PLANNING FOR CHEMICAL DISASTERS AT POINT LISAS, TRINIDAD AND TOBAGO

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ABSTRACT :

No major chemical disaster has taken place so far in Trinidad and Tobago. Even so, in view of the numerous hazards that the various chemical handling plants deal with at Point Lisas, the Country has to be prepared to deal with chemical disasters.

The Country's emergency preparedness plan for chemical disasters aims to localize the emergency, if possible, eliminate it and minimize the effects of the accident on people and property.

The hazards of Ammonia, Hydrogen, Chlorine, Hydro-carbon and Methanol release can have devastating effects on the workers and the residents in the vicinity of the Plants.

The Emergency Plan identifies an Emergency Co-ordinating Officer who would take command of the off-site activities and co-ordinate the activities of Works Management, Local Authority, Police, Fire Services, Defence Force, Health Authority and Factory Inspectorate.

Resources of fire fighting, medical treatment, telecommunications, waste management and public education have to be enhanced immediately. In the long term a new fire station and a new county hospital have to be built, some housing settlements have to be phased out and non-essential staff relocated.

INTRODUCTION :

"The wise man will rule over planetary influences, which do not necessarily bring their properties to bear upon terrestrial bodies; but he only influences the latter, because it is possible to protect oneself through prudence and discretion."

Ptolemy

It has been said that God often tries us with a little to see what we could do with a lot. (McKenzie 1980).

Although there is an impression on the minds of the public that hazardous events in the chemical industry are increasing, the statistical facts of Trinidad point to the contrary. Actually no major chemical disaster has taken place in this country. But there have been many minor incidents involving the leak of toxic gases, fires, explosions and hazardous waste in the country. (Mathur *et al.* 1992). Maybe God, who is widely reputed to be Trinidadian, is trying to tell us something.

TYPES OF CHEMICAL ACCIDENTS :

Chemical accidents may arise in a number of ways, and no two accidents are exactly the same. Some of the more important types are as follows :

a) Explosions in a plant or in a storage facility

b) Release of toxic gases

c) Fires

d) Accidents during the transportation of chemicals

e) Improper waste management.

The safety record in Trinidad, as far as we have been able to determine, is dependant upon the maintenance of the strictest safety regulations and accident prevention through staff training. It is instructive that all major accidents around the world involving chemical storage and manufacture had human failure as the root cause of the problem. Let us consider two case studies in different parts of the world and examine the lessons drawn from them.

CASE STUDIES :

PEMEX - Mexico City : This is a state-owned oil company which operated an LPG (Liquefied Petroleum Gas) storage and distribution centre.

On November 19, 1984 an explosion at the factory killed 542 and injured 4000. At that time this was the most serious chemical industry accident. It held this record for 2 weeks only. Bhopal happened on December 3, 1984.

It seems that there was a leak in a 20 cm feed pipe to the storage tanks. At 0530 hours the LPG escaped with a deafening noise.

There was a slight breeze and the gas cloud moved south-west over an area about 200 x 150 metres. One edge of this cloud reached a residential area. Another edge was drifting towards a flare on the site. There was a village downwind of the site towards which the cloud of gas, about 2 metres high, was drifting at about half a metre a second. At 0540 hours the gas cloud reached the flare and ignited. There was an immediate and explosive conflagration engulfing both the Plant and the village.

The initial explosion ruptured exposed piping which increased the volume of gas released and fueled the fire. Successively other storage tanks exploded raining burning gas, red hot metal and liquid gas to distances as much as 600 metres from the Plant.

In all, nine explosions were recorded between 0530 and 0730 hours, two of them powerful enough to be recorded on earthquake measurement instruments 25 km away.

Devastation was complete out to 300 metres from the Plant perimeter fence. Two thousand houses were destroyed as far out as 400 metres from the site.

Both the police and the emergency services were aware of two similar plants nearby to which PEMEX distributed LPG by underground pipeline. Indeed, the main office of one of these plants was demolished by a 40 tonne piece of metal hurled by one of the explosions. Fortunately, due to adequate protection of the tanks on this site, they were not ruptured.

At the third Plant, nearly one hundred trucks loaded with household gas cylinders were totally destroyed by fire. (Cranfield 1990).

Bhopal : Bhopal is a city of 800,000 in Central India. In 1934, Union Carbide, a major multi-national chemical manufacturer established a plant in the city. 1984 was its Golden Jubilee year.

On December 3, 1984 a man-made accident at the plant caused the greatest industrial accident known. Over 3000 were left dead, killed by toxic fumes and as many as 250,000 suffered permanent disability in sight, breathing and general physical or mental health.

As so frequently happens in chemical disasters, there was little the emergency services were able to do to rescue survivors other than assist a very small proportion to hospital.

A study of the events leading up to and subsequent to the disaster does, however, contain a number of lessons (Varadarajan *et al.* 1985) :

* Due to faulty engineering and operating (washing out pipes), water got into the system where it should not have been and caused a chemical reaction.
* Chemicals were stored in far greater quantities than were necessary for production.
* When the accident happened, the Union Carbide staff took themselves up-wind to safety and took no preventative or remedial action.
* A siren was sounded. Because the local people had no knowledge of the warning system or what they should do, they rushed into the street and even towards the plant to help fight what they thought was a fire.
* None of the plant safety devices worked.
* Operating and Safety Manuals were not being observed although developed in consequence of a serious accident in 1982.
* The local authorities had never been advised of the hazards so that they could plan against such an emergency.
* In 1934 the Plant was outside the Bhopal City. Over the next five years residential areas spread out to the Plant and the area became densely populated.
* In 1975 the Administrator of Bhopal told Union Carbide to move the Plant. The Plant stayed, the Administrator was transferred, Union Carbide donated US$2000 for a public park and the notice to move was withdrawn. In 1979/80 the Plant began manufacture of the deadly MIC (Methyl Icocyrate).

CABINET APPOINTED COMMITTEE :

It was not too soon that the Cabinet of Trinidad and Tobago decided last year to appoint a permanent committee to evaluate and plan for disaster preparedness at Point Lisas including community awareness programmes. Chairman of this committee is the Chief Co-ordinator, National Emergency Management Agency (NEMA), while the membership comprises representatives from the Trinidad and Tobago Police Service, Fire and Ambulance Service, Defence Force, Ministry of Energy and Energy Based Industries, Point Lisas Industrial Port Development Corporation Limited (PLIPDECO), Inter Enterprise Safety Advisory Committee, Trinidad and Tobago Emergency Mutual Aid Scheme (TTEMAS), Ministry of Health, and Factory Inspectorate. We have co-opted a member of the Local Government to the Committee.

FORMULATING THE PLAN :

Objectives :

The overall objectives of the Emergency Plan are :

a) To localize the emergency and, if possible, eliminate it, and

b) To minimize the effects of the accident on people and property. (OECD 1992).

IDENTIFICATION AND ASSESSMENT OF HAZARDS :

This stage was crucial to both on-site and off-site emergency planning and requires Works Management to systematically identify what emergencies could arise in their plans. We visited various industries at Point Lisas to get first hand information on the hazards at each plant and identified the following hazards :

a) **Release of Ammonia :**

This situation can result from storage tank failures at the three Ammonia Plants located on the Estate - FERTRIN, HYDRO AGRI and TRINGEN - and ammonia can also be released from pipelines. Because of its toxic nature and because it is also flammable, ammonia also poses threats of fire and explosion.

b) **Release of Hydrogen :**

This situation can result from leakage in the steam reformer at FERTRIN, the two Methanol Companies, Hydro Agri Company Limited and TRINGEN. Leaking lines may also result in a release of hydrogen. Hydrogen ignites and burns rapidly and it also presents an explosion hazard. Since the flame is non-toxic, it may not be visible.

c) **Release of Chlorine :**

This situation can occur as a result of storage tank failure at the Chlorine Plant on the Estate. This release is potentially one of the most severe hazards presented by the Chemical Industry.

d) **Hydro-Carbon Release :**

This can occur as a result of a natural gas release. The hydro-carbons are flammable and give rise to hazards both of fire and of toxic release.

e) **Release of Methanol :**

This can result from a failure of the large vessels at either of the two Methanol Plants. The releases may also be as a result of line breakage or line leakage. Methanol also presents a fire hazard and burns with a non-luminous flame which is difficult to see. (Boodoosingh 1993).

ASSESSMENT OF RISKS :

The aim at this stage of the hazard evaluation process is to establish what is the likelihood of hazards being manifested, and how the accident would affect the vulnerable areas.

The following conclusions can be drawn from the studies made so far :

a) The potential is there for the occurrence of a major chemical disaster at the Point Lisas Industrial Estate.

b) Catastrophic failure of process equipment, pipelines or storage vessels can result in devastating effects both on the workers and the residents in the vicinity of the Plants.

c) Some of the housing settlements are definitely too close to the Estate. These settlements include Brechin Castle, Couva, Couva Housing Settlement and California.

d) There may not be enough time to evacuate the Estate and surrounding settlements should the release of chemicals occur. Six thousand employees and 17,615 people in surrounding areas may be involved.

ON-SITE EMERGENCY PLANNING :

Most of the Plants have their own Disaster Preparedness Plans. Generally, the plans are in the following four sections :

i) General information which gives site manning and community population and site operations.

ii) Possible emergencies and hazards.

iii) The individual responsibilities for emergencies.

iv) General information for handling injuries, radio communications, traffic control and telephone systems.

The primary purpose of the on-site emergency plan is to control and contain the incident and to prevent it from spreading to nearby Plants.

OFF-SITE EMERGENCY PLANNING :

The off-site emergency plan is an integral part of our major hazard control system. It is based on those accidents identified by the Works Management which could affect people and the environment outside the works. Thus, the off-site plan follows logically from the analysis that took place to provide the basis for the on-site plan and the two plans should, therefore, complement each other. The off-site plan in detail is based on those events which are most likely to occur, but other less likely events which would have severe consequences have also been considered. The key feature of a good off-site emergency plan is flexibility in its application to emergencies other than those specifically included in the formation of the plan.

The plan identifies an Emergency Co-ordinating Officer who would take overall command of the off-site activities. As with the on-site plan, an Emergency Control Centre is required within which the Emergency Co-ordinating Officer can operate.

An early decision will be required in many cases on the advice to be given to people living "within range" of the accident - in particular, whether they should be evacuated or told to go indoors. In the latter case, the decision can regularly be reviewed in the event of an escalation of the incident. Consideration of evacuation may include the following factors :

a) in the case of a major fire but without explosion risk, eg, an oil storage tank, only houses close to the fire are likely to need evacuation, although a severe smoke hazard may require this to be reviewed periodically;

b) if a fire is escalating and in turn threatening a store of hazardous materials, it might be necessary to evacuate people nearby, but only if there is time; if insufficient time exists, people should be advised to stay indoors and shield themselves from the fire. This latter case particularly applies if the installation at risk could produce a fireball with very severe thermal radiation effects, eg, LPG storage;

c) for releases or potential releases of toxic materials, limited evacuation may be appropriate down wind if there is time. The decision would depend partly on the type of housing "at risk". Conventional housing of solid construction with windows closed offers substantial protection from the effects of a toxic cloud, while shanty houses offer little or no protection.

The major difference between releases of toxic and flammable materials is that toxic clouds are generally hazardous down to much lower concentrations and, therefore, hazardous over greater distances. Also, a toxic cloud drifting at, say, 300 metres per minute covers a large area of land very quickly. Any consideration of evacuation must take this into account. (Farabi 1991).

ROLE OF THE EMERGENCY CO-ORDINATING OFFICER :

The various emergency services are co-ordinated by an Emergency Co-ordinating Officer (ECO) who is a senior Fire Officer. The ECO will liaise closely with the Site Main Controller. Again, depending on local arrangements, for very severe incidents with major or prolonged off-site consequences, the external control may pass to the National Emergency Management Agency (NEMA).

ROLE OF MAJOR HAZARD WORKS MANAGEMENT :

The role of the Works Management in off-site emergency planning will be to maintain liaison with the Cabinet Appointed Committee to provide information appropriate to such plans. This will include a description of possible on-site accidents with potential for off-site harm, together with their consequences and an indication of the relative likelihood of the accidents.

Advice should be provided by Works Management to all the outside organizations which may become involved in handling the emergency off-site, and which will need previously to have familiarized themselves with some of the technical aspects of the works activities, eg, emergency services, medical departments and also water authorities (if water contamination could be a consequence of an accident).

ROLE OF THE LOCAL AUTHORITY :

The local corporation has appointed an Emergency Planning Officer (EPO) to carry out this duty as part of the EPO's role in preparing for a whole range of different emergencies within the local authority area. The EPO will need to liaise with the works to obtain the information to provide the basis for the plan. This liaison will need to be maintained to ensure that the plan is continually kept up to date.

It will be the responsibility of the EPO to ensure that all those organizations which will be involved off-site in handling the emergency know of their role and are able to accept it by having, for example, sufficient staff and appropriate equipment to cover their particular responsibilities.

Rehearsals for off-site plans are important for the same reasons as on-site plans and need to be organized by the EPO.

ROLE OF THE POLICE :

Formal duties of the Police during an emergency include protecting life and property and controlling traffic movements.

Their functions include controlling bystanders, evacuating the public, identifying the dead and dealing with casualties, and informing relatives of death or injury.

ROLE OF THE FIRE AUTHORITIES :

The overall control of an emergency will be assumed by the Fire Service, with a senior officer designated as Emergency Co-ordinating Officer.

The control of a fire is normally the responsibility of the Senior Fire Brigade Officer who would take over the handling of the fire from the Site Incident Controller on arrival at the site. The Senior Fire Brigade Officer may also have a similar responsibility for other events, such as explosions and toxic releases. Fire authorities would familiarise themselves with the location on-site of all stores of flammable materials, water and foam supply points, and fire-fighting equipment. They may well have been involved in on-site emergency rehearsals both as participants and, on occasion, as observers of exercises involving only site personnel.

ROLE OF THE DEFENCE FORCE :

Defence Force is assigned the duties of search and rescue of the victims and providing additional transport for evacuation of victims and those threatened by the disaster.

ROLE OF THE HEALTH AUTHORITIES :

Health authorities, including doctors, surgeons, hospitals, ambulances and so on, have a vital part to play following a major accident, and they would form an integral part of any emergency plan.

For major fires, injuries will be the result of the effects of thermal radiation to a varying degree, and the knowledge and experience to handle this in all but extreme cases may be generally available in most hospitals. For major toxic releases the effects vary according to the chemical in question, and it is important for health authorities who might be involved in dealing with the aftermath of a toxic release to be familiar with the treatment appropriate to such casualties.

Major off-site incidents are likely to require medical equipment and facilities additional to those available locally, and a medical "mutual aid" scheme should exist to enable the assistance of neighbouring authorities to be obtained in the event of an emergency.

The local Couva District Hospital would be used as a first stage Management Unit.

ROLE OF THE FACTORY INSPECTORATE :

In the event of an accident, the Factory Inspector will have a close involvement in advising on operations. In cases where toxic gases may have been released, the Factory Inspectorate may be the only external agency with equipment and resources to carry out tests.

In the aftermath, the Factory Inspector may wish to ensure that the affected areas are rehabilitated safely. In addition, they may require items of plant and equipment essential for any subsequent investigation to be impounded for expert analysis, and may also want to interview witnesses as soon as practicable.

REHEARSALS AND EXERCISES IN OFF-SITE EMERGENCY PLANNING :

Extensive experience in the chemical industry with on-site emergency planning has proved the need and value of rehearsals of emergency procedures.

NEMA would test the off-site plan in conjunction with on-site exercises. Table-top rehearsals are also extremely useful in such cases.

An essential component of any trial is that of testing fully the various communication links necessary to gather the information needed for overall co-ordination, eg. between works and emergency services, and between the works emergency control centre and the incident.

Trinidad and Tobago Emergency Mutual Aid Scheme (TTEMAS), which involves most of the industries located at Point Lisas, is well placed to advise on the setting up of rehearsals and particularly to advise on the scope for an escalation in the degree of emergency.

IMMEDIATE MEASURES :

Fire and Emergency Unit :

It is proposed to acquire appliances and equipment worth approximately TT$14 million for dealing with the Point Lisas Industrial Estate. This equipment would be located at Chaguanas Fire Station until the Fire Station is built at Point Lisas.

Medical Facilities :

Setting in place arrangements with PETROTRIN for the use of the Augustus Long Hospital for receiving, treating and caring for industrial casualties. It will be necessary to establish a specialized de-toxification, poison control, burn therapy and industrial trauma care unit at these facilities.

Telecommunications :

The Telecommunications Division in the Office of the Prime Minister will design a communications system for efficient command and control in emergency situations. The system will be reinforced by the mobile sets from the Defence Force.

Waste Management :

Manufacturing companies to ensure disposal of hazardous solid waste at Forres Park Site in consultation with Solid Waste Management and treat / separate liquid waste before discharge into the waterways.

Public Education :

The public education programme would be undertaken to inform the public of the hazards present at Point Lisas Estate and the Outline Emergency Plan. This would take the form of workshops and seminars to inform the public concerned about the actions which they would take. Media would also be involved in this exercise.

Legislation :

Enactment of legislation should be done for minimizing risk of technological disasters and adoption of international standards, codes and practices. (Health and Safety Executive 1990).

LONG TERM MEASURES :

- Construction of a new Fire Station suitably designed to include Observation Tower, Control Room facility and Seal-Proof interior.
- Expediting construction of a County Hospital in Couva, feasibility study for which is currently taking place.
- Phasing out of residential buildings at California, Couva Housing Settlement and Brechin Castle.
- Relocation of non-essential staff of various manufacturing companies beyond 1.9 km radius of the Estate.

Security of operations outside the fence should be considered critical and should be immediately addressed by Point Lisas Industrial Port Development Corporation (PLIPDECO) in conjunction with the Police. (Mathur *et al.* 1994).

CONCLUSION :

The initial management of chemical accidents requires a thorough knowledge of properties of materials, their reactivity under varied conditions, the circumstances of the accident, estimate of nature and quantity of various products released and their effects on life systems and environment. The relief measures depend largely on such knowledge. Containment of toxic material, disposal and decontamination again demand a multi-disciplinary approach.

With the growth in volume and variety of chemicals produced at Point Lisas, much greater care is required in operation and maintenance of plants than ever before. Open discussion and disclosure by technologists and manufacturing units are urgently needed to ensure greater safety.

A fund has to be established immediately at Point Lisas Industrial Port Development Corporation (PLIPDECO) to implement the Outline Emergency Plan and short term plan. Once the Corporations at Point Lisas demonstrate their commitment to emergency planning, I am confident the Government will chip in to assist in the Long Term Planning for emergency management.

For too long we, the Government and Industry have been keeping our fears to ourselves. The time has now come to share each other's burden. All of us will then be able to walk a little straighter.

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BIOGRAPHY :

Colonel Mahendra Mathur served in the Corps of Engineers of the Indian Army for 21 years before coming to Trinidad and Tobago to build the Claude Noel Highway in Tobago in 1975.

On completion of the highway, Colonel Mathur was appointed Technical Officer in the Ministry of National Security with responsibility for all engineering works in support of the Defence Force, Police, Fire and Prisons Services.

When the National Emergency Management Agency (NEMA) of Trinidad and Tobago was set up on 1 May 1989, Colonel Mathur was asked to head it. Initially, Colonel Mathur's responsibilities were confined to national disasters. Since 1993 he has also been entrusted the responsibility of planning for chemical disasters.