlorobenzenes may have produced from isomers, produced during the manufacture of HCH.

The results clearly establish that there has been a serious environmental contamination due to UCIL factory. Although, it has been 16 years since it ceased to function, still, a number of chemicals are present and are making its way to other areas. It is evident, that many of organisms normally thriving in soil would have been wiped out from the contaminated areas. The vegetables grown in the interior of a residential area opposite to the front gate of the factory had the ability to absorb these toxic chemicals and transfer to the next trophic level of a food chain, which may be either herbivore or an omnivore, like human beings. Another very significant aspect is that the human breast milk showed maximum concentrations for VOC's and a higher concentration of the pesticide HCH. It is evident that these carcinogenic toxics are bio-concentrated in the breast milk. Hence, this poses a serious concern to infants, as it is the easiest and shortest route of exposure of number of these suspected carcinogenic chemicals.

OH-1A.

REPORT ON UNION CARBIDE CORPORATION

by
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ACKNOWLEDGEMENTS AND SOME WARNINGS

I would like to thank Deena of the Organizing Committee for inviting me to contribute this report to the Fact Finding Mission. Thanks are due to Nicola Yeates for assistance in obtaining material.

The remit of the report set out in the *Fact Finding Mission* was to provide an overview of Union Carbide in terms of assets, annual profits, facilities, products, board of directors, number of employees, number of countries, new projects, rating as corporation, other disasters and health and safety records. When I enquired about length constraints, I was informed what was important was that the report be comprehensive. To satisfy the desire for comprehensive coverage, yet to avoid overtaxing the reader with every detail, I have divided the report into two, the report itself and various appendices which provide comprehensive details on many issues fleetingly mentioned in the report.

Some further caveats have to be entered here. The first and most basic is that the corporation of which this report treats no longer exists. In February 2001 Union Carbide was merged with Dow Chemical. Faced with this situation, and with the criminal history of Dow being so voluminous as to require a report in itself, the report confines itself to Union Carbide, with a short note on the merger, and Dow itself dealt with rather summarily in an appendix.
Another failing is the skewed balance in the report between information on Union Carbide's operations in its home

country and elsewhere. Here the balance simply reflects the availability of information. It is one of the bitter ironies of Bhopal that its major reformist effects were felt in Union Carbide's home country. Inspired by the massacre and the public response to it, the US state increased regulatory activities. One major step forward came through the setting up of the Toxic Releases Inventory and other freedom of information measures that greatly increased public access to information on toxic chemical releases and waste arising. Thus the following report will provide detailed material on Union Carbide's operations in the US and their environmental impact, while it is unable to provide such information on Union Carbide operations and joint ventures outside the US. Given the limited time available to compile the report, it seemed best to concentrate on available information.

Another point that must be made is that some of the report provides raw data, without interpretation. The section on routine releases simply provides poundage of various chemicals currently released routinely into the environment by Union Carbide plants in the US, without providing details of the media into which these toxics are released or an interpretation of damage caused. Thus much of the report is *material for analysis* rather than a fully formulated position.

Finally, a note, as to the structure of the report. The first section provides details of Union Carbide as a capitalist enterprise, the second deals with the effect of Union Carbide on the environment, including human beings, throughout the world.

1. Bhopal: A Crime of Globalisation

The Bhopal massacre has been described as a crime of globalisation. Speaking in Genoa in July 2001 Satinath Sarangi of the *BGIA* said "The double standards of Union Carbide and Dow, the death and destruction caused by them in war and peace, the impunity they enjoy with regard to the Indian government and the utter failure of international relief or judicial agencies to respond to Bhopal - all characterise it as a glaring example of the evils of Globalisation. Indeed, in its timing and in the composition of the principal actors, Bhopal is a curtain raiser to the sordid drama of Globalisation. Bhopal is a window to what lies at the end of Globalisation."

The results of the disaster exposed the dark side of global inequality. In India people were killed and maimed, while the major safety measures taken in response to the disaster resulted from government action in the core countries. A small number of chemical companies reformed their operations globally, but most cleaned up only when they had to. Some companies got out of producing toxic chemicals in core countries, either by subcontracting production to a chemical company in a peripheral country or by getting out of the market entirely, while some companies moved whole production processes from the metropolitan heartlands to peripheral countries in Asia and Latin America.

If Bhopal was a local crime, it also was a global crime. The deal UNION CARBIDE cut over Bhopal with the Indian government was the go-ahead to the chemical corporations to return to business as usual: with the costs of chemical disasters set at Third World standards, corporations can easily afford the odd massacre.

These toxic corporations operate globally, endangering people throughout the world, whether in peripheral countries like India or among those people and places considered expendable in metropolitan countries, places like Louisiana or Texas in the USA. While there has been some cleaning up done on a (highly) selective basis, as long as the price for mass murder is set as cheaply as it was in Bhopal, 48 cents a share, no-one and nowhere is safe.

2. Bhopal: a Result of Globalisation

More generally we can see the Bhopal story as showing the intersection of various globalising strategies at different stages –that of UNION CARBIDE first through Foreign Direct Investment, and later through such new forms of investment as joint ventures and licensing –that of the Indian state first isolating itself from the global economy and later attempting to insert itself into the global economy –and later still (though not covered in this report) the strategies of transnational NGOs like Greenpeace seeking to expand into peripheral country markets now the core country markets have become saturated.

Here the useful insight Bhopal offers to globalisation theories is the depiction of the changing nature of the relation between the Indian state and the US multinational, which was in no way as one-sided as strong globalisation theorists proclaim, but which varied over time. On a macro level we can see Bhopal as a direct result of globalising strategies involved in the development of the Green Revolution, which allowed capital to expand its reach into what were previously at least partially subsistence and peasant economies. Here we should note that the Green Revolution was a co-production of state and capital.

The factory in Bhopal was a direct result of the implementation in India of the Green Revolution and here (on a micro level, if you wish) local peculiarities are important. At the time of the Green Revolution India had greater autonomy in relation to multinational capital then had Latin American countries and not only was not dominated by US capital but was able to indulge in playing off the US and the USSR for the benefit of the local ruling elite. Through control of access to the Indian market India was able to exert control on foreign capital, which, if it was unhappy, could always leave. By the time of the Bhopal massacre the balance of power between state and capital had shifted, with the collapse of the command economies and India's desire for economic modernisation and liberalisation.

Let us now turn from these more general questions to practicalities relating to Union Carbide(UC).

3. Union Carbide History

3.1 Origin and Growth

Though its history can be traced back to 1898, the present form of Union Carbide appeared in 1917 when five individual American chemical companies joined forces to create one of the world's leading industrial gas producers. The companies which merged were Union Carbide (calcium carbide, acetylene) with plants at Niagara Falls and Sault Ste. Marie, Michigan, National Carbon (carbide electrodes and Ever ready batteries), Prest-O-Lite (headlights and welding/cutting equipment), Linde Air Products (liquid oxygen) and Electro-Metallurgical Co (metal alloys). Thus from the beginning UNION CARBIDE was a heavy manufacturing and raw materials company. Noble presents the merger as the result of a technical fit between the five companies: 'The formation of Union Carbide and Carbon Corporation in 1917 followed logically from the technical interdependence of five companies. The oldest, national carbon, processed coke to make carbon products of importance to the growing electrical industry: carbon electrodes for arc lamps, brushes for electric motors and dynamos, and batteries. In addition, it produced carbon electrodes for electric furnaces, which were used in the production of metal alloys. Union Carbide employed electric furnaces to produce calcium carbide, and Electro-Mettalurgical (Electromet) needed them to manufacture metal alloys. Prest-O-Lite produced acetylene, which was generated in a calcium carbide reaction, and Linde extracted oxygen from air, which, together with acetylene, made possible oxyacetylene welding and cutting equipment'. (Noble:17) Noble also presents the formation of Union Carbide as one of the wave of mergers (500 in all during the 1920s), which consolidated the American chemical industry after World War One.

Union Carbide's history shows the increasing importance of scientific research in capitalist development in the 20th century. Research by George Curme and others at the Mellon Institute, funded by UNION CARBIDE, by 1920 had led to the synthesis of a raft of ethylene derivatives: ethylene oxide, ethylene glycol, eythylene dichloride, diethyl sulphate, ethanol and isopropanol. This research seemed so promising that UNION CARBIDE set up a new division to develop it. Thus Union Carbide can lay claim to a significant part in the origin of the petrochemicals industry when, as a result of research work funded by Union Carbide, the first significant production of ethylene and propylene took place. Union Carbide set up a pilot plant to crack petroleum fractions in Clendenin, West Virginia, in 1920, which produced a series of ethylene derivatives, including ethylene oxide, ethylene glycol, dichloroethane and ethyl alcohol.

Chandler describes how this research and development was used by Union Carbide to become a leading petrochemicals producer. 'In the late 1920s, by setting up plants next to Standard of Indiana's largest refinery at Whiting and another at Texas City, Texas, that division became the most focussed pioneer in petrochemicals. In the 1930s the division led the way in such basic chemicals as butadiene and ethylene (from grain alcohol) and polymers including polyvinyl chloride (PVC), vinyl chloride monomers, ethyl vinyl chloride and polystyrene. By 1936 Union Carbide began production of Vinylite for flooring, phonograph records and fabric coatings and then in 1939 a synthetic fabric Vinyon'. (Chandler: 421)

The first commercially produced ethylene glycol was produced at Union Carbide's Charleston, West Virginia plant in 1924 -this was sold as a substitute for glycerine in the production of dynamite before it was marketed as antifreeze for car engines. Within four years production of ethylene glycol had reached close to 6000 tpa. Between 1929 and 1939 Union Carbide pushed ahead with its groundbreaking reserarch at the Mellon Institute and was the first to market synthetic ethanol, ethylene oxide, glycols, ethanolamines, acetones and acetic anhydride. Through its Niacet subsidiary, set up in 1924 with Canadian company Shawinigan Chemicals, it produced acetaldehyde, acetic acid, vinyl acetate and -from 1936- vinyl copolymers To pursue its interests in the latter products, Union Carbide bought the Bakelite Corp in 1939, which also gave it access to the British market.

World War 2 gave a tremendous impetus to the development of the US petrochemicals industry, which massively increased production of toluene for TNT and various other chemicals for aviation fuel and other aviation uses, as well as developing synthetic rubber. Production of synthetic material for the war effort boomed and Union Carbide, along with other US corporations, benefitted. ICI passed on its method for making polyethylene (PE), which was important for making insulating cables for radar, to both

Union Carbide and DuPont. By 1943 Union Carbide was making a low-density PE that was superior to ICI's product. Union Carbide also played a major part in the Manhattan Project. After the war, Union Carbide was the US's largest producer of petrochemicals, the leading producer of butadiene, stryrene, ethylene and polyethylene and a major player in industrial gases and alloys. With such a wide variety of product areas, Union Carbide began to lose focus, falling behind Dow and DuPont in the 1960s and facing increased competition in industrial gases and metals. It was here that Union Carbide made a fateful mistake. Rather than facing competitors and fighting them as what it was, a low-cost producer of chemicals and plastics, it began abandoning markets it knew and suffering from conglomerate fever, diversifying into various new ventures, none of which covered the corporation in glory, "branching off more and more into new businesses about which management knew little. There were ventures in salmon farming, synthetic gemstones, in integrated circuits and diaper manufacturing" (*Forbes* 18/5/87) In the mid-1970s Union Carbide abandoned these ventures, and also pulled out of PVC, styrene, polystyrene and out of petrochemicals produuction in Europe (due to an overcapacity crisis) and turned to concentrate on core products such as polyethylene, ethylene oxide and industrial gases. In the late 1970s Union Carbide developed a new process for synthesising polyethylene, which sharply reduced the production costs of HDPE. Union Carbide began licensing this technology in 1979 and also began selling engineering services. In 1978 *Fortune* reported that Union Carbide operated more than 350 plants in the US. In 1979 Union Carbide owned some 500 plants, mines and mills in 37 different countries. That same year it lost its position as second largest chemical company in the US to Dow, though it was still ranked as 7th largest chemical company in the world.

3.2 Union Carbide's Internationalisation

After the war Union Carbide continued its production of plastics and began to expand internationally. It had long had its Canadian operation along with its factories in Charleston and Institute in West Virginia, moved into England through the purchase of Bakelite and set up its first Belgian factory after WW2. During the 1950s Union Carbide expanded its production of PE internationally, setting up factories in Sweden, Antwerp, India and Brazil. In 1957 Union Carbide operated in 27 countries through 42 wholly-owned and partly-owned subsidiaries. Its international operations also grew in the area of graphite electrodes, industrial gases, ferro-alloys, batteries and anti-freeze; creating an industrial giant whose turnover exceeded $1.5 bn by 1960. In 1961 Union Carbide commissioned a 25,000 tpa low density PE plant in Antwerp, with further expansions inceasing capacity to 130,000 tpa in 1975. By 1963 Union Carbide had become the world's second largest chemical company.

As part of its internationalisation, Union Carbide became India's first petrochemical producer, setting up a wholly-owned subsidiary in Bombay to build and operate an ethylene plant of 10,000 tpa, later expanded to 20,000 tpa. In a review of the industry by the OECD, it was noted 'Union Carbide is the only member of the US "first league" to be involved in all regions, but this is due to its recent shift to a systematic use of arms-length licensing for its LLDPE Unipol process.' The OECD noted its involvement in Brazil and India by operating subsidiaries and in Argentina, China, Korea,, Saudi Arabia and Libya through technology transfer (licensing) only.

By 1975 25per cent of Union Carbide's sales were foreign. In 1980 Union Carbide was ranked 5th largest thermoplastic producer in the world with overall capacity of 1626000 tpa, following Hoechst (1687000tpa), Shell (1705000tpa), BASF (1847000) and Dow (2865000tpa) In 1985 Union Carbide had a worldwide salaried workforce of just under 50,000, 23,000 of whom worked outside North America. Of Union Carbide's total international workforce of 47,000, 38% were based in the Far East and 34% in Latin America. Union Carbide employed 6679 workers in Europe and 2,883 in Africa and the Middle East. At the beginning of the 1990s, Union Carbide was still in the top 30 US exporters -along with DuPont, Allied-Signal, Dow and Monsanto.

3.3 Union Carbide in Bhopal

Rather than search for some unnecessary conspiracy involving chemical warfare, Union Carbide's arrival in Bhopal should be seen as the result of two types of globalisation, not only the internationalisation of Union Carbide we have already detailed, but also the globalisation of pesticide use that accompanied the global restructuring project called the Green Revolution. Union Carbide's arrival in Bhopal was part of this internationalisation. On February 25, 1974 *Chemical and Engineering News* reported

Union Carbide India would build a plant at Bhopal with 10 million lb capacity for Sevin and 5 million lb capacity for Temik. Similarly the overcapacity of the plant can be easily explained by over-optimistic estimates of the Indian market. (Such over-estimation is common to the petrochemicals industry, which is generally recognised to suffer from periodic overcapacity crises).

3.4 Carbide After Bhopal: Decline Until Disappearance

Its response to Bhopal showed Union Carbide's ruthlessness when faced with the victims of its operations. Union Carbide followed a series of strategies that sought to distance the US corporation from the Bhopal operation with the intention to insulate the US corporation from liability. While loudly proclaiming its moral responsibility, Union Carbide took care to remain distant from legal responsibility. We should not see Union Carbide's strategies only as revealing the evil nature of Union Carbide staff but also as an expression of the evil of market forces. A study of investor reaction to Union Carbide management responses to Bhopal found that accommodative positions were punished by the markets, with investors reacting sharply and negatively, while defensive positions resulted in market approval.(Marcus)

One successful result, from the point of view of the market, was the way that Union Carbide was able to get its capital out of danger. In December 1985 Union Carbide set out a major restructuring programme, which led to a massive reduction in the assets Union Carbide Corporation possessed from which to pay eventual Bhopal claims. While this restructuring was finally forced on Union Carbide by its battle for management control with the GAF corporation, the net result was the same. A large part of Union Carbide's capital base was sold off, major assets such as the consumer products division were divested and the proceeds distributed as a special dividend to Union Carbide shareholders. Union Carbide also bought back stock from its shareholders.

While Union Carbide had planned this restructuring, it was the December 1985/January 1986 battle with GAF that forced it into the major restructuring it finally undertook. This take-over bid and the jockeying for control of Union Carbide added a bitter twist to an already bitter story. It provided us with a sickening example of the vile perversity of the owners and controllers of toxic capital in the US. While two vultures fought over the carcass of Union Carbide, one was playing tough in its negotiations with the Indian state over Bhopal and the other had no compunction about using the Bhopal issue as part of its takeover strategy. Thus Samuel Heyman, who headed the GAF takeover bid, held up to Union Carbide shareholders the illusory scenario that he would move quickly to resolve the Bhopal suit as part of his take-over strategy. Though Heyman was reported to have put a high priority on settling the Bhopal suits, he had previously shown himself to be an extremely tough litigator. In December 1983 GAF had 12,000 asbestos-related suits pending against it and fought them to the bitter end. *Business Week* pointed out 'it would be to Heyman's advantage to have Carbide's shareholders think he would move towards settlement more quickly'.

During the battle with GAF, Union Carbide handed out golden parachutes to its golden boys far more lavishly than it gave relief to Bhopal victims. Union Carbide directors had allowed, in the event of a successful hostile takeover $28 million for some 42 top executives, $8.7 million of which was for its top five officials. Neither result of the battle boded well for the victims of Bhopal: Heyman intended funding his bid with high-risk junk bonds and intended selling off choice assets to pay for the take over. Union Carbide finally defeated Hayman by pursuing his strategy themselves, announcing their intention of selling off their consumer sales division, which accounted for $1.9 billion of Union Carbide's $9.5billion 1984 sales, a particularly profitable part of total sales. The cost of compensating the victims of Bhopal pales compared with the debts incurred in fighting the takeover, the legal and banking fees and golden parachutes.

Beating off GAF doubled Union Carbide's debt to $4.5billion and slashed its equity value to a quarter of what it had been. The new, highly leveraged, Union Carbide was reliant on 'highly cyclical industrial businesses' with a 'low-growth mix of industrial gases, chemicals and plastics.' GAF came out of the battle with a $200 million gain. After the battle GAF's lawyers and merchant bankers were owed $60 million. Union Carbide's bankers took at least $14 million, while Anderson complained 'Wall Street is becoming a casino rather than an investment organisation.'

The result of Union Carbide's restructuring was a company whose base had been drastically curbed and which seemed fated to face a future of decline.

3.5 Union Carbide's decline

While Union Carbide recovered from the economic jeopardy in which it had placed itself to escape from GAF, in part through reengineering, astute joint ventures and licensing technology, it entered a period of relative decline which saw it slowly slide down the *Fortune 500* list until it finally lost its independence through merger with Dow. As Chandler observed 'Union Carbide has yet to recover from Heyman's raid. In the early 1990s, its debt ratio was higher than any of its competitors. Its revenues were one-half of what they had been before 1985. By 1994, sales and income came entirely from basic chemicals and petrochemicals. Of these only 15% came from goods listed as speciality polymers and products. Union Carbide had lost the capabilities and the funds to implement competitive strategies comparable to those of DuPont, Dow or Monsanto.' (Chandler:431)

Chandler's diagnosis is borne out by Union Carbide's gradual slipping down the ranks of the *Fortune 500*, the principal list of major US corporations ranked by revenues. The following table provides details from the Fortune 500 ranking from 1991 to 2000; giving basic financial details of sales, profits, etc.

In 1992 Union Carbide spun off its industrial gases business, which is now known as Praxair.

UNION CARBIDE IN THE FORTUNE 500

Year	Rank	Rank Previous year	Revenues (Millions) $	Profits (Millions) $	Assets (Millions) $	Stock (Millions) $	Market Value (Millions) $	Profits as % of revenues	Earnings	Total return investo
1991	66	65	7,346.0	(28.0)	6826.0	2239.0	3147.7	(0.4)	(0.22)	30.1
1992	88	66	6,167.0	(175.0)	4941.0	1267.4	2242.1	(2.8)	(1.46)	35.3
1993	114	88	4.640.0	(58.0)	4689.0	1428.0	2632.0	1.3	0.36	40.1
1994	236	114	5,888.0	379.0	5028.0	1509.0	4550.9	7.8	2.44	34.9
1995	223	236	6,106.0	925.0	6256.0	2045.0	6537.1	15.7	6.44	30.6
1996	237	223	6,502.0	593.0	6546.0	2114.0	6192.0	9.7	4.28	10.9
1997	250	237	5,659.0	659.0	6964.0	2348.0	6436.3	10.1	4.41	6.8
1998	288	250	5,870.0	403.0	7291.0	2449.0	5771.8	7.1	2.91	1.0
1999	292	288	292	291.0	7957.0	2617.0	6198.6	5.0	2.13	59.8
2000		284		6,526.0	162.0 8346.0	2654.0	-	2.5	1.18	(17.8)

4. Union Carbide - Current Situation

4.1 Products and markets

At 31 December 2000, Union Carbide employed 11,346 people around the world. In essence Union Carbide is a bulk chemicals and plastics manufacturer of both speciality and commodity chemicals, with a sideline in licensing technology. Its speciality and intermediate chemicals sales accounted for 68% of revenues in 2000. This sector's products includes water-soluble and performance poymers, acrolein and derivatives, emulsions, speciality polyolefins, ethylene oxide derivatives, glycols, solvents, intermediates and monomers for the print industry. This sector of Union Carbide also licences Union Carbide proprietary technology for the production of PE and PP. The Basic Chemicals and Polymers division produces ethylene, propylene, ethylene oxide, ethylene glycol, polyethylene and polypropylene, all bulk or commodity chemicals (greater details on products can be found on pp.3-5 of Union Carbide 10-K form; reprinted as Appendix 1)

The chemical industry is a highly competitive one. In the speciality and intermediate chemicals sector, Union Carbide estimates 24 other major speciality chemical companies are in competition with Union Carbide, while in basic chemicals there are at least 12 other major competitors. Union Carbide has a functional split internationally "Products that the corporation markets are largely produced in the US, while products marketed by the corporation s joint ventures are principally produced outside the US" (10-K form, p.7)

The range of markets, which Union Carbide supplies, may be seen in the next table, which gives end markets as a percentage of Union Carbide annual sales for 2000

END MARKET AS PERCENTAGE OF SALES		
1.	Packaging and consumer plastics	23
2.	Paints, coatings, adhesives	21
3.	Wire and cable	11
4.	Textile	7
5.	Households and personal care	7
6.	Car industry, including anti-freeze	7
7.	Agriculture, food	4
8.	Oil and gas	2
9.	Industrial cleaners	2

While the majority of Union Carbide sales are within the US, foreign sales are a major source of income. The following table details the geographical breakdown of Union Carbide sales for the year ended 31 December 2000

S.No.	LOCATION	Million $
1	US and Puerto Rico	3951
2	Canada	272
3	Europe and Middle East	841
4	Latin America	456
5	Far East and others	1006
6	Net sales	6526

Research and development costs were $152 million in 2000 and $154 million in 1999. Capital expenditure in 2000 was $459 million, compared with $764 million in 1999. For these two years capital expenditure divided into spending on new capacity (68 per cent) cost reduction and replacement (27%) and environment health and safety (5 per cent).

4.2 DIRECTORS

C. Fred Fetterolf
Retired director, president and chief operating officer of Aluminum Company of America. A UCC director since 1987, he chairs the Health, Safety & Environmental Affairs (HS&EA) Committee and serves on the Audit, Compensation & Management Development, Executive and Nominating Committees.

Rainer E. Gut
Chairman of Credit Suisse Group, Credit Suisse First Boston and Credit Suisse, all of Switzerland. A UCC board member since 1994, he chairs the Finance and Pension Committee and is a member of the Compensation & Management Development and Nominating Committees.

Vernon E. Jordan, Jr.
Senior managing director of Lazard Freres & Co. He is chairman of the Nominating Committee and a member of the Executive, Finance & Pension and Public Policy Committees. He has been a board member since 1987.

William H. Joyce
Chairman, president and chief executive officer of Union Carbide Corporation. A director since 1992, he is chairman of the Executive Committee.

Robert D. Kennedy
Retired chairman and chief executive officer of Union Carbide Corporation. He serves on the Audit, Executive, Nominating and Public Policy Committees and has been a director since 1985.

Ronald L. Kuehn, Jr.
Director and chairman of El Paso Energy Corporation. A UCC board member since 1984, he chairs the Compensation & Management Development Committee and serves on the Executive, Finance & Pension and HS&EA Committees.

Rozanne L. Ridgway
Former assistant secretary of state for Europe and Canada. A director since 1990, she chairs the Public Policy Committee and is a member of the Audit, HS&EA and Nominating Committees.

James M. Ringler
Vice-Chairman of Illinois Tool Works Inc. He has been a director since 1996 and is chairman of the Audit Committee and a member of the Compensation & Management Development, Finance & Pension and HS&EA Committees.

Paul J. Wilhelm
President of the U.S. Steel Group of USX Corporation and a director of that corporation. Elected a director in 1998, he serves on the Audit, Finance & Pension, HS&EA and Public Policy Committees.

Specialties & Intermediates

<TABLE>
<CAPTION>

Millions of dollars, except as indicated	1999	1998	
<S>	<C>	<C>	<C>
Segment revenues	$4,182	$4,139	$4
Cost of sales, exclusive of depreciation and amortization	3,100	3,007	3
Gross margin	1,082	1,132	1
Depreciation and amortization	262	247	
Partnership income	6	27	
Operating profit	$ 607	$ 833	$
Income (loss) from corporate investments carried at equity	$ (1)	$ 1	$
Customer volume (millions of pounds)	8,946	8,101	8
Unit variable margin (cents/pound)	22.5	24.3	
Fixed cost per pound of products sold (certs/pound)	13.9	14.7	
Capital expenditures	$ 291	$ 438	$
Investments, advances and acquisitions	64	42	
Segment assets	$4,603	$4,403	$4

Specialties & Intermediates Joint Ventures

<TABLE>
<CAPTION>

		Combined		UCC
Millions of dollars	1999	1998	1997	199
<S>	<C>	<C>	<C>	<C>
Net sales	$2,000	$2,060	$2,246	$99
Cost of sales	1,334	1,345	1,395	65
Depreciation	104	119	90	4
Income from operations	92	231	340	5
Interest expense	40	43	42	1
Provision for income taxes	61	48	76	3
Net Income (Loss)	$ (7)	$ 141	$ 224	$
UCC share of dividends & distributions				$ 6
Total assets	$2,086	$1,981	$1,837	$92
Total third-party debt	786	616	588	33
Net Assets	$ 606	$ 474	$ 451	$31

Basic Chemicals & Polymers

<TABLE>
<CAPTION>

Millions of dollars, except as indicated	1999	1998	1
<S>	<C>	<C>	<C>
Segment revenues	$1,976	$1,802	$2
Cost of sales, exclusive of depreciation and amortization	1,765	1,550	1
Gross margin	211	252	
Depreciation and amortization	146	142	
Partnership income	5	6	
Operating profit (loss)	$ (21)	$ 20	$
Income (loss) from corporate investments carried at equity	$ 3	$ (67)	$
Customer volume (millions of pounds)	7,817	6,614	6
Unit variable margin (cents/pound)	7.2	9.6	
Fixed cost per pound of products sold (cents/pound)	5.8	7.5	
Capital expenditures	$ 473	$ 344	$
Investments, advances and acquisitions	85	69	
Segment assets	$3,137	$2,686	$2

Basic Chemicals & Polymers Joint Ventures

<TABLE>
<CAPTION>

		Combined		UCC'S
Millions of dollars	1999	1998	1997	199
<S>	<C>	<C>	<C>	<C>
Net sales	$2,135	$1,996	$2,078	$1,04
Cost of sales	1,649	1,597	1,661	81
Depreciation	244	253	102	9
Income from operations	155	50	219	10
Interest expense	157	206	70	7
Provision for income taxes	26	27	49	1
Net Income (Loss)	$ (27)	$ (182)	$ 100	$
UCC share of dividends & distributions				$ 1
Total assets	$3,548	$3,724	$3,980	$1,50
Total third-party debt	1,241	1,474	1,595	58
[illegible]	[illegible]	[illegible]	[illegible]	$ 44

4.3 UNION CARBIDE FACTORY LOCATIONS

Union Carbide's geographical reach can be seen in the following lists of manufacturing locations. For Union Carbide's manufacturing sites within the US, the Specialities and Intermediates division operates at Torrance, California: Tucker, Georgia; Alsip, Illinois; Greensburg, Norco and Taft, Louisiana; Bound Brook, Edison and Somerset, New Jersey; Bayamon, Puerto Rico; Garland, Seadrift and Texas City, Texas and Institute and South Charleston in West Virginia, while the Basic Chemicals and Polymers division operates plants at Norco and Taft, Louisiana and Seadrift and Texas City, Texas.

Internationally, Union Carbide's Specialities and Intermediates division operates plants at San Lorenzo, Argentine; Vilvoorde and Zwijndrecht, Belgium; Aratu, Cabo and Cubatao in Brazil; Sarnia, Canada: Wilton, England; Jakarta, Indonesia; Seremban, Malaysia; Guangdong and Shanghai in the PRC; Batangas, Philippines; Rayong, Thailand and Dubai in the United Arab Emirates, while the Basic Chemicals and Polymers division operates plants at Wilton in England and at Joffre and Prentis in Canada.

Union Carbide also maintains an international presence through the manufacturing operations of the various joint ventures and partnerships Union Carbide has contracted. The following are the principal joint ventures with their major manufacturing sites

In the Specialities and Intermediates sector, Union Carbide is involved in the following joint ventures

1 UOP LLC -joint venture with Honeywell -
Has manufacturing plants in Mobile, Alabama; Des Plaines and McCook, Illinois; Shreveport, Louisiana: Tonawanda, New York; Brimsdown, England; Leverkusen, Germany and Reggio di Calabria, Italy.

2 UOP itself has participated in further joint ventures with manufacturing sites at Shanghai, China and Hiratsukaa and Yokkaichi, Japan

3 NIPPON UNICAR CO LTD joint venture with Tonen Chemical Corp
Has manufacturing plants at Kawasaki and Komatsu, Japan.

4 ASPELL POLYMERES SNC -partnership with subsidiary of TotalFinaElf S.A.

Has manufacturing plant at Gonfreville, France

5 WORLD ETHANOL COMPANY -partnership with Archer Daniels Midland (ADM)
Has manufacturing plants in Peoria, Illinois and Texas City, Texas.
6 UNIVATION licensing joint venture with ExxonMobil
Has manufacturing facilities at Mont Belvieu, Texas.
7 ASIAN ACETYLS CO LTD -joint venture with BP Chemicals and Samsung Fine Chemicals Co
Has manufacturing facility at Ulsan, South Kores.
8 OPTIMAL CHEMICALS MALAYSIA SDN BHD joint venture with Petronas
Currently building world-scale ethylene and propylene derivatives plant at Kerteh, Terengganu, Malaysia.

In the Basic Chemicals and Polymers sector Union Carbide is involved in the following joint ventures

1 POLIMERI EUROPE SRL -joint venture with ENIChem SPA
Has manufacturing plants at Dunkirk, France: Oberhausen, Germany and Brindisi, Ferrara, Gela, Priolo and Ragusa; Italy.

2 EQUATE PETROCHEMICAL CO KSC -joint venture with Petrochemical Industries Co and Boubyan Petrochemical Co
Operates worldscale ethylene, PE and ethylene glycol plants at Shuaaiba, Kuwait.

3 PETROMONT AND CO -partnership with Ethylec Inc
Operates manufacturing plants at Montreal and Varennes, Auebec, Canada.

4 ALBERTA AND ORIENT GLYCOL CO LTD -joint venture with Mitsui and Far Eastern Textile
Operates a manufacturing facility at Prentiss, Alberta, Canada.

5 OPTIMAL OLEFINS MALAYSIA SDN BHD and OPTIMAL GLYCOLS MALAYSIA SDN BHD

4.4 Union Carbide - New projects

With the chemical industry currently in the trough period of its economic cycle, Union Carbide has announced very few new projects over the last few years. In the main, the few new projects that have been announced have been by joint ventures –an example of the recent tendency of consortia, rather than single companies, to undertake construction of new plant, due to increasing size and financing requirements of new plant. In 1996 Union Carbide announced that a 20,000 tpa latex polymer emulsions plant would be built by it and Shanghai Petrochemicals at Jinshanwe, PRC to be completed by 1997. (ECN 27/5/96 p25 and CMR 20/5/96 p 5) In 1997 Union Carbide announced a 300 MMlb butanol plant for Taft, Louisiana, due online in June 1999. (HP Aug 97). In 1998 Equate –Union Carbide's joint venture with Kuwaiti Petrochemical Industries Company- announced a $2 billion worldscale plant at Shuaiba Industrial Area, Kuwait, involving 650Mtpy ethylene, 450 Mtpy polyethylene and 350 Mtpy ethylene glycol. (HP Jan 98) In July 1998 Union Carbide announced 65MMlb glycol ethers plant for Seadrift, Texas and 55MMlb glycol ethers plant for Wilton, England. (HP July 98) In 1999 Union Carbide announced plans for a joint venture with Tosco to build a 352,000 tpa polypropylene plant in New Jersey, intended for start-up in early 2001. It also announced expansions of 9000 tpa of speciality polyolefins-based compounds at Seadrift, Texas and 4500 tpa at Kawasaki, Japan were under construction. In 1999 also Union Carbide finally started its 90,000 tpa ethylene-propylene rubber plant at Seadrift. In 1999 also Union Carbide announced plans in another joint venture with Petronas for 385,000 tpa ethylene oxide and 360,000 tpa ethylene glycol at Kerteh, Malaysia, due on-line in 2001. In the year 2000 a Nova/Union Carbide joint venture was reported to be bringing a new worldscale 1 Mmton ethylene plant in Canada on-line. (HP Mar 00) Also in the year 2000 Union Carbide announced plans to double latex capacity at its plant in the Jebel Ali Free Zone in Dubai intended to start up in 2002 (ECN 18/12/00 p33) In June 2001 Union Carbide announced that Optimal Olefins -a joint venture between Petronas (64 percent), Union Carbide (24percent) and Sasol Polymers (12percent)- would build plants with capacity of 600,000 tpa of ethylene and 90,000 tpa propylene at Kerteh in Malaysia. (ECN 18/6/01 p58)

4.5 Union Carbide – Licensing Activities

Union Carbide s involvement in licensing technology provides another example of globalising strategies. Here what Union Carbide is selling is knowledge, proprietary information on chemical plant and process technology. The chemical industry is a major licensor of technology globally. The overall process licensing industry was worth $3.5

billion in 1997, but was expected to drop to $2.8 billion in 1998. Here again globalisation's pattern of inequality is reproduced. The knowledge belongs to companies in the core countries and is most commonly licensed to companies from the peripheral countries. In markets where multinationals are prevented from operating, or which they do not wish to enter, corporations can obtain income from licensing their technology to companies alsready operating in the market. We may see this in the increase of technology licensing fees paid by Indian chemical producers in the early 1980s..

FOREIGN CHEMICAL COLLABORATION PAYMENTS APPROVED ($M)

1981	1982	1983	1984	1985	1986
12	25	49	118	76	240

Union Carbide's major licensing assets are its UNIPOL technology for polyethylene and polypropylene production. At one stage, Union Carbide held about 50% of the PE licensing business. Since April 1997, much of Union Carbide's licensing takes place through a joint venture with ExxonMobil called Univation. Through Univation, Union Carbide's Unipol polypropylene technology is licensed, as well as Unipol polyethylene technology, chrome catalysts and mettalocene technology. 31 Unipol polypropylene plants have been built and 5 more are in design or construction. (Uc's interest in PP are mainly licensing ones; it is only a minor producer, with capacity of 400,000 tpa spread between two American plants) Since Univation was formed, it has licensed PE processes to ExxonMobil for Singapore, DSM in Germany, Polimeros in Brazil, ExxonMobil/Pequivan in Venezuela, Chempetrol, in the Czech Republic and China Petrochemical in China. The other joint venture for Union Carbide licensing is UOP, a joint venture with Allied Signal which holds more than 65 processes in petroleum-refining, aromatics, olefins and gases.

Recent announcements on licensing include SABIC licensing UNIPOL process technology for 400 Mtpy lldpe/hdpe plant due for start-up in 2002 at Al-Jubail, Saudia Arabia (HP Aug 2000) and Chempetrol from the Czech Republic taking a UNIPOL PE license for 2000 Mtpy HDPE plant at Litvinov in the Czech Republic due 2001. (HP Oct 98)

4.6 Union Carbide and Dow-the merger

Depictions of corporate mergers and acquisitions by corporate critics and anti-globalisation activists tend to describe the increasing number of mergers as involving an increase in corporate power and control through everincreasing concentration, both of wealth and productive capacity. While this is obviously true, it tends to create a simple picture of mergers which ignores the fact that some mergers are indications more of corporate weakness than of corporate strength, defensive mergers forced on corporations by the need, for example, to increase scale to face new competition in the industry. The merger between Dow and Union Carbide is indeed a defensive merger, with cost savings reported to be the main driver, intended to integrate their commodity chemical operations to face new competition from Middle East producers.

Secondly, the example of the Dow/Union Carbide merger also illustrates the shifting balance of power between state and capital and corrects the often oversimplified vision of TNCs walking roughshod over nation states espoused by some analysts. When announced in August 1999 Dow confidently expected the merger would be completed in the first quarter 2000. Unfortunately it was not to be and only in February 2001 did the merger finally pass all the regulatory hurdles erected by regulators in the US and the EU. The need for regulatory intervention is exemplified by the impact of the merger on the octene-based lldPE market where the combined Dow/Union Carbide/Polimeri Europa would have held 80% of the European market. Here the emphasis by the regulatory authorities in both the U.S. and Europe was on possible monopoly peoblems while the issue of criminal liability for the Bhopal massacre was totally ignored.

An attempt was made by Green Caucus in European Parliament to raise the failure of the merger proposal to deal with the issue of criminal liability and issue was raised with EC in U.S but to no avail.

As a result of the merger with Union Carbide, Dow, with sales of $24.4 billion, will become the largest chemical company in the world, if pharmaceutical interests are excluded. (If they are included Dupont and Bayer would be larger then Dow) The new corporation will have operating income of $3billion, a combined market capitalisation of nearly $35bn and assets of over $30billion. It will operate in 168 countries and will employ 49,000.

Dow's share of the North American lldPE market is expected to be 36 to 38 percent. Dow will also become the world's second largest manufacturer of HDPE, second only to Exxon Mobil. Dow is also currently global leader in low density PE and linear low density PE and maintains its position against challenge by Exxon Mobil by the purchase of Union Carbide. Dow is also expected to become the world s largest producer of ethylene, as the following table indicates

GLOBAL ETHYLENE PRODUCERS 2003			
S.No.	Company	Capacity 000 tonne	Market share percent
1	Union Carbide/Dow	10,753	9.40
2	Exxon Mobil	8,359	7.31
3	Royal Dutch Shell	5,771	5.05
4	Equistar	5,112	4.47
5	Sabic	3,920	3.43
6	BP Amoco	3,801	3.32
7	Nova Chemical	2,960	2.59
8	Formosa Plastics	2,845	2.49
9	BASF	2,602	2.27

Source: ECN Supp Sept 1999; p 26

Some indication of the strength of the merged company can be seen from the following capacity figures for the year 2000

S.No.	Chemical	DOW	Union Carbide	Combined
1	Ethylene	3.8	2.4	6.2
2	LDPE	0.6	0.2	0.8
3	Ethylene oxide	0.4	1.0	1.5
4	EB/Styrene	0.2	0.0	0.2
5	EDC/VCM	1.1	0.0	11

Source: DeWitt & Co Inc.

Another predictable result of the merger will be job cuts. In May 2001 Dow announced its intention of cutting 8% of its work force by firing 4,500 workers as part of its plan to cut costs by $1.1 billion. Predictably also most of the job cuts will affect Union Carbide, with administration jobs losses of 80%; sales and marketing 45%; research and development 35% and manufacturing 25%. These workforce reductions, expected to be completed by February 2002, should account for 55 percent of Dow's intended savings. In addition Dow is taking a charge of $1.4 billion for merger-related costs, including employee severance and write down of duplicate plant and other assets.

5. Union Carbide's Toxic History and Present

This second section of the report attempts to examine Union Carbide's health and safety and environmental record. It does this by looking both at the current reality of pollution from Union Carbide plants in the US and the company's shameful record across many areas that have effected the environment and public and worker safety.

5.1 Union Carbide's polluted history

If Union Carbide was strongly identified with some US activities, in particular the military/industrial complex, it has also struggled against state in other ways, in particular in opposition to state regulation of health, safety and environmental impacts and thus achieved for itself in the early 1970s the status of Environmental Public Enemy Number One. Most famously Union Carbide was involved in 'one particularly embarrassing public fiasco in the late 1960s and early 1970s. For the better part of four years, Carbide stone-walled public and government efforts to make it clean up several plants that were polluting the air over large areas of West Virginia. By the time Washington prevailed, the imbroglio had earned the company the reputation of a reactionary ogre obsessed with profits and disdainful of the environment.' (*Fortune* 25/9/78:87)

By the 1980s Union Carbide had become less radical in its opposition to government regulation, or at least more prepared to compromise when forced to. This has been illustrated in the chemical industry response to the introduction of Superfund legislation to deal with abandoned toxic waste dumps in the US. At the beginning of 1980 Union Carbide was a strong proponent, with Dow, Allied-Signal and Dupont, of resistance to Superfund but, as the legislative process went ahead, Union Carbide moved from total opposition, arguing if legislation was inevitable, it was best to have a voice in shaping it.

According to Jerry Kenney, then UC's representative in Washington, 'I think society will demand some level of federal effort to clean up waste sites like Love Canal. Politically the chemical industry is not going to escape without paying a fee' (Mahon: 160) Thus Union Carbide began distancing itself from outright rejection of Superfund and by September 1980 had moved to a collaborative position, which it finally made public in November 1980 when Union Carbide Chairperson William S. Sneath announced his support of compromise Superfund legislation.

As to its spending on environmental areas, Union Carbide notes "in 2000, worldwide expenses related to environmental protection for compliance with Federal, state and local laws regulating solid and hazardous wastes and discharge of materials to air and water, as well as for waste site remedial activities, totalled $104 million. Expenses in 1999 were 118 million "(and in 1998 were 91 million). In addition worldwide capital expenditures relating to environmental protection, including those for new capacity and for cost reduction and replacement, in 2000 totalled $34 million compared with 35 million in 1999". (10-K, pp.16 and 46) Union Carbide estimates anticipated average annual expenses of $100 million and capital expenditures of $65 million over the next five years.

5.2 Union Carbide's Political Action

While more restrained than before, Union Carbide still tries to influence the US state. One of the most obvious ways in which Union Carbide seeks to gain political influence is through donations from its Political Action Committee (PAC) to various Republican and Democratic Party candidates. The following table shows figures for Union Carbide PAC donations from 1978 to 2000, illustrating relative donations to Republican and Democratic parties.

UCC PAC CONTRIBUTIONS

S.No.	Election Cycle	Republicans	Democrats	Total
1	1978	18,950	7,900	26,850
2	1980	21,350	8,150	29,500
3	1982	30,850	6,600	37,450
4	1984	25,500	5,312	30,812

5	1986	7,189	3,300	10,489
6	1988	16,350	8,650	25,000
7	1990	10,000	19,350	29,350
8	1994	20,500	9,800	30,300
9	1996	3,000	12,000	15,000
10	1998	11,000	17,201	18,201
11	1999	7,500	17,950	25,450
12	2000	1,000	2,000	3,000

Sources from www.tray.com, figures for 1978 and 1980 from Abuse of power, p.114

Of course this is only the most obvious example of Union Carbide's spending money to obtain political influence. Union Carbide also spent over one million dollars lobbying the US Congress from 1997 to 1999 on nuclear energy, hazardous waste, consumer product safety and labour issues. In 1998 the Union Carbide Charitable Fund gave out approximately $9.8 million in charitable contributions.

5.3 Toxic releases and waste generation

We are in a position to provide basic information on Union Carbide's environmental impact, but mainly within the US. There, right-to-know laws, introduced in partial response to Bhopal, have forced corporations to publish details of (some) toxic chemicals emitted into the environment and, since a later date, of waste arisings. The following table gives gross poundage of emissions from Union Carbide's American and Puerto Rican operations from 1987 to 1999 and of waste arisings from 1991 to 1999.

Releases of selected toxic chemicals and waste generation (in lbs)

Year	Total releases	Waste generated
1987	69,556,343	
1988	16,679,484	
1989	20,235,351	
1990	16,832,351	
1991	13,925,039	185,494,608
1992	12,966,749	227,302,200
1993	11,992,854	212,892,945
1994	6,915,755	183,338,996

1995	6,898,579	195,773,274
1996	6,949,052	193,240,191
1997	5,733,087	195,011,636
1998	6,830,939	150,495,645
1999	6,063,839	164,247,503

The following table gives more detailed accounting, by location and chemical emitted, for the most recently reported period, 1999, in lbs.:

S.No.	Chemical	Releases	Waste
1	Propylene	698128	39636791
2	Ethylene	2110943	30815735
3	Ethylene glycol	4482531	15438646
4	Glycol ethers	392739	12867385
5	Acetaldehyde	74356	8150282
6	Acrylic acid	69312	5959342
7	Vinyl chloride	461	4230469
8	Formaldehyde	510468	2545650
9	Hydrochloric acid aerosols	72116	1892927
10	Methanol	1049395	1868247
11	Nitrates	172200	1617200
12	Ammonia	96762	1287347
13	2-ethoxyethanol	106707	1242408
14	Butyraldehyde	5247	1230357
15	Vinyl acetate	807817	954901
16	Hydroquinone	36499	739499
17	Chlorobenzene	729157	734088
18	1,3-butadiene	80412	662195
19	Dicyclopentadiene	34342	643905
20	Diethanolamine	296840	578143
21	Ethylene oxide	43299	464167
22	Ethyl acrylate	92019	462140
23	Styrene	432936	455356
24	Allyl alcohol	10348	419321
25	Benzene	147101	405630

26	Formic acid	7129	362129
27	Butly acrylate	328757	350557
28	Dimethylamine	292444	292444
29	n-hexane	56681	277079
30	Acrolein	3790	229730
31	Methyl ethyl ketone	94576	209731
32	Cyclohexane	36196	208149
33	Naphthalene	169159	195304
34	Nitrate compounds	175207	175207
35	Chloroethane	161700	161700
36	2-methoxyethanol	4370	143370
37	Antimony compounds	40161	137087
38	n-butyl alcohol	36350	136751
39	Toluene	88940	135616
40	1,2-dichloroethane	1590	113589
41	Ethylbenzene	38217	80747
42	Methyl isobutyl ketone	70636	79813
43	1,4-dioxane	25192	67266
44	Zinc compounds	52402	52484
45	Phenol	15693	49873
46	Xylene	18559	48404
47	Methyl methacrylate	42950	36218
48	Biphenyl	22130	32935
49	Silver	29773	29773
50	Nitric acid	28537	28537
51	Titanium tetrachloride	265980	26600
52	Silver compounds	85175	24025
53	Copper compounds	20792	20792
54	Propylene oxide	6777	19732
55	Decabromodiphenyl oxide	19484	19484
56	Chlorodifluoromethane	18023	18023
57	Phenathrene	11968	11968
58	Peracetic acid	7891	11891
59	Anthracene	3985	10854

60	Sulphuric acid aerosols	7912	7910
61	Butyl acrylate	2493	6882
62	Benzyl chloride	6478	6482
63	Polycyclic aromatics	4548	5734
64	1,2,4-trimethylbenzene	4082	5072
65	Chromium compounds	4852	4880
66	Cresol	4440	4441
67	Chlorine	4364	4367
68	Nickel compounds	3752	3752
69	Benzoyl chloride	2470	2470
70	Methyl acrylate	1561	2463
71	Sodium nitrite	2241	2241
72	Acrylonitrile	873	2159
73	Diisocyanates	1815	1815
74	4,4-isoproplyideneiphenol	1725	1724
75	Ethyl methacrylate	31	722
76	Isobutrylaldehyde	339	339
77	Styrenee	251	256
78	Pyridine	47	224
79	Ozone	43	76
80	Acrylamide	6	6
81	n-methylolacrylamide	5	5
82	Acetamide	1	1

For Union Carbide's plant at Wilton, England Friends of the Earth England's Factory Watch reports the following air emissions in 1999, in kilograms

1,4 dioxane	2220.0
2,2,4,6,6-pentamethylheptane	7500.0
acetaldehyde	93100.0
carbon dioxide	153290000.0
carbon monoxide	13400.0
ethylene glycol	71.2
ethylene	567200.0
ethylene oxide	3870.0

formeldehyde	720.0
methane	340400.0

For waste disposal at Wilton, Friends of the Earth reports non-special waste to landfill of 15,500.0 kg and reuse of non-special waste at 22,400.0 kg. As to its treatment of special waste, 75.0kg was land-filled, 16500.0 kg was 'recovered as fuel', 975.0 was 'recovered' by other means and 1054.0kg was disposed of by other means.

5.4 Accidental releases

Along with the routine emission of toxic chemicals, Union Carbide also releases chemicals accidentally into the environment through spills, leaks and explosions. Before looking at the details it should be noted that, aside from its responsibility for the Bhopal massacre, Union Carbide is not a particularly bad actor in terms of public safety, being neither the best nor the worst in the industry. The following is a list of larger accidents at various Union Carbide factories from 1973 to 1993.

1969 October 23 Explosion and fire at Texas City plant resulted in no serious injuries but damaged nearby houses as well as causing $9million damage to the plant.

1973 Three workers killed at Penuelas, Puerto Rico complex

1973 Worker at Penuelas killed by benzene leak

1973 Worker at Institute, West Virginia killed by propane fumes

1975 February 10 Six workers killed by explosion at Antwerp, Belgium PE plant

1978 Worker electrocuted at the Everready battery plant in Jakarta, Indonesia.

1979 January 9 Five supervisors were killed by an accident at a strike-bound ferromanganese plant operated by Union Carbide at Beauharnois, Quebec.

1980 1982 July Several hundred residents were evacuated and some were treated at hospital when hydrogen chloride leaked from a tankcar at Union Carbide Massey yard in South Charleston, West Virginia

1982 December 11 17,1000 people were evacuated when a tank containing acrolein exploded at the Taft, Louisiana plant

1984 December 2-3 BHOPAL MASSACRE

1985 January 400 people were evacuated from Taft, Louisiana plant after a sharp rise in temperature in a peracetic acid and ethyl acetate storage tank. The same week an explosion and fire was reported in the ethylene unit.

1985 March Dozens of residents became ill after exposure to acetone and mesityl oxide leak from Union Carbide's South Charleston, West Virginia plant

1985 August 11 Six workers were injured and over a hundred residents received hospital treatment when methylene chloride and aldicarb oxime leaked from the Institute, West Virginia plant

1986 June Worker injured at Institute, West Virginia by explosion

1988 August 13 Fire and explosion of 4300 pounds of ethylene oxide at institute plant

1990 February 2 Seven workers were injured when MIC leaked at the Union Carbide/Rhone-Poulenc plant at Institute, West Virginia.

1991 March 12 One contract worker was killed and 26 other workers injured by explosion at Seadrift, Texas plant

1991 June 27 Eight contract workers were injured when ammomnia spilled at Seadrift, Texas plant.

1991 August 28 Two workers were injured in a leak of ethylene oxide at South Charleston, West Virginia

1993 June 22 One person was injured by a leak of anhydrous ammonia at South Charleston, West Virginia

1993 Union Carbide's Responsible Care Progress Report listed the number of fires and explosions per year as 6 in 1988, 3 in 1989, 3 in 1990, 2 in 1991 and 2 in 1992.

These are major incidents. A more realistic account of these accidental releases is provided by the following table which lists numbers of spills by Union Carbide in the US from 1985 to August 1994.

Year	Number of spills
1985	8
1986	3
1987	12
1988	10
1989	14
1990	95
1991	134
1992	120
1993	89
1994	94

We may flush out this picture by reprinting a compilation relating examples from Union Carbide s health and safety record in West Virginia.

5.5 Air Pollution From Union Carbide Factories

We are lucky to have information on reported health impact of routine emissions from one Union Carbide plant in Puerto Rico. In a survey conducted in 1982 among residents of Yabucoa, a neighbouring community to Union Carbide's graphite plant, 44% of residents reported skin problems, 21% respiratory problems, 21% asthma attacks, 36% throat problems, 44% eye problems and 21% ear problems.

More recently a Union Carbide plant manufacturing emulsion paint resins and synthetic adhesives in the Ekala Industrial Estate near Colombo, Sri Lanka was closed by the local authorities after ethyl acrylate fumes leaked from the factory in October 2000, causing more than 1000 people to seek medical treatment. The factory was blamed for the widespread incidence of respiratory problems, chest pain, stomach trouble and headaches locally. Drinking water had been polluted by effluent discharged by the Union Carbide factory: 'People have to go a long way to fetch drinking water' reports said. Local environmentalists claim all eleven factories at the Industrial Estate have been polluting air and water and for the previous five years residents have been complaining of health effects from this contamination. Prof. Carlo Fonseca of the Medical Faculty, Kelaniya University, has warned that continued exposure will result in skin diseases, kidney failure and mental illness.

5.6 Toxic Waste Sites

Bhopal of course is not the only place where Union Carbide has abandoned toxic waste. For the US, Union Carbide itself estimates that there are 105 hazardous waste sites where it may be liable for investigation and/or remedial costs. By March 2001 Union Carbide had set aside $180 million to deal with its expected responsibilities for environmental remediation. 'These accruals have two components, estimated future expenditures for site investigation and cleanup and future expenditures for closures and postclosure activities. In addition the corporation had environmental loss contingencies of $67 million.' (10-K form, 31/3/01, p.9) Union Carbide estimates that it is solely responsible for 40% of the waste sites for which it has established accruals.

Appendix 4 lists toxic waste sites where Union Carbide has been sued by the US government to obtain clean up costs. According to the PIRG Union Carbide is in the top four for 'potentially responsible parties' at Superfund National Priority List sites, with Union Carbide being considered a party responsible for dumping at 51 sites, trailing General Motors (64 sites), Dupont (81 sites) and General Electric (86 sites).

Certainly Union Carbide waste has been dumped at some of the worst toxic waste sites in the US. In May 1979 *Science* reported that Nicholas Fernicola contracted with Union Carbide to dispose of 4,500 55-gallon drums of distillation residues, organic wash solvents and other organic wastes. Fernicola dumped the chemicals on a farm he leased near Tom's River, New Jersey, telling the owner the drums were empty. Chemicals leaked from the drums and polluted the aquifer that supplies local wells. The site was placed on the National Priority List on 9/1/83. From 1972 to 1974 Union Carbide removed drums, trench waste and contaminated soil from the site and later 'in response to concerns regarding potentially elevated childhood cancer cases in Tom's River, Union Carbide agreed to further treat [ground]water using a carbon adsorption unit.' (EPA NPL Site Fact Sheet)(*Science* 25/5/79:821) Union Carbide was also one of ten corporations whose waste was dumped at Price's Pit, which in January 1982 was reported to be threatening the water supply at nearby Atlantic City, New Jersey. Pollutants at Price's Pit included berrylium, chloroform, VCM, ethylene chloride, mercury, cadmium, lead, zinc, 1,2-dichlorobenzene, toulene, nickel and arsenic. (*CMR* 4/1/82:7,61) Union Carbide waste was also found in the infamous Chem-Dyne waste site in Hamilton, Ohio, which was reported in 1982 to presnet an 'imminent and substantial danger to human health'. (*WSJ* 27/8/82:20; *CMR* 30/8/82:, 5,48.) In July 1983 Union Carbide was asked to clean up dioxin contamination at its Marietta, Ohio site. (*NYT* 28/7/83:A12) In September 1983 Union Carbide was one of 246 companies which entered into a settlement agreement to clean up the Environmental Conservation Chemical Corporation dump at Zionsville, Indiana. (*CMR* 26/9/83:7,18; *CEN* 26/9/83:15) In June 1987 Union Carbide was one of twenty companies that agreed to pay for the cleanup of the Motco toxic waste site near La

Marque, Texas, which ranked 27th on the list of most dangerous waste sites in the US. (*CMR* 28/6/87:7,25)

Some indications of Union Carbide's zeal in cleaning up after itself can be seen in the case of the contamination of the Columbia Slough in North Portland, where Union Carbide had operated a calcium carbide and ferroalloys processing plant until 1982. In the 1980s official investigations found toxic substances –including metals, PCBs and persistent pesticides like DDT- in soil, sludge ponds and a drainage ditch. Union Carbide agreed to a cleanup in February 2000.

Nor is it only in the US that Union Carbide has abandoned waste. In 1997 Greenpeace began a campaign for the cleanup of dioxin in Homebush Bay, near Sydney Harbour, Australia. Greenpeace reports:

> 'In 1957 the multinational giant Union Carbide purchased Timbrol Ltd. and continued chemical production at the site until 1985. From 1957 to 1976 Union Carbide continued production of the chlorinated herbicides 2,4-D and 2,4,5-T, the two chemicals that make up the infamous Agent Orange used in the Vietnam war. Union Carbide abandoned Australia and its toxic legacy in the early 1990s.
>
> 'Polychlorinated dioxins and furans (often simply referred to as dioxin) are produced as byproducts during the production of organochlorines such as 2,4-D and 2,4,5-T. Large areas of the Rhodes Peninsula were reclaimed from the bay using solid wastes from the Union Carbide factory as the primary fill material. The waste was heavily contaminated with a wide range of persistent organic pollutants (POPs), including dioxins, organochlorine pesticides (DDT,DDE,DDD) and chlorinated phenoxy and aliphatic compounds. Together with the very real likelihood of direct discharge of pollutants via the Union Carbide stormwater system over decades, Homebush Bay is now one of the most contaminated waterways in the world.'
>
> 'In June 1997 Greenpeace investigations revealed an orphaned stockpile of thirty-six 50-litre drums of highly dioxin contaminated waste adjacent to the former Union Carbide factory site.'

6. UNION CARBIDE AND THE NUCLEAR INDUSTRY

Before concluding this section on Union Carbide criminal history by examining the Gauley Bridge massacre, it's necessary to examine Union Carbide's responsibility for radioactive contamination, both as a member of the military/industrial complex and as a supplier to the nuclear power industry. Union Carbide's history as a mining and resource extraction company will not be dealt with here but is covered in the Mine watch company profile reprinted in Appendix 6. *Multinational Monitor* reports lying on Union Carbide's toxic and radioactive history:

> 'Carbide got its start in nuclear power during World War II. Indeed, it was one of the pioneers. Working under US government contracts, Carbide ran the Oak Ridge National Laboratories for most of the lab's existence, losing the contract to Martin Marietta corporation in 1984. After World War II, Carbide consolidated all the contracts for Oak Ridge operations, replacing Monsanto, Eastman, Kodak and Dow Chemical. For the next 41 years, Carbide produced nuclear weapons components, enriched uranium for Pentagon needs, as well as for fuelling commercial nuclear power plants and conducted other nuclear energy research.'

> 'The Y-12 plant at Oak Ridge, built in 1943 as part of the Manhattan project, is the main nuclear weapons factory for the US government. In 1977, a declassified Department of Energy report revealed that 2.4 million pounds of mercury had been released into the ground, water and air between 1950 and 1963, a time when the plant was still under Carbide management.' (Summa:23)

Of course Union Carbide's radioactive history goes even further back than the 1940s, as shown by the case of the Uravan Uranium waste site in Montrose County, Colorado, which was placed on the Superfund National Priority List on June 10, 1986. Set up originally to recover radium in 1915, it expanded to vanadium in 1935 and in the 1940s began recovery of uranium, first for national defence and later for nuclear power. The EPA reports on the site: 'Federal and state agencies have inspected this facility many times and have brought action against Union Carbide for numerous violations and hazardous materials spills. These efforts have established that ground water and air at the site are contaminated with process wastes, including uranium, from the milling operations'.

Multinational Monitor also reported on contamination in Colorado:

'In Colorado, the Carbide subsidiary Umetco Minerals has operated uranium mines and mills for decades, often with little regard for the health of area residents or the environment. According to Melinda Kassen of the Environmental Defense Fund, there were no specific regulations governing uranium mining and milling until 1978 because Carbide and other uranium mining outfits had long resisted such government action.'

'The industry is fighting with the state of Colorado over the cleanup of the toxic waste it has generated for decades. To settle a suit brought under the Superfund law, Carbide in 1986 agreed to a $50 million cleanup plan for a uranium site where Umetco, along with other companies, had dumped tons of uranium tailings.' (Summa:24)

Union Carbide was also responsible for radioactive contamination in New York. In February 1981 a report by the New York State Assembly Task Force on Toxic Substances charged that highly caustic and slightly radioactive waste was pumped into the ground in Tonawanda, New York, by Linde Air Products Company, now a division of Union Carbide, from 1944 to 1946. The 37 million gallons of liquid waste came from a Manhattan project uranium refinery. The study claimed the disposal method was chosen so that the pollution could not be traced back to the Army and its contractors. (CMR 9/2/81:5,27)

6.1 Occupational Safety and Health

The other major industrial crime in which Union Carbide was involved is what has been described as the Hawk's Nest scandal, when to quote the *Wall Street Journal Europe* (3/1/85:2) 'in a Depression-era scandal in West Virginia, 476 workers died of the lung disease silicosis while building a diversion tunnel for a Carbide-sponsored hydroelectric project. Hundreds of others suffered and died later from the disease in what labour experts call the worst incident of its kind in US history' others sources claim the figure of victims was as high as 1200. What the *Journal* finds too delicate to mention is the racist nature of the Hawk's Nest massacre. Some 80% of the tunnel workers were black. A critical account of the massacre reports 'it is apparent that the illnesses and deaths that resulted were not only known to them, but *expected* by them. For as the purchasing agent for the contractor candidly stated "I knew we were going to kill these niggers, but I didn't know it was going to be this soon." Sen Holt of West Virginia reported that the company further stated openly that "if we kill off those, there were plenty of other men to be had."

> 'More important than these off-the-cuff remarks, however was the fact that early in the project Rinehart and Dennis contracted with a nearby undertaker to bury the dead at $55 apiece. Asked why he had accepted the job at a price so low that the local Gauley Bridge undertaker had apparently refused, H. C. White declared that the "company had assured him there would be a large number of deaths"
>
> 'Mr White performed his tasks with great efficiency –the standard time between death and burial was three hours. In this manner the company was able to avoid both the filing of a death certificate and the performance of a possibly incriminating autopsy.'(Healkth/PAC:12)

Here we may see operating two tactics the company later utilised in dealing with the Bhopal massacre, racist discrimination and presenting itself as the victim. In those cases brought by exposed workers or their surviving families, settlements ranged from $80-250 for blacks and from $350-1000 for whites. One observer noted: 'Because there were black workers on the job the company tolerated far worse conditions than they would have if the workforce had been all white' (Health/PAC: 15)

When the Gauley Bridge massacre was investigated by the US House Labour Committee, not only did Union Carbide deny the negligence charges brought against it, it claimed itself to be the true victim of the disaster. A Union Carbide spokesperson declared that the company was 'very proud of its safety record everywhere' and denied that there had been a single death from silicosis. As the Industrial Medical Assocxiation history notes of the time silicosis suits were widely seen as an organised racket and a fraud. 'Industry was portrayed as the *true* victim of enterprising lawyers and workers out to make a quick buck' (Health/PAC:13)

Some Conclusions

From the evidence presented in this report it's possible to arrive at some tentative conclusions. To begin with, Union Carbide now is not the same Union Carbide that was responsible for the Bhopal massacre. While Union Carbide survived the crisis Bhopal posed, it fell victim to a deeper and more general crisis in the chemical industry which led to its merging with (or, more accurately, takeover by) Dow Chemical. The report shows a consistent pattern of disregard by Union Carbide for health of the environment and humans (both workers and residents exposed to pollution from its operations). However Union Carbide is not unique in this: the vast majority of corporations operate in a similar fashion. Union Carbide is unique only in its participation in two of the worst industrial disasters of the twentieth century.

And is escaping from both of them nearly scot-free.

If Union Carbide survived the crisis Bhopal posed and escaped with the light cost of 48 cents a share, it was not due to superb company management but rather to the mendacity of an Indian government anxious to demonstrate to foreign capital how prepared it was to sacrifice its population on the alter of economic development. With the buzzwords in the early 1980s being economic liberalisation and economic modernisation, amid visions of the Indian elephant transforming into an Asian tiger, the Indian state wished to attract foreign capital, not scare it away. This combined with the desire of the local and national political elite, compromised by its own involvement in the genesis of the disaster, to close the case with the minimum of dirty laundry on public display. Here again we may note there is nothing unusual about this.

Due to lack of time it hasn't been possible to adequately position Bhopal in the context of globalisation but I believe that Bhopal shows that the picture is more complicated than enthusiasts of strong globalisation theories such as Mr. Stavoapoulis of Dow claim and, as such, is more amenable to revisionist criticism of strong globalisation which sees globalisation as a political strategy rather than a fait accompli. In this view not only is the victory of capital not inevitable, but the unity attributed to capital by strong globalisation theorists and its control of the state are questioned.

Here Pearce and Tombs' position seems most useful:

> 'Everest, for example, overestimates both the freedom of individual enterprises and their overall unity of interest. He tends to invoke a unitary class subject variously called 'foreign capital' 'foreign investment' or 'foreign multinationals'. This unitary class subject operates within both Third World countries and within the US. Thus, Everest represents UCC's arguments that the Bhopal court case should be heard in India as an expression of the view of corporate capital. A more convincing interpretation is that the corporation was trying to mobilise the support of other corporate and governmental personnel. However basic the capital/labour relation, both capital and labour exist as differentiated entities –as 'many capitals' which may be organised fictionally and as individual workers who may be organised in different kinds of trade unions, may work part time and so on. The capitalist class should not be assumed to be a 'class subject' with the state as its instrument, nor should it be assumed that capitalistic social formations automatically function (however complexly) to reproduce capitalistic domination. There are both conflicts that unify the capitalist class –for example, those against the working class, rival imperialistic powers, or rival social systems- and others that divide it such as competition between corporations for markets and for capital. Neither nation state, capital as a whole, nor individual; capitalists and corporations are guaranteed victory. The unity of the capitalist class can be real enough but it is often fragile.' (Pearce and Tombs p. 207)

With all due respect to the great work and spirit that went into them, the transnational campaigns against UC showed the limits of anti-corporate campaigns. The predominant form of anti-corporate campaign has been one which has attempted to mobilise consumers to boycott the corporation while also attempting to pressure the corporation via a general publicity campaign and particularly by attending AGMs and attempting to mobilise dissident shareholders to place pressure on corporations by passing resolutions.

The most successful of these campaigns have been the calling of consumer boycotts. In its current manifestation UC appears immune to this tactic, as it sells nothing directly to the public, its market being other corporations whose purchasing policies are not normally ethics-driven. At the time of the massacre UC had a large consumer products division. In response to the attempted takeover by GAF in 1985 UC sold this off. Conveniently this also insulated Union Carbide from a consumer-based campaign.

Despite this, tribute must be paid to the success of the international campaign in the following ways:

1. That Bhopal still remains and issue, despite Union Carbide's attempt to close the books on it.
2. In scuttling the attempted out of court settlement 1987.
3. The reinstigation of the criminal charges, which had been quashed in the February 1989 court settlement.
4. Through raising the issue via shareholders at Union Carbide AGMs forced Union Carbide to acknowledge continued water and soil contamination in Bhopal.
5. While Dow initially refused to have any dealings with victims of Bhopal, the demonstration of 28th February 2001 forced Dow to enter negotiations.

Unfortunately appealing to Union Carbide's shareholders will similarly prove to be fruitless. The problem with reformist appeals to the better side of corporations is that, in the final analysis, the large shareholders (the market, in all its glory) will vote for increased profit above all. While some shareholders may be motivated by ethical concerns, they are always in a minority. And while management may spin green wash about the triple bottom line –financial, environmental and social- in the final analysis, the greatest of these is financial.

Some possibilities do exist, with the Dow merger, to again strategically target corporate rhetoric. With Dow currently espousing rhetoric of the 'triple bottom line of sustainability –economic, social and environmental needs' (see Appendix 7) it is time to call their bluff loudly and publicly

The recent growth of an anti-globalisation movement in core countries presents a possible new course. We need to insert Bhopal into the concerns of this new movement, with the glorious object of encircling a Dow/UCC AGM just as the WTO was encircled at Seattle.

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