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IndianOil

A Study report on the emergency preparedness plan of IOCL LPG BOTTLING PLANT BHOPAL.

By

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CERTIFICATE

This is to certify that Miss Anuranjana Bara, student of M.Tech (Health Safety and Enviornment) third semester, University pf Petroleum and Energy Studies, Dehradun has completed internship at LPG Bottling plant, Bhopal, from 02.07.07 to 16.07.07.

Date: 6-07-07

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Bhopal.

AKNOWLEDGEMENT

Work without inspiration is ineffective; with the successful completion of the internship I come to realize the importance of it and also the fact that how much we rely upon the selfless efforts and goodwill of others. I thank all who directly or indirectly helped me to make the report.

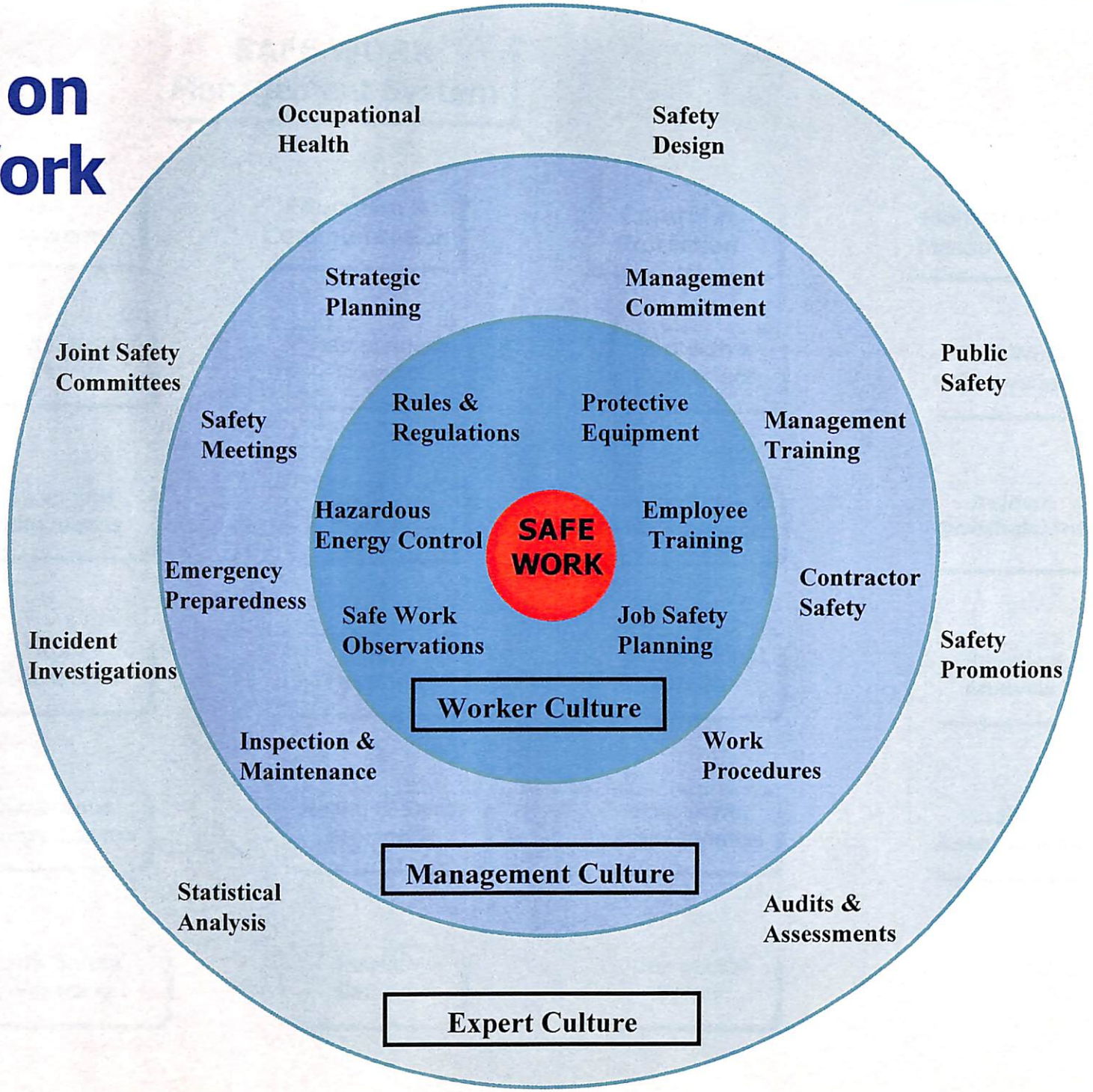
My heartfelt gratitude to Mr.Sabu (DY. Plant Manager), for providing the able guidance and the timely assessments he took to keep us on the toes. Actually it made us feel the work. Also the ample study material he provided was very helpful to relate with the work in the plant. His approach to any matter is impressive and through.

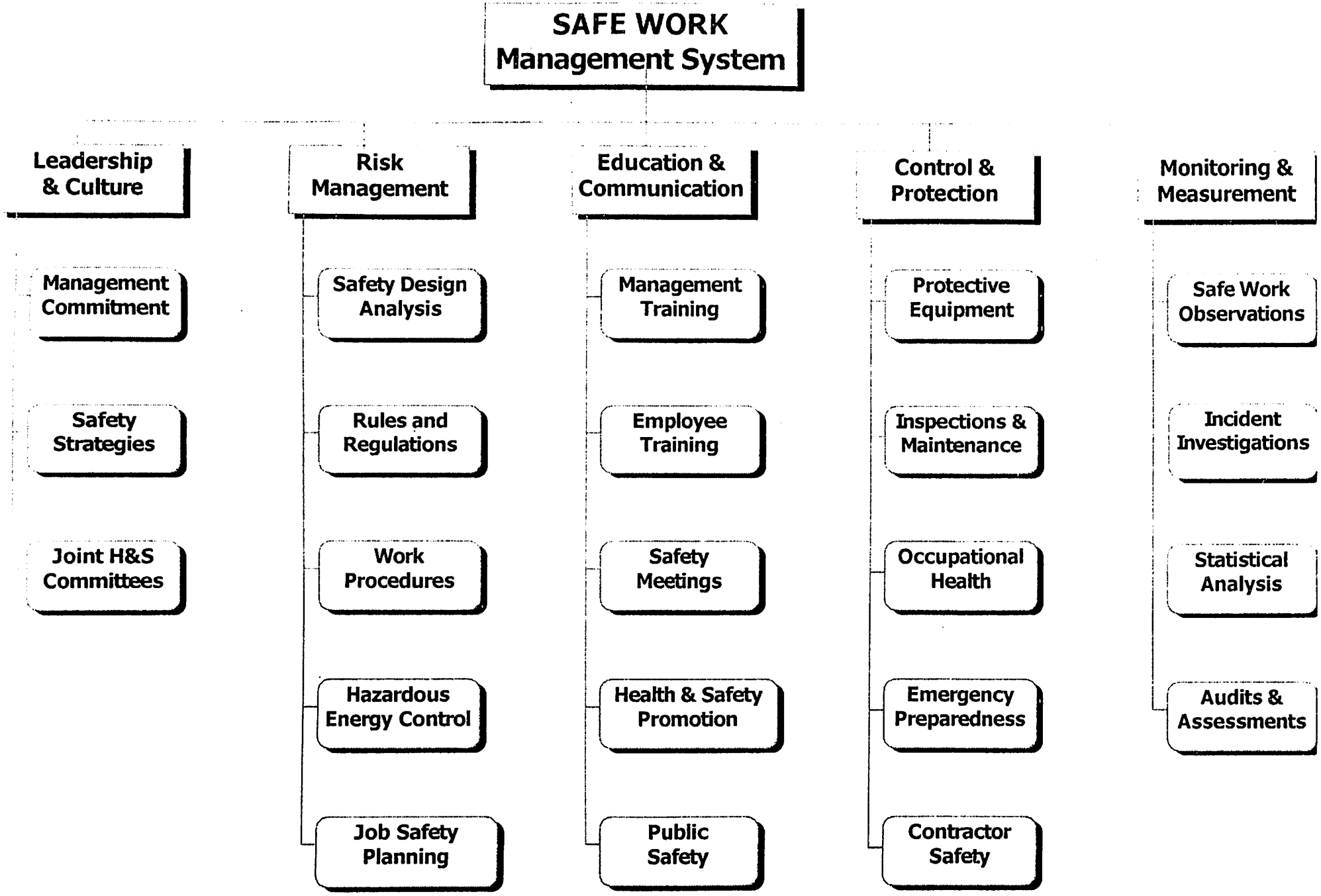
Also my sincere gratitude to Mr. Naveen Kumar Pandey (Assistant Plant Manager), for patiently and practically guiding us to understand all the technical details of the plant. His enthusiasm for work was contagious.

Last but not the least, my thanks to my colleagues though we were of different disciplines it was a teamwork done to complete our respective work, giving versatility to my thought pattern and understand different faces of the mechanisms.

Anuranjana Bara.

Focus on Safe Work




SAFE WORK
Management System
Leadership & Culture
Management Commitment
Safety Strategies
Joint H&S Committees
Risk Management
Safety Design Analysis
Rules and Regulations
Work Procedures
Hazardous Energy Control
Job Safety Planning
Education & Communication
Management Training
Employee Training
Safety Meetings
Health & Safety Promotion
Public Safety
Control & Protection
Protective Equipment
Inspections & Maintenance
Occupational Health
Emergency Preparedness
Contractor Safety
Monitoring & Measurement
Safe Work Observations
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Indian Oil Corporation Limited

Indian Oil Corporation Ltd. (IndianOil) was formed in 1964 through the merger of Indian Oil Company Ltd. (Estd. 1959) and Indian Refineries Ltd. (Estd. 1958). It is currently India's largest company by sales with a turnover of Rs. 220,779 crore (US $51 billion), the highest–ever for an Indian company and profit after tax of Rs. 7499 crore (US $1.73 billion) for fiscal 2006-07. IndianOil is also the highest ranked Indian company in the prestigious Fortune 'Global 500' listing, at 153rd position. It is also the 21st largest petroleum company in the world.

India's Downstream Major

IndianOil and its subsidiaries account for 46.9% petroleum products market share in the industry, 40.4% national refining capacity and 67% downstream sector pipelines capacity. For the year 2006-07, the IndianOil group sold 54.9 million tonnes of petroleum products. This includes sale of natural gas, which has gone up to 1.5 million tonnes from 1.3 million tonnes in the previous year. In addition, product exports went up to 3.1 million tonnes from 2 million tonnes in the previous year. The IndianOil Group of companies owns and operates 10 of India's 19 refineries with a combined refining capacity of 60.2 million tonnes per annum (1.2 million barrels per day). These include two refineries of subsidiary Chennai Petroleum Corporation Ltd. (CPCL) and one of Bongaigaon Refinery and Petrochemicals Limited (BRPL). The Company's cross-country crude oil and product pipelines network spanning over 9,300 km meets the vital energy needs of the country. To maintain its competitive edge and leadership status, IndianOil is investing Rs. 43,250 crore (US $ 10. 65 billion) during the XI Plan period (2007-12) in integration and diversification projects, besides refining and pipeline capacity augmentation, product quality upgradation and expansion of marketing infrastructure.

Network beyond compare

As the flagship national oil company in the downstream sector, IndianOil, together with its IBP Division reaches precious petroleum products to millions of people everyday through a countrywide network of around 32,550 sales points. They are backed for supplies by 177 bulk storage terminals and depots, 97 aviation fuel stations and 90 Indane LPG bottling plants. IndianOil operates the largest and the widest network of petrol & diesel stations in the country, numbering around 16,455. It reaches Indane cooking gas to the doorsteps to over 46.4 million households in 2,709 markets through a network of 4,996 Indane distributors. IndianOil's ISO-9002 certified Aviation Service commands a 63% market share in aviation fuel business, meeting the fuel needs of domestic and international flag carriers, private airlines and the Indian Defence Services. IndianOil also enjoys a dominant share of the bulk consumer business, railways, state transport

undertakings, industrial, agricultural and marine sectors. IndianOil's world class R&D Centre is perhaps Asia's finest. Besides pioneering work in lubricants formulation, refinery processes, pipeline transportation and alternative fuels such as bio-diesel, the Centre is also the nodal agency of the Indian hydrocarbon sector for ushering in Hydrogen fuel in the country. IndianOil joined the league of global technology providers in 2006-07 with its in-house developed IndMax technology selected for the 4 MMTPA Fluidized Catalytic Cracking (FCC) units at the Corporation's upcoming 15 MMTPA refinery-cum-petrochemicals complex at Paradip in Orissa, as well as for the FCC unit coming up at BRPL.

Synergy through Subsidiaries

A wholly owned subsidiary, IndianOil Technologies Ltd., is commercialising the innovations and technologies developed by IndianOil's R&D Centre, across the globe. Merger of Bongaigaon Refinery & Petrochemicals Ltd. with the parent company is in process.

Widening Horizons

IndianOil has set its sight to reach US$ 60 billion revenues by the year 2011-12 from current earnings of US$ 53 billion. The road map to attain this milestone has been laid through vertical integration – forward into petrochemicals and backwards into exploration & production of oil – and diversification into natural gas business, besides globalisation of its marketing operations. In petrochemicals, IndianOil is currently implementing a master plan envisaging Rs. 30,000 crore (US$ 6.8 billion) investment by the year 2011-12. Through the world-scale Linear Alkyl Benzene plant for detergents manufacture at Gujarat Refinery, the Corporation has already captured 38% market share and product has been exported to Indonesia, Turkey, Thailand, Vietnam, Norway and Oman. An integrated Paraxylene/Purified Terephthalic Acid plant for polyster intermediates is already in operation at Panipat, while a Naphtha Cracker with downstream polymer units is coming up at Panipat. IndianOil's refinery-cum-petrochemicals complex at Paradip on the east coast to strengthen its presence in the sector is proposed to be completed by 2011-12. In exploration & production (E&P), IndianOil has bagged eight blocks under NELP (New Exploration Licencing Policy) in India, in consortium with other companies. It has also acquired participating interest in on-shore blocks in Assam and Arunachal Pradesh region. Overseas ventures include two gas blocks in Sirte Basin of Libya, the Farsi Exploration Block in Iran, onshore farm-in arrangements in Gabon, an onland block in Nigeria and two on-shore blocks in Yemen. The Corporation is also exploring opportunities to acquire a suitable medium-sized E&P company to quickly consolidate its upstream portfolio. In natural gas business, IndianOil is targeting sale of 2 million tonnes in 2007-08, up from 1.5 million tonnes in 2006-2007. An LNG import terminal and city gas distribution projects are in the pipeline in partnership with GAIL (India) and Great Eastern Energy Corporation Ltd.

To emerge as a transnational energy major, IndianOil has set up subsidiaries in Sri Lanka, Mauritius and UAE and is simultaneously scouting new opportunities in energy markets in Asia and Africa.

LPG Bottling plant Bhopal.

- One of the biggest LPG bottling plant of IOCL, which was commissioned on First of March 1989.
- Its main functions are :

(i) Receipt of LPG (bulk / packed)
(ii) Storage of LPG (bulk / packed)
(iii) Filling of LPG (bulk / packed)
(iv) Deliveries of LPG (bulk / packed)

- The plant is licensed to store 8200 MT of bulk LPG and 12600 cylinders.
- Average bottling at the plant is 420 MT per day and 10000 MT per month.
- The total land area is 116 acres.
- The plant works in two shifts, one from 6.00 am to 2.00 pm and the other from 2.00 pm to 10.00 pm.

General Introduction.

This report aspires to study the emergency preparedness plan (EPP) of the plant as the plant deals with a highly in-flammable substance. Though it is non-toxic at vapour stage, yet an emergency preparedness plan is mandatory action plan to be documented and rehearsed regularly. Following are the salient points the report will attempt to understand:

1. An understanding of LPG.
2. Hazards of LPG.
3. Different process involved in the plant.
4. An understanding of an emergency preparedness plan.
5. The requirement emergency preparedness plan of in a LPG bottling plant.
6. The emergency preparedness plan of the LPG bottling plant.

An understanding of LPG:

Liquefied Petroleum Gas (LPG) is a mixture of light hydrocarbons primarily C_3 & C_4 derived from petroleum, which is gaseous at ambient temperature and atmospheric pressure, is liquefied at ambient temperature with application of moderate pressure. LPG due to its inherent properties is susceptible to fire, explosion and other hazards. Such hazards can have an impact on the property, equipment, plant personnel and public. Liquefied Petroleum Gas (LPG) handling, bottling and distribution throw major challenges due to its inherent properties. Major incidents i.e. fires/explosions in LPG facilities in world have underlined the need for total in depth review of design, procedures, maintenance, fire fighting and safety aspects in LPG handling.

The oil and gas industry over the years have learnt lessons from fires and explosions and have been updating and standardising design, operations, bottling and distribution of LPG.

Some of the important properties of LPG are as below :

- LPG at atmospheric pressure and temperature is a gas which is 1.5 to 2.0 times heavier than air. It is readily liquefied under moderate pressures. The density of the liquid is approximately half that of water and ranges from 0.525 to 0.580 @ 15 °C.

- The pressure inside a LPG storage vessel/ cylinder is equal to the vapour pressure corresponding to the temperature of LPG in the storage vessel. The restriction on vapour pressure is stipulated by IS-4576.

- LPG has an explosive range of 1.8% to 9.5% volume of gas in air. This is considerably narrower than other common gaseous fuels. This gives an indication of hazard of LPG vapour accumulated in low lying area in the eventuality of the leakage or spillage.

- Water, being insoluble in LPG, if present in LPG can cause rust and corrosion and freeze-up of valves, drain valves, excess-flow check valves, cylinder valves and regulators thereby affecting their functioning and at times can lead to leakage of LPG.

- LPG liquid has low viscosity of around 0.3 CS @ 45 °C and can leak when other petroleum products normally cannot, thus demanding a very high integrity in the pressurised system to avoid leakage.

- LPG even though slightly toxic, is not poisonous in vapour phase, but can, however, suffocate when in large concentrations due to the fact that it displaces oxygen. In view of this the vapour posses mild anaesthetic properties.

- LPG is colourless both in liquid and vapour phase. During leakage the vapourisation of liquid cools the atmosphere and condenses the water vapour contained in them to form a whitish fog which may make it possible to see an escape of LPG.

- The coefficient of expansion is around 0.00237 per °C. At liquid full condition any further expansion of the liquid, the container pressure will rise by approx. 14 to 15 kg./sq.cm. for each degree centigrade.

- LPG has only a very faint smell, therefore, ethyl mercaptan is normally used as stenching agent for identifying the leakage as per IS: 4576.

- The auto-ignition temperature of LPG ranges from 410 to 580 °C.

An understanding of LPG points out the following:

- LPG is safe when kept within a properly designed and sealed system.

- It is hazardous when released to atmosphere and mixed with air.

- Sources of ignition must be eliminated.

- The whole system should be leakproof and intact.

Hazards involving LPG handling:

BEHAVIOUR OF LPG IN CLOSED CONTAINERS

The quantity of LPG that may be filled in a given container depends on the size of container; the temperature of the liquid in the container and the maximum permitted filling density. **LPG containers MUST not be completely filled with liquid; adequate vapour space MUST be left.** The LPG vapour exerts a pressure on the walls of the container. The pressure is dependent on the temperature and the composition of LPG in the container. Propane has a much higher vapour pressure than Butane; and mixture of the two has a vapour pressure between that of Propane and Butane depending upon the percentage composition. **It is important to remember that the pressure in the vessel is independent of the amount of liquid within it as long as it is neither full nor empty of liquid. For any given LPG, the temperature is the only variable factor governing the pressure.**

As more LPG is added into a container, the liquid level rises and the vapour space becomes smaller. This compresses the vapour, condensing some of it to the liquid state. This condensation produces heat which warms the remaining vapour resulting into an increased pressure. Thus, the addition of liquid has disturbed the temperature and consequently the pressure equilibrium. It is, however, only temporary. When filling ceases, the production of heat ceases and the system soon returns to its equilibrium

temperature and consequently to its equilibrium pressure. Now the vessel has more liquid in it than before but there has been no increase in pressure. The reverse of the above will occur when liquid or vapour is withdrawn from the container. There is first reduction in pressure and more vapour is formed by vaporization of the liquid to replace the vapour drawn off. This vaporization requires heat, which is obtained by absorption from the liquid itself and from the walls of the container. The absorption of the heat results in some pressure drop, but unless the container is emptied, it again returns to its former pressure and temperature soon after withdrawal ceases.

Should the container be completely filled with liquid LPG leaving no vapour space, even a slight rise in temperature will cause the liquid to expand and exert an excessive pressure on the container; because liquids are practically non-compressible. Under these circumstances a relief valve on the container opens to discharge liquid and relieve the excessive pressure. However, if there is no pressure relief device, as in the case of a cylinder, or if it fails to operate, the vessel itself may be distorted or ruptured. **If liquid LPG escapes, either from the relief device or from a ruptured container, a fire or explosion may result, if a source of ignition is present.**

A spring actuated safety valve would re-set itself when the pressure is reduced below the valve setting and thus prevent further escape of product to the atmosphere.

From the above details, it could be summarised that vapour pressure has no relation to the quantity of liquid present. If the temperature of liquid LPG inside a container remains constant, the pressure inside the container when full or when empty would be practically the same.
The possibility of a container becoming full of liquid by an increase in temperature is minimized by working out safe filling capacities.

EFFECTS OF LPG UPON MATERIALS

EFFECTS UPON METALS

(a) Commercial LPG has no harmful effect upon steel or the majority of metals in common use.

(b) Aluminium may be affected by traces of caustic remaining in the LPG after the refining processes.

(c) Odourants added to LPG are non-corrosive.

EFFECTS UPON NON-METALS

(a) The effect of LPG upon non-metallic materials can not be generalized.

(b) Some plastic materials becomes either soft or spongy, others become hard or brittle,

(c) Natural rubbers are usually affected whereas many synthetic rubbers and plastics are unaffected.

(d) An indication may be obtained of the effect of LPG upon a particular material in liquid Pentane for 72 hours. Any change in weight or volume or evidence of any swelling or brittleness indicates that the material would be unsatisfactory for long term usage.

HEALTH HAZARDS

(a) **INHALATION – VAPOUR PHASE:** LPG contains no toxic components such as carbon monoxide and is, therefore, non-poisonous. If leakage of large amount of LPG occurs in a closed space, difficulty in breathing and asphyxiation due to lack of oxygen can be caused but is improbable in practice. LPG is slightly anaesthetic when high concentrations are breathed in sufficient quantities over a period of time, resulting in stomach-upset and headache, which themselves are warning symptoms.

(b) **INHALATION – PRODUCTS OF COMBUSTION:** Assuming that the product of combustion, which is being inhaled, is discharged into a confined area and further the combustion process, is being properly controlled, the individual would be exposed to an increased concentration of water vapour and carbon dioxide in the atmosphere. The water vapour naturally increases humidity within the atmosphere and in case it is excessive, the unpleasantness associated with excessive humidity would be noticeable. The liberation of carbon dioxide by the combustion process may result in deficiency of oxygen in the atmosphere.

(c) **BURNS BY FREEZING: LPG in liquid form should not come in contact with the surface of the body.** It is particularly important that contact with the liquid propane or a product with relatively high vapour pressure be avoided. In the event that LPG in liquid form comes in contact with the skin, the product immediately vaporizes. During this vaporization process, heat will be absorbed directly from the skin and flesh causing a freezing effect. The ultimate result of freezing is usually referred to as a burn. The results may be serious. Therefore, **if the possibility of exposure to liquid LPG exists, suitable safety gloves, safety goggles and protective clothing should be used.**

(d) **BURNS BY FIRE:** Burns may result from the exposure to LPG flames or by exposure of clothing directly to appliance flames or by mishandling of portable devices such as torches and burners. In the type of exposure in which the LPG Flame

acts as an igniter, the severity of the burns may be dependent upon the time required to extinguish the burning clothing. In the event of exposure of an individual to a flash fire or explosion of LPG vapours accidentally discharged, the burns may be direct result of LPG flames compounded by clothing if they are highly flammable such as those made from synthetic fibre. **In general, clothing which is not highly flammable may provide a degree of protection when exposed to a flash fire.** For example, shirt of cotton or woolen material may provide protection against the possibility of freezing burn and likewise may provide a type of barrier against the flame of flash fire.

As a precaution to avoid exposure to flash fire or an explosion, an awareness of the odour of the product, the observance of "NO SMOKING" regulations and the elimination of possible ignition sources within the area in which possible flammable mixture may exist, can reduce and perhaps eliminate the possibility of burn injuries.

FIRE HAZARDS

(a) **PRODUCT DISCHARGE – LIQUID PHASE:** LPG has been described as a safe fuel because of the fact that so long as it is contained within a cylinder, vessel, or a pipeline, fire hazard is non-existent. It is only the accidental discharge of the product from the container, which creates a hazard. In the event of an accidental discharge it is possible that either the liquid or vapour may discharge. A liquid discharge is always more serious than a discharge in the vapour phase. In the first place the volume of the product, which may discharge, may be considerably less in the vapour phase than the liquid phase through the same size of opening. As liquid discharges and vaporises, the volume of the liquid changes into vapour of volume approximately 250 times greater and therefore, a greater hazard exists.

It is always important to arrange equipment so that if an accidental discharges does occur, it will be in the vapour phase.

(b) **PRODUCT DISCHARGE – VAPOUR PHASE :** The accidental discharge of vapour from a container or a pipe may result in the vaporisation of liquid within the container or pipe. This process will require heat and will in effect have a cooling action upon the container. If a container is exposed to surrounding fire, the cooling effect caused by the vaporisation within the container can aid in preventing the development of excessive temperatures of the container.

(c) IGNITION SOURCE

(i) Flame: As a general rule it may be said that if a flame is visible it has sufficient heat to be used as a source of ignition for the combustion of flammable LPG vapour mixture. A flame from a match stick is sufficient to provide temperature considerably above that is required, for ignition.

(ii) Heat: A piece of metal heated to 600 °C may not be particularly noticeable and might not attract attention. However, so long as the metal on its surface has a temperature in excess of the ignition temperature of flammable LPG vapour mixture, it can provide as an ignition source. Likewise heat of a lighted cigarette or a bidi is sufficient source to provide ignition.

(iii) Electric: Source of ignition may be developed electrically through resistance in electrical circuit which heats an element or a portion of the circuit to a temperature equal to or in excess of the required ignition temperature. The making or breaking of an open switch or the disengagement of a plug from a receptacle may cause a "Spark" which has sufficient temperature to cause ignition.

(iv) Static Electricity and Friction Sparks: Static electricity or friction sparks may be the source of ignition for a flammable mixture of LPG vapour within the atmosphere. Static electricity may be caused by agitation or pumping of liquid; venting liquid to the atmosphere; sand blasting; non-conductive belts; the contact of separation of materials such as synthetic clothing and action of foot wear on certain type of floorings.

Static electricity is also produced by natural causes. Static charge is induced from lightening discharges, by thunder clouds either directly overhead or in the distance; by dust storms; or in rare instances from a large volume of charged air. Friction sparks are usually caused by the striking of one hard object against another as in the case of striking a hardened steel tool against a pipe or a casting; hitting of a cylinder against a steel structure.

(d) COMBUSTION

(i) Explosion: Rapid oxidation or rapid burning is the cause of explosion. It may also be accompanied by such a release of energy that structural damage may result. The rate at which energy is released, rather than the amount of energy released, is the criteria of an explosion.

The distribution of LPG vapour within the atmosphere in proper proportions and within a confined space can create an

explosion, should the source of ignition be provided. Following an LPG explosion a fire may be caused by the ignition of other flammable materials or a continuing discharge of gas may burn. In some cases if the discharge of gas has been stopped prior to the explosion, there may be no fire following the explosion.

(ii) Fire: Depending upon the circumstances, the accidental LPG Fire may take on any number of forms. In general, a fire fed by a liquid discharge will be seen at ground level and may be remote from the point of actual discharge. A fire fed by a vapour discharge may be elevated and not impinging upon tanks, buildings, etc. The vapour fed fire would normally burn relatively close to the point of discharge

(iii) BLEVE: Boiling Liquid Expanding Vapour Explosion (BLEVE) occurs when LPG containers are accidentally surrounded by fire. Vapour pressure in the container rises with the increase in temperature. At the same time, temperature of the container wall in contact with the vapour phase also rises. The wall strength deteriorates and eventually even though a pressure relief valve may be operating, the stress imposed by the vapour pressure exceeds the reduced strength of the wall. The container then ruptures and super heated liquid is released, expands and vaporize, in fraction of a second. As the contents of the container are flammable, they form explosive mixtures with the air. Catastrophic damage usually results from the spread and/or ignition of the vapours. This phenomenon is true for any pressure vessels storing LPG, be it a storage vessel, tank wagon bullet, tank truck bullet, or a LPG cylinder. However, larger the vessel, larger would be the catastrophe.

a. **PUVCE:** When large quantity of LPG is released to atmosphere and it forms vapour clouds which, when unconfined, may travel from one place to another. Vapour cloud can ignite and burn as deflagrations or fire balls. This is termed as '**Percussive Unconfined Vapour Cloud Explosion' i.e., PUVCE** in short. Even though large quantities of LPG emission are necessary, only a fraction of this contributes to the percussive effect (more reactive molecules such as ethylene in much smaller quantities). Rare though PUVCE may be, their damage is large and sometimes enormous.

OTHER HAZARDS

(a) LPG is usually stored as a liquid under pressure. Leakage to atmosphere, especially as liquid, will result in rapid vaporisation creating large volumes of flammable vapour. Because LPG is heavier than air, it will tend to flow along the ground or through drains, and will sink to the low level of the surroundings. Unless efforts are quickly made to disperse the accumulation of vapour it may under normal conditions remain there for a long time, with the possibility of fire through a source of ignition at some distance away from the source of leakage.

(b) A very small proportion of vapour in the air will give rise to a flammable mixture, which can cause fire, if source of ignition is present.

(c) (i) Thermal expansion of LPG can lead to very serious hazards. LPG streams under pressure in pipelines and equipment expand rapidly as a result of only moderate increase in the temperature. For example, the sun shining on a blocked line full of LPG, not provided with a relief valve to protect against thermal expansion, can lead to excessive pressures being built up within the line with eventual rupture of the pipe.

(ii) The problem of thermal expansion also applies to laboratory sample bombs where instructions must be clearly given not to fill the container fully. The container should be filled up to a limit which permits liquid expansion due to a normal rise in temperature without danger of over- stressing the container. The maximum liquid level is usually marked on the sample bomb.

Different process involved in the plant.

The bottling of LPG at the plant is done in a very systematic way:

(1) The LPG is unloaded from the rail tank cars at the rail gantry and via pipelines with the use of compression technology applied by the air and LPG compressors/pumps to the storage vessels (Horton spheres or bullets).

(2) The new cylinders are sent to the purging unit to pump out the air and to fill in with some vapor of LPG.

(The whole system at the plant is based upon the pneumatic system i.e. the maximum working is based upon the air compression system which is used in water hydrant system and working of the carousels.)

(3) Bottling of LPG is done with the machine called as CAROUSEL, which fills 24 cylinders per minute.

(4) Then the cylinders are made to pass through the water bath to detect any leakage.

(5) Thereafter the valves and O-rings of the cylinders are then checked by valve/O-ring machine and the defective cylinders are sent for valve replacement to the valve change shed.

(6) Finally after the quality control checks the cylinders as a packed product is ready for dispatch.

(7) Also the plant dispatches the bulk product in the lorry tanks to other process industries.

Emergency preparedness plan. WHY???

Emergency planning is an integral part of the overall loss control program. It is important for effective management of an accident/incident to minimize losses to people and property, both in and around the facility.

Main objectives – Emergency Preparedness

- To control events and prevent escalation.
- To minimize the effect on people, property and the environment.
- Effective rehabilitation of the affected persons.

Critical elements – Emergency Plan

- Reliable and early detection of an emergency and careful planning.
- The command, coordination and organization structure along with efficient trained personnel.
- Resources for handling emergencies.
- Appropriate emergency response actions.

On-site Emergency Plan Rehearsal

- ✓ **Frequency**: Half-yearly
- ✓ **Involvement**:
  - o Key Personnel
  - o Mutual Aid Members

On-site Emergency Plan Rehearsal

- ✓ **Highlights**:
  - o Well equipped Emergency Control Centre.
  - o Assembly Points identified and displayed.
  - o Likely emergency Scenarios identified and rehearsed
  - o Observers from senior management
  - o Well laid out / written mock drill assessment sheet
  - o Review of rehearsal by Executive Director with senior management officials and observers, for identifying improvement areas.
  - o Review immediately after the rehearsal.
- ✓ **Assessment by observers is done w.r.t.**:
  - o Communication
  - o Response Time
  - o Action by
    - ✓ Plant Staff
    - ✓ F&S Staff
    - ✓ Security
  - o Assembly Point
  - o Use of PPEs
- ✓ **Assessment by observers is done w.r.t.**:
  - o Transport
  - o ECC (Emergency Control Centre)
  - o Mutual Aid

Offsite Emergency Plan additionally consists of following information:

- ✓ Shelters Details
- ✓ Telephone Numbers of District / Civil Authorities
- ✓ Evacuation plan

Emergency preparedness plan for IOCL bottling plant Bhopal.

GENERAL INFORMATION

1.	Name	:	LPG Bottling Plant, Bhopal	
2.	District/ State	:	Bhopal/ Madhya Pradesh	
3.	Date of commissioning	:	01.03.1989	
4.	Land Area			
	a) Licensed	:	51 Acres	
	b) De Licenced	:	25 Acres	
	c) Green Belt	:	40 Acres	
	d) Total	:	116 Acres	
5.	Adjoining Properties			
	a) North	:	Railways	
	b) East	:	Agricultural Land	
	c) West	:	Agricultural Land	
	d) South	:	Road	
6.	Nearest Facilities			
	a) Fire Brigade	:	Bairagarh	- 11 kms
	b) Police Station	:	Khajuri	- 03 kms
	c) Hospital	:	Bairagarh	- 11 kms
7.	LPG Tankage	:	8200 MTs	
8.	Manpower			
	a) Officers	:	14	
	b) White Collar	:	03	
	c) Blue Collar	:	27	
	d) DGR Security	:	25	
	e) Contract Labour	:	90	

FIRE FIGHTING FACITLITY AT LPG BOTTLING PLANT, BHOPAL

FIRE EXTINGUISHERS & EQUIPMENTS

a)	75 Kg DCP	07 Nos.
b)	10 Kg DCP	156 Nos.
c)	4.5 Kg CO_2 type fire extinguisher	14 Nos.
d)	Sand Buckets	60 Nos.
e)	Fire Hoses	68 Nos.
f)	Fire Nozzles	34 Nos.
g)	Jet Nozzles	02 Nos.
h)	Curtain Nozzles	06 Nos.
i)	Triple Purpose Nozzles	02 Nos.
j)	Safety Helmets	14 Nos.
k)	Hose Boxes	42 Nos.
l)	Rubber gloves for electrical purpose	02 Nos.
m)	Low Temperature Gloves	04 Nos.

FIRE WATER NETWORK

There is an extensive Fire water network spread all over the plant including the green belt area. This serves the fire fighting requirements of the plant. The automatic hydrant and sprinkler systems in the plant are a part of this network. The firewater network is kept at a pressurized state and the farthest point is to have a minimum pressure of 7 kg/sqcm. This is maintained at the Fire Pump House through a well maintained system of Fire engines and Jockey Pumps as follows.

a) Diesel Driven Pump - 4 nos. of KIRLOSKAR make, size 150 x 200 mm, capable of delivering 113.89 Ltr./Sec (410 m^3/Hr. at 88 M head coupled to CUMMINS N-743-TF Diesel Engines, 196 HP, running at 1900 RPM.
b) Diesel driven pump - 4 Nos. of KIRLOSKAR make, 300 x 250 mm, capable of delivering 180.5 ltrs./ sec. (650 m^3/Hr. at 88 M head) coupled to CUMMINS NTA-855-F of diesel engine, 309 HP, running at 1900 RPM.
c) Electrically operated Jockey pump - 2 Nos. of KIRLOSKAR make, size 40 x 50 mm, Multi stage capable of delivering 5.5 ltrs./sec (35 m^3/ Hr. at 93 M head) coupled to CROMPTON GREAVES make 15 HP, operating at 415 volts, 3 phase 50 cycles AC supply, speed-2900 RPM.

AUTOMATIC HYDRANT SYSTEM

a) Water Monitor - 48 nos. 75 mm with 38 mm nozzles.
b) Hydrant Points - 31 Nos. single outlet and 63 Nos. double outlet ground hydrant
c) Hose boxes - 43 Nos each containing 2 nos. 7.5 mtr firehoses of 63 mm Dia. and 7.5 M long

AUTOMATIC SPRINKLER SYSTEM
(Automatic/ Semi Automatic Medium Velocity Water Spray System)

The following locations are covered with automatic-sprinkler system consisting of water spray system and detection air line along-with Deluge Valve (DV):-

	LOCATION	DELUGE VALVES
1)	Filling Shed including loading/unloading fingers	5 Nos.
2)	Empty Cylinders Storage Shed	5 Nos.
3)	Filled Cylinders Storage Shed	5 Nos.
4)	Cold Repair Shed	2 Nos.
5)	Horton Sphere (4 x 650 MT) + (4 x 1400 MT)	8 Nos.
6)	TLD platform (1 x 8 bays)	2 Nos.
7)	LPG Tank-Wagon unloading area (3 x 2 Railway siding)	6 Nos.
8)	LPG Product-Pump House and manifold	1 No.

Detectors air line of DVs is normally kept charged at 3 Kg/cm^2 with compressed air supply from security air compressors located at FPH.

In the event of fire the quartzoid-bulb-detector senses the heat of fire and fuses at 175°F (79°C) releasing the compressed air to the atmosphere. This results in drop of air pressure in the detecting pipe work, which operates the automatic deluge valve to start the sprinkler system around the concerned equipment. 2 Nos. of Air Compressors are provided for charging the detector air pipe work of automatic water spray system. (Ingersoll Rand make, operating at 415 volts, 3 phase, 50 cyls., AC supply).

WATER CONSUMPTION

Hydrant Valve : 500 LPM

Monitors	:	2500 LPM at 7.5 Kg/ cm^2
Filling Shed	:	2244 KL/HR with 5 DVs
Empty cylinders storage shed	:	2316 KL/HR with 5 DVs
Filled cylinders storage shed	:	2208 KL/HR with 5 DVs
Cold Repair Shed	:	557 KL/HR with 2 DVs

Horton Spheres : 1170 KL/HR with 7 DVs
(4 x 650 MT) + (4 x 1400 MT)

TLD Platform	:	270 KL/HR with 1 DV
LPG Product Pump House and manifold area	:	105 KL/HR with 1 DV
LPG Tank Wagon unloading area	:	2160 KL/HR with 6 DVs

WATER STORAGE

2 X 5000 KL	:	Vertical Tanks
2 x 113 KL	:	Static Water Tanks
Total Storage 10000 + 226	:	10226 K.L

TUBE WELLS & OPEN WELLS

a) Tube Wells

No.1: 60 LPM No. 2: 60 LPM No. 3: 60 LPM

No. 4: 60 LPM No. 5: 400 LPM No. 6: 400 LPM

b) Open Wells

No. 1: 1000 LPM No. 2: 1000 LPM

LIFE SAVING EQUIPMENTS

Equipments		Qty.	Location
i)	Fire Proximity Suit	2 Nos.	Frisking Gate
ii)	First-Aid Box	3 Nos.	Frisking Gate, S&D, Main Gate
iii)	Stretcher	2 Nos.	Frisking Gate
iv)	Water Jel		
	a) Non-medical	8 Nos.	Frisking Gate, S&D, Main Gate etc.
	b) Medical use	1 No.	Frisking Gate
v)	Breathing Apparatus	2 Nos.	Frisking Gate
vi)	Resuscitator	2 Nos.	Frisking Gate/ PMCC

2.8 INTER LOCK SHUTDOWN SYSTEM

The plant has latest PLC based Interlock Shutdown System. The system consists of seven Manual Call Points (MCP) situated at the following locations.

MCP 1 - FS1
MCP2 - FS2
MCP3 - TLD
MCP4 - PPH
MCP5 - TW GANTRY
MCP6 - HS1
MCP7 - HS7

The system receives fire signals from manual call point station & displays the alarms graphically on the PC. In event of any fire alarm, LPG pumps & compressor drives shall be tripped & audio siren shall be actuated.

The system is provided with a hard wired MIMIC displaying the status of various DVs & ROVs. The control panel has a PC, which graphically displays the status of ROVs & DVs. An Auto/Manual switch is provided to avoid tripping of drives & closure of ROVs while testing DVs. The pressure switches (PS1 & PS2) provided at each DV ensures that actuation of any DV shall result in triggering the electrical siren and tripping power. Remote operation of the DVs is also possible through the solenoid switches provided at the DV.

The system is designed to comply with the norms stipulated OISD section 4.4.1.
The system monitor level in all LPG storage vessels & ensures that no vessel can be filled beyond high liquid level limit set for each tank by closing the appropriated ROVs. The high liquid level in the tank however does not inhibit the opening of ROVs for transferring the LPG from that particular vessel. Remote operation of all 27 ROVs is also possible from the MIMIC panel.

GAS MONITORING SYSTEM

The GMS is a microprocessor based safety monitoring system which monitors the gas concentration at various sensor location points and indicates at central common panel. Each channel value is compared against set limits. There are two levels of alarm states which are "Warn" and "alarm". The system currently has

i) 21 sensor locations expandable to 24
ii) 3 Analog field transmitter units (flameproof)
iii) Data logger which collects data through RS-485 interface
iv) PC and associated software & a MIMIC pannel

Sr. No. (CHNO)	GAS SENSOR Location	% LEL Measured	% LEL Calibrated
1 (1)	Carousel FS1	43%	49%
2 (2)	Evacuation FS1	41%	48%
3 (3)	Weight Corr. FS1	42%	51%
4 (4)	CRS Machine	38%	50%
5 (5)	CRS	40%	49%
6 (6)	FCS	43%	47%
7 (7)	FS2-1	43%	48%
8 (8)	FS2-2	41%	47%
9 (9)	TLD	40%	51%
10 (10)	TLD	40%	50%
11 (11)	PPH Pump	41%	49%
12 (12)	PPH Comp.	40%	48%
13 (13)	Gantry 1	43%	50%
14 (14)	Gantry 2	41%	49%
15 (15)	Gantry 3	40%	48%
16 (16)	Gantry 4	42%	48%
17 (17)	HS 2	41%	51%
18 (18)	HS 3	40%	49%
19 (19)	HS 1	42%	47%
20 (20)	HS 4	41%	49%
21 (21)	Manifold	40%	51%
22(22)	HS1TOP	43%	50%
23(23)	HS2TOP	41%	47%
24(24)	HS3TOP	44%	49%

25 (25)	HS 8	40%	50%
26 (26)	HS 7	42%	47%
27 (27)	HS 6	40%	49%
28 (28)	HS 5	41%	51%
29(33)	HS4TOP	46%	49%
30(34)	HS5TOP	45%	47%
31(35)	HS6TOP	48%	49%
32(36)	HS7TOP	49%	49%
33(37)	HS8TOP	43%	47%

OTHERS

a) Non sparking tools - Records Room (1st floor)

b) Emergency Rescue Kit consisting of : - Frisking Gate

(i) Rope

(ii) Adaptor for pumping water into Horton Sphere

(iii) Metallic Gaskets of various sizes.

(iv) M-Seal

(v) Spanners

(vi) Red/ Green Flags

c) Unitised Gas Detector - Frisking Gate

OPERATING INSTRUCTIONS OF IMPORTANT FIRE – FIGHTING EQUIPMENTS

SPRINKLER SYSTEM

Operates automatically when quartziod bulb detector senses heat of fire and fuses at 79°C releasing the compressed air. This results in drop of pressure in pipe work, which operates the automatic deluge valve to start the sprinkler system.

Can be operated manually also by using any of the following methods of the affected area:

a) Break the quartzoid bulb's glass.
b) Pull down the lever of deluge valve.
c) From S&D by keeping ILSD in manual mode and pressing the push button

To economise the use of water, operate only those DVs which are required. For example, if HS-2 is on fire, the neighbouring vessels (HS-3 & HS-4) are required to be cooled.

HYDRANT SYSTEM

Operates automatically when hydrant points or water monitors are operated and the line pressure drops below 7 Kg/cm^2. Fire Engines start in the following sequence:

1^{st} & 5^{th} Pump starts at 6.5 Kg/ cm^2.
2^{nd} & 6th Pump starts at 6.0 Kg/ cm^2 and so on.

PRESSURE SWITCH SETTING:

System pressure for hydrant/ Monitor system & automatic medium velocity water spray system. = 8.5Kg/ cm^2

i) Jockey pump -1

Start - 8.5 Kg/ cm^2

Stop - 9.0 Kg/ cm^2

i) Jockey pump -2

Start - 8.0 Kg/ cm^2

Stop - 9.0 Kg/ cm^2

ii) Starting of fire engines

Pump No. 1 & 5- 6.5 Kg/ cm^2

Pump No. 2 & 6- 6.0 Kg/ cm^2

Pump No. 3 & 7- 5.5 Kg/ cm^2

Pump No. 4 & 8- 5.0 Kg/ cm^2

Pressure setting given above is approximate settings. Final settings may be changed slightly depending on actual site conditions.

HYDRANT POINTS

- Remove the cap.
- Fix male coupling and of fire hose with hydrant point.
- Uncoil the hose by placing coil of hose on ground and rolling it towards fire.
- Fix the nozzle and direct towards the base of fire.

- Hold the nozzle and direct towards the base of fire. (Two persons required, who are trained in the above).
- Open hydrant valve gradually. (One person)

WATER MONITORS

- Open the lower swivel joint lock.
- Open the upper swivel joint lock.
- Direct the monitor nozzle towards the fire point.
- Open the monitor valve gradually.
- If flames are coming towards water monitor, the upper and lower swivel joints should be locked so that water is directed towards base of fire.

10 KG DCP FIRE EXTINGUISHERS

- Remove from the clamp.
- Carry to fire site by grasping handle at top.
- Keep extinguishers up right position and in line with wind direction.
- Remove safety clip.
- Hold nozzle by right hand and strike knob by left hand.
- Direct the jet to the base of fire in a sweeping motion.
- Do not get entrapped in the cloud of powder.
- Do not invert the extinguisher.

75 KG DCP EXTINGUISHER

- Shift to the fire location.
- Open the nozzle of the rubber hose.
- Uncoil the rubber hose.

- Open the valve of CO_2 Gas cylinder and connect the body.
- Direct the jet to the base of flames in sweeping motion.
- Do not get entrapped in the cloud of powder.

4.5 Kg CO_2 FIRE EXTINGUIHSER

- Remove to operate extinguisher from the clamp.
- Place on the floor.
- Hold discharge horn with left hand and direct it towards base of fire.
- Remove the safety pin.
- Open the valve with right hand in anti-clockwise direction.
- Do not get entrapped in the cloud of CO_2 gas.

BREATHING APPARATUS

- Check the pressure of air cylinder.
- Lift the cylinder and belt it on own back in inverted position.
- Put the facemask, ensure proper filling so that air does not leak from sides.

FIRE ENTRY SUIT

- Insert the legs inside the suit and wear the shoes.
- Wear the breathing apparatus, check for proper fit & operate.
- Insert the hands inside the suit & close the zip properly.
- Put on hand gloves.
- Wear the helmet before entering the fire.
- Do not stay inside fire with suit for more than 30 seconds.
- Do not get engulfed in the fire.

FIRE PROXIMITY SUIT

- Insert the legs inside the suit and wear the shoes.

- Wear the breathing apparatus, check for proper fit & operate.
- Insert hands inside the suit & close the zip properly.
- Put on hand gloves.
- Wear the helmet before entering the fire.
- Do not go less than 50 ft. nearer to flames.

LOW TEMPERATURE SUIT

- Put on breathing apparatus, check for proper fit & operate.
- Insert legs inside the suit followed by hands.
- Wear the suit properly (Breathing apparatus fits into accommodation provided for it)
- Close zip properly.
- Check for proper fit of hand sleeves.
- Put on hand gloves.
- Check for proper tight fit.

TYPE OF HAZARDS

EXPLOSION

Rapid oxidation or rapid burning is the cause of explosion. It may also be accompanied by such a release of energy that structural damage may result. The rate of energy is released, rather than the amount of energy released, is the criteria of an explosion.

The distribution of LPG vapour within the atmosphere in proper proportions and within a confined space can create an explosion should the source of ignition be provided. Following an LPG explosion a fire may continue caused by the ignition of other flammable materials or a continuing discharge of gas may burn. In some cases, if the discharge of gas has been stopped prior to the explosion, there may be fire following explosion.

FIRE

Depending upon the circumstances, the accidental LPG fire may take on any number of forms. In general, a fire fed by a liquid discharge will be seen at ground level and may be remote from the point of

actual discharge. A fire fed by a vapour discharge may be elevated and not impinging upon tanks, buildings etc. The vapour fed fire would normally burn relatively close to the point of discharge.

BLEVE

Boiling Liquid Expanding Vapour Explosion (BLEVE) occurs when LPG containers are accidentally surrounded by fire. Vapour pressure in the container rises with the increase in temperature. At the same time, temperature of the container wall in contact with the vapour phase also rises. The wall strength deteriorates and eventually even though a pressure relief valve may be operating, the stress imposed by the vapour pressure exceeds the reduced strength of the wall. The container then ruptures and superheated liquid is released, expands & vapourise, in fraction of a second. As the contents of the container are flammable, they form explosive mixtures with the air. Catastrophic damage usually results from the spread and/or ignition of the vapours. This phenomenon is true for any pressure vessel storing LPG, be it a storage vessel, tank wagon bullet, tank truck bullet, or a cylinder. However, larger the vessel, larger would be the catastrophe.

CONFINED AND UNCONFINED VAPOUR CLOUD EXPLOSIONS

Confined explosions are those, which occur within some sort of containment such as vessel or pipe-work. Explosions in buildings also come under this category. Explosions that occur in the open air are referred to as unconfined explosions and produce peak pressure of only a few kPa. The peak pressures of confined explosions are generally higher and may reach hundreds of kPa.

PRELIMINARY HAZARD ANALYSIS

The plant handles LPG, which is highly inflammable and explosive. The hazards involved in the plant are:

- Large scale fire and explosion in storage area due to damage of the bulk storage vessels.
- Over turning of LPG road tankers and other transport hazard.
- Flash fire due to leakage of LPG.
- Equipment failure/ malfunction like relief valve failure, flange gasket failure, pump mechanical seal failure etc. resulting in leakage of LPG to atmosphere.
- Accidents due to overfilled cylinders or fire in the vicinity.
- Lack of adequate fire protection facilities available at different places of LPG unloading, loading and usage.

- Experience level of personnel involved and their capacity to cope with emergency situation.

Apart from the above, accidents due to mal-operation, negligence and sabotage are also not ruled out.

RISK ANALYSIS

Introduction

LPG Bottling facilities mainly pose fire and explosion hazards due to unwanted and accidental releases of hydrocarbons. This section deals with listing of various failure cases leading to various hazard scenarios, analysis of failure modes and consequence analysis. Consequence analysis is basically a quantitative study of the hazard due to various failure scenarios to determine the possible magnitude of damage effects and to determine the distances upto which the damage may be affected. The reason and purpose of consequence analysis are manifolds like:

- For computation of risk.
- For evaluating damage and protection of other plants.
- To ascertain damage potential to public and evolve protection measures.
- Fore preparation of effective emergency planning both ON-SITE and OFF-SITE.
- For formulating safe design criteria of equipment and protection systems.

The results of consequence analysis are useful for getting information about all known and unknown effects that are of importance when some failure scenarios occur and to get information about how to deal with possible catastrophic events. It also gives the plant authorities, workers and the public living outside in the vicinity of the plant an understanding of hazard potential and remedial measures.

Modes of failure

There are various potential sources of large/ small leakages, which may release hydrocarbon to the surrounding atmosphere. This leakage may be in the form of a small gasket failure in a flanged joint or snapping of hoses, a guillotine failure of a pipeline or any other source of leakage.

Damage Criteria

The damage effects are different for different types of failure scenarios. The physical effects of ignition of hydrocarbon vapours, e.g. blast wave, thermal radiation and BLEVE due to release of LPG from the containment are discussed below:

(i) Hydrocarbon vapours released accidentally will normally spread out in the direction of the wind. If it comes into contact with an ignition source before being dispersed below the lower flammability limit (LFL), a flash fire is likely to occur and the flame may travel back to the source of leak. Any person caught in the flash fire is likely to suffer from severe burn injury. Therefore, in consequence analysis, the distance to LFL value is usually taken to indicate the area, which may be affected by flash fires. Any other combustible material within the flash fire is likely to catch fire and may cause secondary fires. In the area close to the source of leakage of hydrocarbon there is a possibility of Oxygen depletion since the LPG vapour is heavier than air. A minimum of 19.5% Oxygen in air is considered essential for human lives.

SELECTED FAILURE CASES

Sl. No.	Failure Case	Failure Mode	Consequence	Max. Affected distance
1	Horton Sphere shell failure	Random Failure	BLEVE Unconfined vapour cloud explosion	1859 m 2648 m
2	Full bore failure of LPG outlet line of Horton Sphere.	Random Failure	Dispersion, unconfined vapour cloud explosion, blast effect, pool fire.	997 m
3	LPG pump discharge line full bore failure	Random Failure	- do -	157 m
4	Road tanker failure Rail tanker failure	Random Failure	BLEVE	567 m 751 m
5	LPG pump mechanical seal failure	Mech. seal failure	Dispersion, UVCE	113 m
6	Gasket failure	Gasket failure	- do -	63 m
7	Filled cylinder failure	Random Failure	BLEVE	860 m

(Source: Risk Analysis conducted M/s. PDIL during June'01)

CONSEQUENCE ANALYSIS

Catastrophic failure of Horton Sphere

The failure frequencies of pressureised storage vessels are very low i.e. 1.0×10^{-6} per year ***(Source: Risk Analysis conducted M/s. PDIL during June'01).*** These are fabricated as per the international standards and code of practices. Moreover, all the safety features and instrumentation have been provided as per international standard, relevant codes and recommendations of OISD. The pressurized storage vessels are subject to inspections and health study at regular intervals and as such the failure of Horton Spheres are very remote. The hazard due to failure of Horton Sphere may therefore be considered as incredible. Maximum distances to have damages, i.e., overpressure of 0.3 bar extend to 766 M (for Day condition) & 747 M (for Night condition) for 85% full of Horton Sphere in case of failure due to flame impingement or heat radiation from a fire in the vicinity. The maximum distances to damage of glass breakage (0.03 bar) extended upto 2648 M for day condition and 2617 M for night conditions for 85% full Horton Spheres ***(Source: Risk Analysis conducted M/s. PDIL during June'01).***

Full Bore Failure of the LPG Outlet Line of Horton Sphere

The Horton Spheres have been provided with a single 200/ 300 mm (650 MT/ 1400 MT Horton Sphere) inlet/ outlet line. Failure frequency of full bore pipe for pipe dia. of 200 & 300 mm 0.03×10^{-06} per year ***(Source: Risk Analysis conducted M/s. PDIL during June'01),*** which indicate that chances of such failure are very remote.

LPG Pump Discharge Line Failure

The LPG pump takes its suction from the Horton Sphere and pumps it to the filling shed for filling of empty LPG cylinders. Distance to thermal radiation of 4.5 KW/M^2 extends to a distance of 26 meter and 27 meter in case of full bore failure in pump discharge line. It is also evident that distance to 1^{st} degree burns, i.e., 4.5 KW/M^2 remains confined within the factory boundary. Distance to repairable damage i.e. for over pressure of 0.1 bar extends to 122 meters for full bore failure ***(Source: Risk Analysis conducted M/s. PDIL during June'01).***

Road Tanker/ Rail Wagon Failure

LPG from different plants is brought to plant site in Road tankers as well as Rail wagons. It unloaded to the Horton Spheres by differential pressure method. Provisions are there to unload 8 nos. of tank lorries at a time. Pressure inside the tank lorries shall be about 5 - 7 Kg/cm2(A) corresponding to ambient temperature. For consequence

analysis purpose the road tanker capacity of 18 MT and Rail wagon of 37.4 MT capacity have been considered. Under pressurized storage vessels category its failure frequency is very low i.e. 1.0×10^{-6} per year ***(Source: Risk Analysis conducted M/s. PDIL during June'01).*** The unloading bay is provided with suitable fire/ gas detection system and with automatic sprinkler system.

LPG Pump Mechanical Seal Failure

Failure of seals releases considerable quantity of hydrocarbons into atmosphere and creates a hazardous zone. Hazard distance to an overpressure of 0.03 bar (glass damage) may extend up to 113 meters under condition of 2F (night) and will be confined within the factory premises ***(Source: Risk Analysis conducted M/s. PDIL during June'01).***

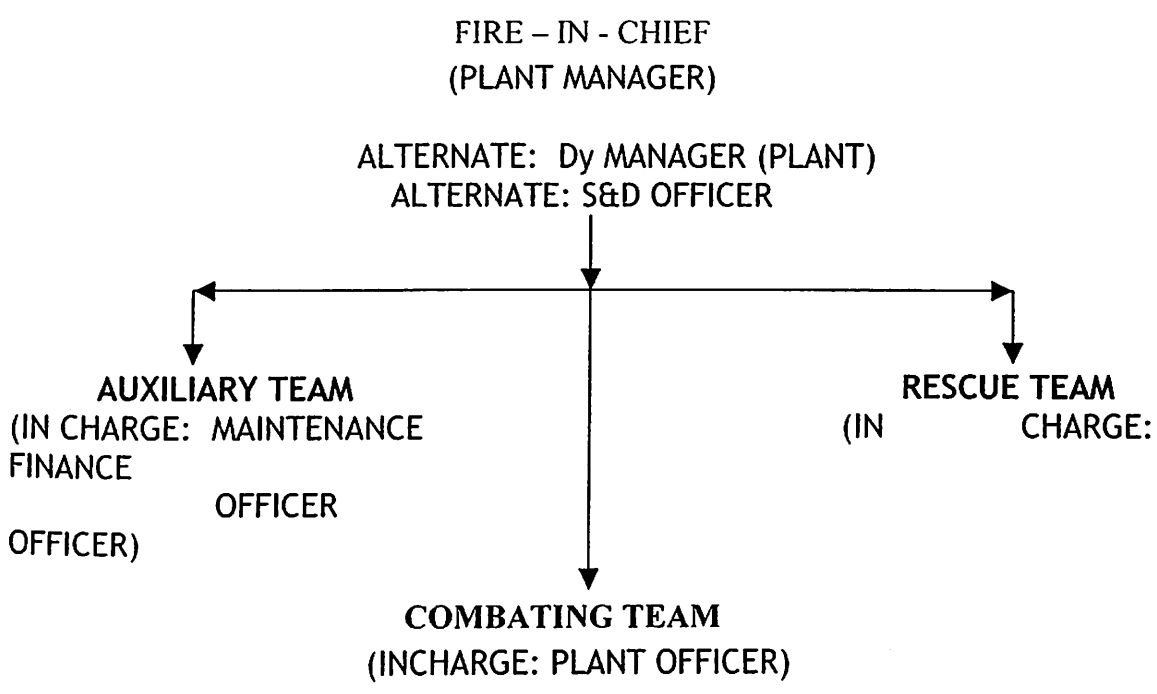
Gasket Failure

Gasket failure of flange joint may be full gasket or partial. Experience shows that gasket failures are mostly partial and segment between two bolt holes mainly fails. Present available data of gasket/ flange failure rate is about 0.5×10^{-6} per running hour ***(Source: Risk Analysis conducted M/s. PDIL during June'01).*** Automatic gas detector/ heat detector and automatic water sprinkler system may be considered to mitigate the hazard.

Filled Cylinder Failure

For domestic purpose LPG is filled in cylinders of 14.2 Kg capacity under a pressure of 7 to 10 Kg/ cm^2 (A). Beyond liquid full condition any further expansion of the liquid the cylinder pressure will rise by approx. 7 to 8 Kg/ cm^2 for each degree centigrade. This clearly explains the hazardous situation that could arise due to overfilling of cylinders. The filled cylinders are stored in filled cylinder storage shed as per OISD guidelines. The filled cylinder storage shed is provided with gas detectors with alarms at 20% LFL as well as 60% LFL and water sprinkler system. It is foreseen that suitable actions will be taken in case of gas leakage and/ or fire in the vicinity of reduce the hazard.

FIRE ORGANISATION CHART



EMERGENCY DURING WORKING DAYS

SPECIFICATION OF DUTIES

COMBATING TEAM

- The person noting the fire will shout "FIRE-FIRE" and will operate the DCP at the base of the fire. He will then operate the nearest hand siren for spreading the alarm. He will also operate the nearest MCP which will activate the electrical siren as well as shut down the electrical supply.
- The Plant Officer, after closing all operations will rush all the employees in the shed to the fire spot.
- The carousal Chargeman will close the LPG Valves and will ensure removal of filling guns from the cylinders.
- The Evacuation Chargeman will remove all the cylinders from the stand, put safety caps on all the cylinders and rush to the fire spot.
- The water bath operator will rush to the fire spot and will position himself at the nearest water monitor.
- The Segregation operator will rush to the fire spot & remove hose from the nearest hose box and will be ready with the fire fighting hoses.
- Other Chargemen/ Operators will rush to the fire spot and will await instructions of the Fire Combating Team In-charge.

AUXILIARY TEAM

- Maintenance Officer will co-ordinate with the Fire-in-Chief and carry Explosive meter to check the presence of vapours.
- Product Pump House Chargeman will close all the valves .

- The TLD Chargeman will, as per the instructions of Fire-in-chief, guide the bulk truck crew out through Gate no 2/ emergency gate.
- FPH Chargeman will watch the discharge pressure of Fire Fighting Pumps and will monitor auto-start fire-fighting pumps as per the requirement.
- PMCC Chargeman will keep track of the situation & restore power supply once all clear is declared.
- The Loading & Unloading security guards will keep the registers safely and will guide the truck crew/ labourers out from the plant.
- Frisking Gate Security Guard will guide the TT crew / labourers to the assembly zone & take a head count.
- The Maintenance Chargemen/ Operator will position additional DCPs, Fire Hoses, Nozzles, etc., near the fire spot.

RESCUE TEAM

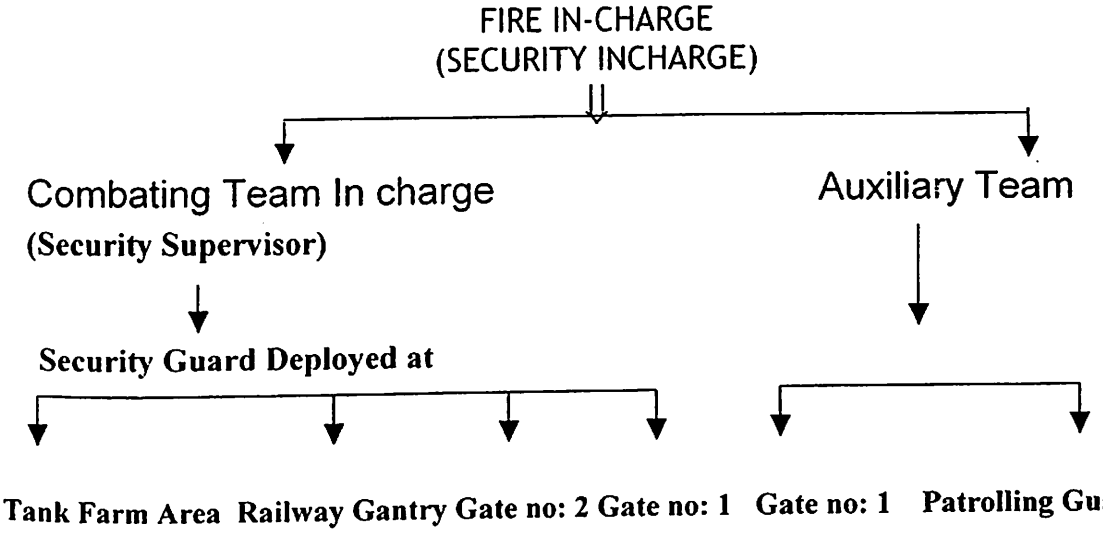
- The Stenographer will bring Public Address System & Helmet to the Fire Spot and will handover the same to Fire-in-chief.
- The Rescue Team In-charge rush First-Aid, Emergency Rescue Kit, Fire Entry Suit, Stretcher etc. to the fire spot.
- He will also confirm from Fire-in-chief whether to contact Fire Brigade, Police, Hospitals, etc.
- He will also send one employee for controlling traffic at the main gate.
- The S&D Officer will position himself in Control Room for outside communication.
- The Car Driver will take out the emergency vehicle and will position the same in front of Administrative Building.

EMERGENCY DURING NIGHT SHIFT/ OFF SHIFTS/ HOLIDAYS

- The security in charge will officiate as Fire-in-chief.
- After operating the sprinkler system, he will immediately contact the Plant Manager, Dy. Manager (Plant), and other officers for help.
- He will then supervise the guards and will fight fire, till help reaches as per the following chart

FIRE ORGANOGRAM CHART FOR SECURITY PERSONEL

(DURING NIGHT TIME/HOLIDAY)



GENERAL STEPS IN HANDLING EMERGENCIES

1. Operate nearest hand siren and shout "FIRE-FIRE". Activate MCP if available near by.
2. Hand siren to be picked up by electric siren. If not automatically activated through ILSD.
3. Electric siren to operate for 2 minutes.
4. Fire pump house operator to stand in fire pump house and watch for drop in outlet pressure of sprinkler/ hydrant lines. In case of drop in pressure, the Engine in manual mode should be started in case it does not start in auto mode.
5. PPH/ TLD operator to usher out TT crew & close all valves. All ROVs will be closed and motors stopped through ILSD.
6. One of the security guards to show the locations of fire on the fire indicator and then to go to the location of fire with a red flag.
7. The other security guard to take a head count and direct all personnel to the assembly zone. Emergency gates to be opened in case of instructions from Fire-in-chief.
8. All combating members should reach the site of emergency immediately.
9. The rescue team should reach the site of emergency with First-Aid, Stretcher, Fire Entry Suit, Low Temperature cloth, breathing apparatus, rope, resuscitator and emergency rescue kits. Rescue team leader should standby for further instructions from fire-in-chief.

10. Auxiliary team members except PMCC/FPH operators should reach the site of emergency. They should collect additional hydrant hoses, nozzles, fire extinguishers, water jel blankets and wait for instructions of fire-in-chief. The members should stand separately under their heads.
11. One of the filling shed officers should stand guard in filling shed, close all operations, ensure removal of all filling guns, ensure that all cylinders are capped.
12. S&D Officer will be in-charge of control room and await instructions from fire-in-chief for contacting outside agencies. (Fire Brigade, Ambulance, Disaster Management Cell, Khajuri Police, Collector/ Commissioner/ Factory Inspector, BPCL Depot., Railways). He should advise canteen to switch off all flames.
13. Emergency Vehicle Driver to take out the Car and keep it in readiness in front of Administrative building.
14. Safety Officer should identify wind direction and should advise fire-in-chief keeping in view of the nature of emergency.
15. Fire-in-chief to nominate one officer to take roll call at the main gate with DGR security in case of major fire.

CONTROL ROOM

CONTROL ROOM - I: S&D OFFICE

Facilities available

1. P & T telephone.
2. Public address/ paging system/ walkie-talkie.
3. First aids.
4. Keys to the jeep.
5. Keys to the water drain valves of Horton Spheres & SRVs.
6. Intercom.

CONTROL ROOM - II: FRISKING GATE

1. First Aid.
2. Intercom.
3. Hotline with railways.
4. Public address system.
5. Fire entry/fire proximity suit.
6. Self contained breathing apparatus.
7. Low temperature clothing.
8. Resuscitator.
9. Helmets.
10. Rope.
11. Keys to the non sparking tool kit (kept in emergency kit).
12. Adaptor for pumping water into Horton Sphere.
13. Emergency rescue kit.
14. Electric siren.

Note :- All outside communications should be done through control room 1.

OUTSIDE AGENCIES TO BE CONTACTED FOR ASSISTANCE IN CASE OF DISASTER.

Inform Fire Brigade, Municipal Corporation, Bhopal, on Telephone No. 2542222 and Fire Brigade, Superintendent on Telephone No. 2542222/ 4234101 to supplement efforts in fighting out large fire and to permit other agencies having fire-tenders for our emergency help.

To advise nearby police station by way of dialing 100 to cordon-off the area around our plant and to restrict traffic movement on National Highway and to arrange evacuation, issue warning to nearby locality, etc.

Dial 101 for Ambulance and Dial 2540222 for help from Civil Hospital.

Please contact district administration through wireless from Khajuri Police Station. Alternately, dial police control room or contact Divisional Commissioner (Old Secretariat)/ Collector/ Superintendent of Police.

IMPORTANT TELEPHONE NUMBERS

1.	Fire Brigade (Bairagarh)		-	101 / 4003106
2.	Fire Brigade Superintendent		-	2542222/ 4234101
3.	Ambulance		-	101/ 2745656/2745637
4.	Civil Hospital (Hamidia Hospital)		-	102 / 2540222
5.	Police		-	100/ 2853255 / 2641223
6.	Plant Manager	(Office)	-	2853352 Fax: 2853352
		(Residence / Mobile)	-	2676423 / 9425014498
7.	Dy. Manager (Plant)	(Office)	-	3295606/ 3295612
		(Residence/ Mobile)	-	2665240 / 9425381477
8.	Dy. Manager (Safety)	(Office)	-	3295606/ 3295612
		(Residence/ Mobile)	-	2666521 / 9425017843
9.	Asst. Manager (Maintenance)	(Office)	-	3853351/ 3853252
		(Residence / Mobile.)	-	2767267 / 982636357
10.	Divisional Commissioner	(Off.)	-	2540772 / 2540859
		(Res.)	-	2420319

11.	Suptd. of Police	(Off.)	-	2443201
		(Res.)	-	2443400
12.	Dy. Controller of Explosives	(Off.)	-	2562039 / 2565176
		(Res.)	-	2560784
13.	Factory Inspector	(Off.)	-	2554776/982607310
14.	Collector	(Off.)	-	2540494
		(Res.)	-	2430003
15.	Other Hospitals :			
	Jawahar Lal Nehru, Berasia Road, Bhopal-			2711452 / 2730178
	Seva Sadan, Bairagarh, Bhopal		-	2641156
16.	Depot. Manager, BPCL	(Off.)	-	3295610
	(Mutual Aid)	(Res.)	-	4287449
17.	Terminal Manager, RIL	(Off.)	-	3052015 / 993001101
18.	Mutual Aid)	(Res.)	-	2495578

PERSONS TO BE INFORMED ON EMERGENCY

1. Plant Manager (Plant) (Res.)
2. Dy. Manager (Plant) (Res.)
3. Dy. Manager (Safety) (Res.)
4. Chief Controller of Explosives, Nagpur
   Telegraphic Address - " EXPLOSIVES"
   Postal Address : -
   Chief Controller of Explosives,
   Petroleum and Explosive Safety Organisation (PESO)
   Govt. of India, "A", 5th Floor, CGO Complex
   Seminary Hills , Nagpur - 440006
5. Jt. Director,
   Industrial Health & Safety,
   236, Zone -1, M.P. Nagar,
   Bhopal - 462 011.
6. Dy. Controller of Explosive, Bhopal
7. Depot Manager
   BPCL, Depot.
8. Terminal Manager
   RIL, Terminal.

INTERNAL COMMUNICATION

An intercommunication system with EPABX and 15 handsets extensions are provided for internal communication between various offices such as administrative office, security gates, canteen, PMCC/DG House, Fire Pump House, etc. One P & T line connected through the Intercom

Exchange with 'O' dialing facility to selected extensions is provided for outside communication through the Intercom System.

In addition, a VHF communication system is provided in the plant for wireless communication between various workstations. The VHF communication system consists of 9 handsets for different locations and a base station located at S&D Control Room. This is communication system enables all plant personnel to instantaneously contact Plant Manager and Vice-versa. In case of emergencies, Plant Manager may issue, specific instructions over this system.

A public address system is also provided for conveying messages to tank truck crew in the truck parking area, which is operated from the Security Control Room in the main gate.

SPECIFIC ACTION PLAN FOR EMERGENCIES

A. LEAKAGE WITHOUT FIRE

LEAKAGE FROM HORTON SPHERE

(a) From bottom flange

i) Follow "General Step in Handling Emergencies".
ii) Rescue Team to prepare one person with breathing apparatus and low temperature cloth.
iii) Cordon off the area.
iv) Take the water-pumping adaptor from the emergency kit and connect it to the water drain line of the Horton Sphere. Close down all down stream LPG valves.
v) Connect hydrant hose to the adaptor.
vi) Open the hydrant valve.
vii) Start the engine.
viii) Open the water drain valve (Three number slowly).
ix) Simultaneously take out LPG vapour from the Sphere with the help of LPG Vapour Compressor.
x) When the water level comes to the bottom flange position tighten the flanges to stop leakage.

(b) From SRV

i) Reduce the pressure in Horton Sphere by cooling and with the help of LPG Vapour Compressor.
ii) If possible transfer the product to other Sphere with the help of LPG pump.

iii) When the pressure reduces try to stop leakage by tightening bolt etc. and by putting m-seal/ other compound.
iv) If the leakage couldn't be controlled inform fire brigade and other outside agencies.
v) Railways to be informed to stop all traffic.

(c) **Rupture of body**
i) Follow the General steps.
ii) Inform district administration, fire brigade and nearby hospital.
iii) Inform railways to stop all traffic.
iv) Stop all traffic on the main highway at-least 3 km on both sides of the plant.
v) Evacuate all near by population residing within 3 KM radius.
vi) M.P.E.B. to be advised to switch off power supply from Lal Ghati.
vii) Dissipate/divert LPG cloud with the help of hydrant system with fog nozzle.
viii) Rescue team to prepare with oxygen mask/ low temperature cloths.
ix) Assess the possibility of preventing leakage.

LEAKAGE FROM TLD

(a) **From Bulk Trucks**
i) Follow "General steps in handing emergencies"
ii) Cordon of area.
iii) If leakage is from bottom put special adaptor in the rescue kit to pumping water from the hydrant system.
iv) Start engine.
v) Open the quick shut-off valve of the TT slowly.
vi) Take out LPG vapour with the help of compressor to reduce pressure inside the TT. If the leakage is from SRV, transfer of product to one or two de-pressurised TT may be attempted.
If the leakage is from roto gauge, possibility of fixing wooden plugs may be attempted. In this connection please refer OISD Standard 161 given in the ANNEXURE.

LEAKAGE FROM GANTRY

(a) **From Wagons**
i) Follow "General step's in handling emergencies."
ii) Close all ROV and all valves in the gantry.
iii) In case of heavy leakage, inform Railways to stop traffic.
iv) Cordon off the area.
v) Wear breathing apparatus and low temperature cloth and rescue rope.
vi) Explore the possibility of pumping water into the wagon.
vii) Explore the possibility of using wooden cleaves to arrest leakage.

(b) **Bursting of hose**

i) Follow "General step's in handling emergencies."

ii) Close the valve on both end of the hose wear low temperature cloth & breathing apparatus and rescue rope.

ii) Disperse vapour cloud with the help of hydrant.

LEAKAGE FROM PIPELINES

i) Follow the "General steps in handling emergencies".
ii) Close all ROVs.
iii) Rescue team to be ready with breathing apparatus and low temperature clothes.
iv) Direct water jet at the place of leakage to disperse vapour clouds.
v) Close all the upstream and downstream valves.

LEAKAGE FROM LPG CYLINDER

a) **In Shed**

i) Follow "General steps in handling emergencies".
ii) Remove the cylinder to an open place.
iii) Alternatively evacuate the cylinder.

b) **From Stack Truck**

i) Follow "General steps in handling emergencies".
ii) If the leakage is heavy do not start truck.
iii) Rescue team to be ready with breathing apparatus and low temperature clothes.
iv) Identify the reach for the leaky cylinder by carefully detaching other cylinders.
v) Evacuate the cylinder.

LEAKAGE FROM BULK TRUCK IN PARKING AREA

i) If the leakage is heavy do not start the truck.
ii) If the leakage is from SRV bring the truck to hazardous area and follow the process as given in leakage "From TLD from Bulk truck".
iii) If the emergency is sought in parking area, evacuate the area upto 800 meters.

iv) Follow process as per OISD standard 161 given in the ANNEXURE.

LEAKAGE FROM STACK TRUCK IN PARKING AREA

i) Follow "General steps in handling emergencies".
ii) M.P.E.B. to switch off power supply.
iii) Evacuate other truck from parking area.
iv) Bring the stack truck to the unloading point.
v) However, if the leakage is heavy do not stack the truck.
vi) Do not use hydrant system in parking area till electric supply from M.P.E.B. is switched off
vii) Identify the leaky cylinder at the unloading finger and evacuate the cylinder.

LEAKAGE FROM EVACUATION UNIT/ CAROUSAL/ SMALLER PIPELINES.

Follow "General step in handling emergencies".
Close down all ROVs.
Close all other valves.
Use hydrant system to disperses cloud if formed.
Wear low temperature cloths with breathing apparatus and rescue rope identify the source of leakage.
Take remedial measures as situation warranty.

B. LEAKAGE WITH FIRE

In case of fire, immediate action is required to extinguish/ control the fire. Small fires can be extinguished with the help of DCP. The role of sprinkler/ hydrant is mainly to control fire. The possibility of the spread of fire should be eliminated. If the leakage cannot be stopped it would be better to allow the fire to continue under controlled conditions to stop formation of vapour clouds. Water should be used with optimum efficiency so as to prolong the availability of water.

STORAGE VESSELS

i) Follow "General steps in handling emergencies".
ii) Put the sprinkler system in operation.
iii) Cool the adjoining vessels also.
iv) Use the nearest water monitor to cover SRVs.
v) Inform out-side agencies.
vi) Evacuate the area in 3 KM radius.
vii) Advise Railway to stop traffic.
viii) Explore the possibility of product transfer from the vessels under fire.
ix) Explore all possibility of re-coupment of water.

TLD(TANK LORRY DECANTATION)

Follow "General steps in handling emergencies".
Operate sprinkler system.
Cool the truck cabin also.
Close all valves and ROVs.
Remove all Tanker not affected.
Inform outside agencies.
Inform Railways to stop traffic.
Evacuate people from 3 km area.
Explore all possibility of re-coupment of water.

FROM GANTRY

i) Follow "General steps in handling emergencies".
ii) Inform the railway to stop traffic.
iii) Use sprinkler system/ hydrant system for fighting fire.
iv) Explore all possibility for replenishment of water.
v) Evacuate people in 3 KM radius.
vi) Evacuate the possibility of removing wagon's not under fire.

LPG CYLINDER UNDER FIRE

Try to extinguish the fire with the help of DCPs.
Cool the surrounding area with the help of hydrant system.
Evacuate non-essential people.

FIRE IN GREEN BELT

i) Follow "General steps in handling emergencies".
ii) Inform Fire Brigade to rush fire tenders to the site.
iii) Connect as many hoses as required from the nearest hydrant point so as to reach the fire spot.
iv) Open emergency exit and the gate to green belt.
v) Rush as many DCPs as possible to the fire spot.
vi) Extinguish the fire with the help of DCPs or water as required.

DERAILMENT OF WAGONS

i) Follow "General steps in handling emergencies".
ii) Inform railway.
iii) Close all ROVs.
iv) Check for any leakage. Evacuate the wagon with suitable measures.
v) All rescue operation should be considered in line with OISD 161.
vi) Arrange for crane in consultation with railway.
vii) In case of LPG leakage, evacuation is to be initiated with the help of district administration.
viii) Assess the possibility of removing healthy wagons.

ELECTRICAL FIRE

i) Trip MOCB.
ii) Operate the Isolator in Sub-station yard.
iii) Remove all combustible nearby.
iv) Fight the fire with the help of CO_2 Fire Extinguishers.
v) Use DCP, if needed.
vi) In case fire is not extinguished but positive isolation of electricity is made, water can be used to fight fire.
vii) If the fire is in administrative building, hydrant at fire escape should be operated for evacuation of people.
viii) Give artificial respiration & first aid to people affected.

ACTION PLAN FOR MEDICAL AID

FOR LPG FREEZES (COLD-BURNS)

1. Do cover the frost bitten area with warm hands or light woolen material.
2. Bring victim inside to warm area as possible.
3. Immerse frost bitten area in cool-water.
4. Gently cover affected parts with light dampened or wet woolen material if affected area cannot be immersed in cool-water.
5. On affected parts, injured party should start exercising fingers, toes, and legs.
6. Give victim a warm, non-alcoholic drink.
7. Take the victim to a physician.
8. Do not use hot water.
9. Do not turn water pressure or pour water on burned area.
10. Do not rub with snow or ice.
11. Tell the Physician that freeze or LPG frostbite is equal to a burn received from a heated object or flame.
12. Use gloves during filling operations.

FOR ELECTRIC SHOCK CASUALTIES

Electric shock results in irreversible damage to brain cell followed by deterioration of other organs.

RESCUE AND FIRST-AID

- Do first thing first, quickly and without fuss or panic.
- Switch-off the supply if this can be done at once.
- If not possible, use a dry - stick, dry cloth or there non-conductor to separate the victim of an electrical contact.
- The rescue must avoid receiving shock himself by wearing gloves or using a jacket to pull the victim.

- Always keep in mind that delay in rescue and resuscitation may be fatal. Every second counts.

ARTIFICIAL RESPIRATION

- Give artificial respiration, if breathing has stopped. There are several methods of artificial respiration, if the victim is not injured over the face, try mouth to mouth. If the victim is injured above the face, use Silverster Brosch method.
    (a) Mouth to mouth method.
    (b) Silverster Brosch method

STEPS FOR (a)

- If there is an obstruction to breathing, remove it with your finger with a cloth wrapped around your fingers if it is in the mouth. Several sharp blows between the shoulder blades may help to dislodge an obstruction.
- Lay casualty on his back, put something under his shoulder to raise them and allow his head to fall backward. The head should be, if possible, a little lower than the trunk. Remember that speed is essential.
- Kneel at the Casualty head and grasp his arms at the wrists. Then cross them firmly over the wrists. Then cross them firmly over the lower chest. This movement should force air out of his lungs. Press with the hands crossed on the lower part of the chest and maintain pressure for two seconds.
- Release this pressure and pull his arms with a sweeping movement upwards and outwards above his head and backwards as far as possible.
- This movement should cause air to be drawn into his lungs. Retain the arm in this position for three seconds. This will keep an equal amount of time at every cycle.
- Repeat these movements rhythmically about twelve times per minute, checking the mouth frequently for obstruction. Such cycle, therefore, takes five seconds (Two seconds for chest pressure and three seconds for arm lifts).
- With the casualty on his back, there is a danger of aspiration of vomit, mucus or blood re-entering the system. This risk can be reduced by keeping his head extended a little lower than the trunk.
- If an assistant is available, he can press the Casualty's lower jaw so that the chin is jutting out.
- The assistant should also ensure that the mouth is kept open as possible, turning the head to one side, if necessary.
- When natural breathing begins, your movement should be adopted to correspond to it.
- If burns are present, cover them with a dry sterile dressing.
- Do not allow people to crowd around and block fresh air.
- Arrange to remove the injured to the care of doctor or hospital as early as possible.

Conclusion:

So we see that an Emergency preparedness plan is a precautionary measure to combat the worst of situations, which is profoundly made after a deep analysis of all the possibilities with appropriate calculations.

Lets conclude all the above studies graphically:

HAZARDS CLASSIFICATION

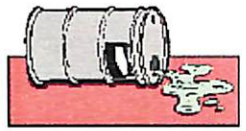
HAZARDS

- **EXPLOSIVE**

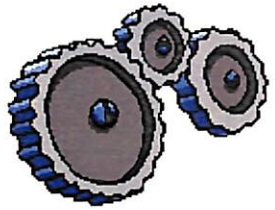
- **FIRE**

- **TOXICITY – INHAL& INGESTION**

- **ENVIRONMENTAL - AIR RELEASE, GROUND SPILL, WASTE DISPOSAL**



- **MECHANICAL - OVER-PRESSURE, MOVING PARTS**



- **REACTION-EXOTHERMS**

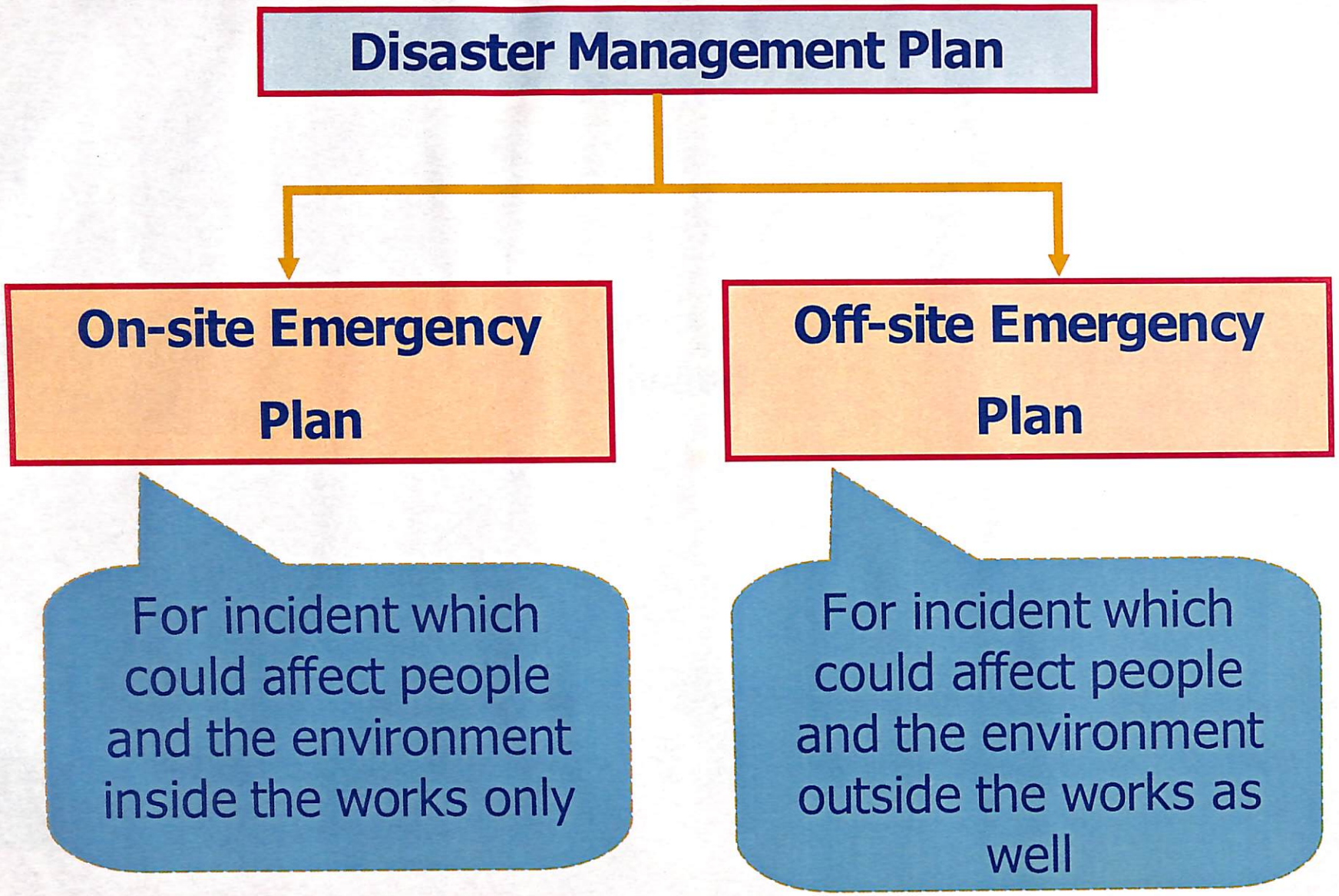
WHAT IS TO BE DONE ?

- ✓TRAINING OF OPERATORS IN THE USE OF DIAGNOSTIC RULES

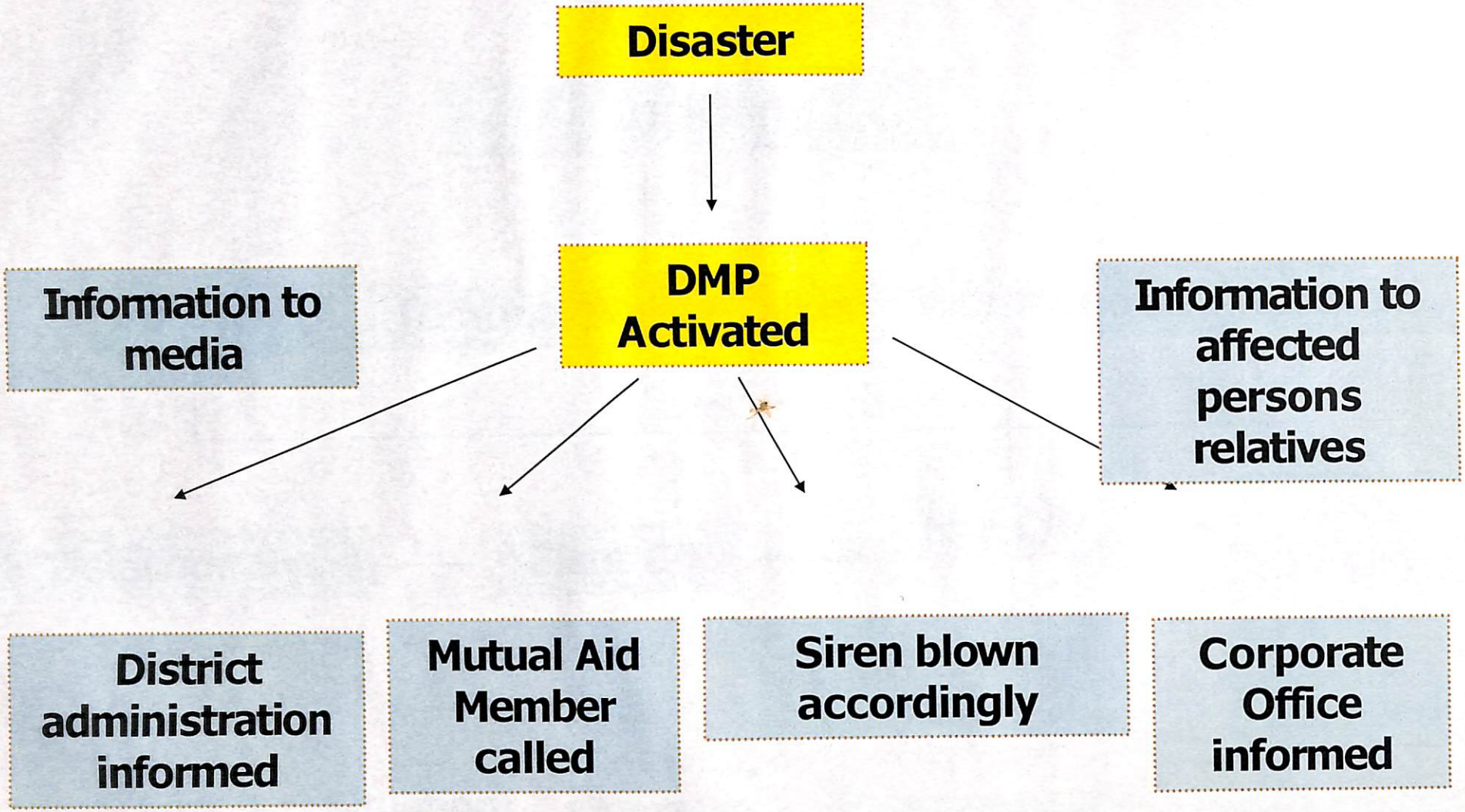
- ✓MINIMISING STRESS DURING EMERGENCIES

- ✓IMPROVING INFORMATION HANDLING

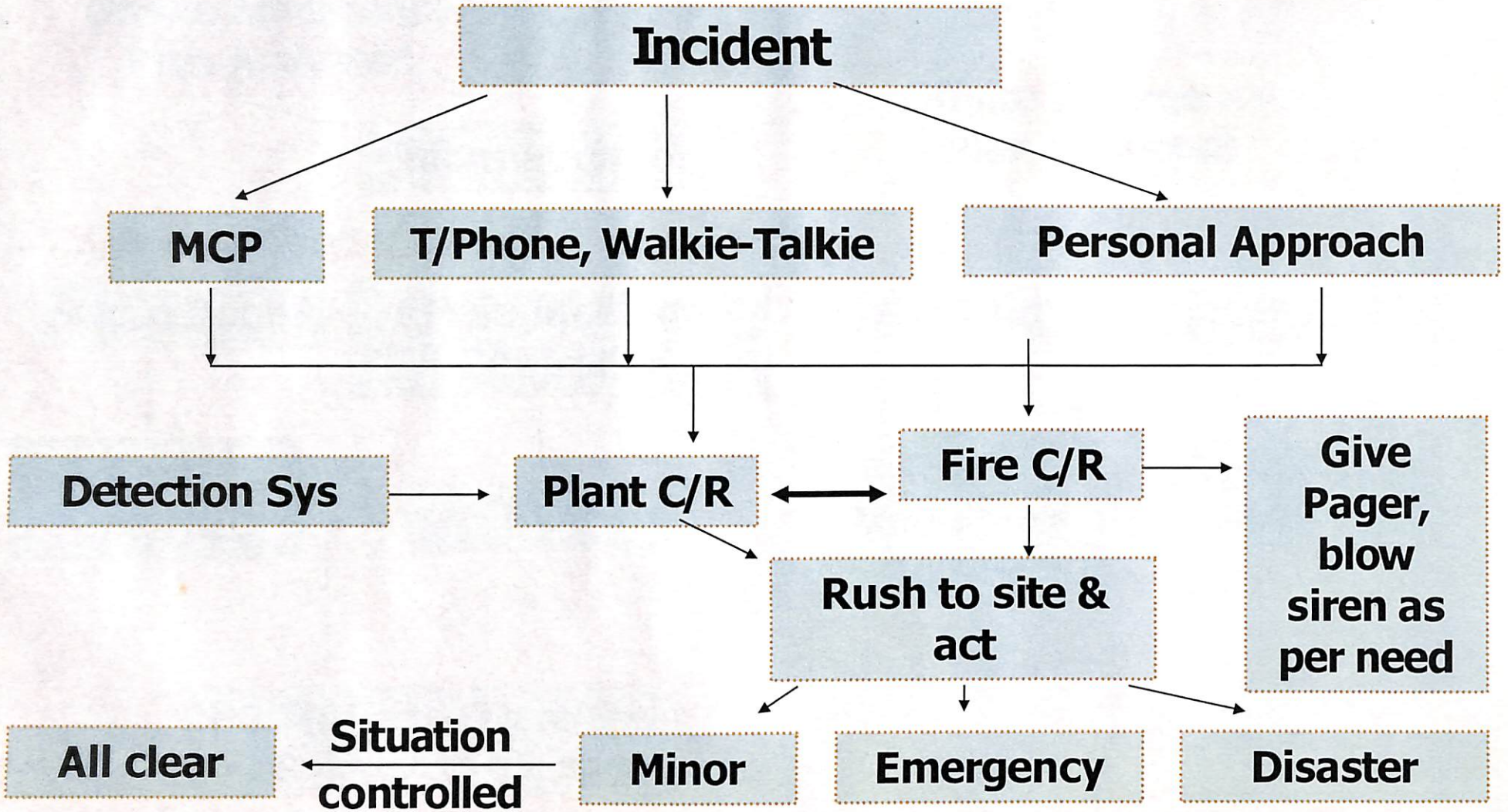
- ✓DESIGNING ENVIRONMENTS TO OVERCOME ALLIED CONDITIONS


Disaster Management Plan
On-site Emergency Plan
Off-site Emergency Plan
For incident which could affect people and the environment inside the works only
For incident which could affect people and the environment outside the works as well

On-site Emergency Plan



On-site Emergency Plan



On-site Emergency Plan