# RISK ASSESSMENT

# CHAPTER -7

# Risk Assessment

## 7.0 RISK ASSESSMENT AND DISASTER MANAGEMENT PLAN

### INTRODUCTION

Hazard analysis involves the identification and quantification of the various hazards (unsafe conditions) that exist in the LPG bottling plant. On the other hand, risk analysis deals with the recognition and computation of risks, the equipment in the plant and personnel are prone to, due to accidents resulting from the hazards present in the LPG storage and bottling plant.

BPCL, Jhansi proposes "Augmentation of LPG storage by addition of Mounded Storage Vessel (MSV) of 300 MT X 3 nos. (900)MT" Presently, the plant has 3 nos. of A/G storage bullets of 150 MT each with cumulative capacity of 450 MT with bottling capacity of approx 12000 cylinders/shift. Thus, after augmentation the total LPG storage capacity of the plant will be 1350 MT with bottling capacity of approx 12000 cylinders/shift. The plant is operating in two shifts. Now the plant is operating from 06:00 to 14:00 in 1st shift and 14:00 to 20:00 in 2nd shift. Risk analysis follows an extensive hazard analysis. It involves the identification and assessment of risks the neighboring populations are exposed to as a result of hazards present. This requires a thorough knowledge of failure probability, credible accident scenario, vulnerability of population etc. Much of this information is difficult to get or generate. Consequently, risk analysis is often confined to maximum credible accident studies.

In the sections below, identification of various hazards, probable risks in the proposed plant, maximum credible accident analysis, consequence analysis, etc., are addressed which give a broad identification of risks involved in the plant. Disaster Management Plan (DMP) has been presented based on the risk estimation for existing and proposed storage of LPG to be installed. The principal conclusions drawn from the risk analysis and recommendations based thereon are summarized hereunder:

## 7.1 APPROACH TO THE STUDY

Risk involves occurrence or potential occurrence of some incidents consisting of an event or sequence of events. Risk assessment study covers the following:

- Identification of potential hazard areas;
- Identification of representative failure cases;
- Visualization of the resulting scenarios in terms of fire (thermal radiation) and explosion;
- Assess the overall damage potential of the identified hazardous events and the impact zones from the accidental scenarios;
- Assess the overall suitability of the site from hazard minimization and disaster mitigation point of view;
- Furnish specific recommendations on the minimization of the worst accident possibilities; and
- Preparation of broad Disaster Management Plan (DMP), On-site and Off-site Emergency Plan, which includes Occupational and Health Safety Plan.

## 7.2 PROPERTIES OF LPG

LPG is a mixture of commercial propane and commercial butane, which may also contain small quantity of unsaturated hydrocarbons. LPG marketing in India is governed by IS 4576 and test methods by IS-1448.

LPG being highly inflammable may cause fire and explosion. It, therefore, calls for special attention during its handling.

### 7.2.1 Physical properties

#### a) Density

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

Since LPG vapor is heavier than air, it normally settles down at ground level/low lying areas. This accumulation of LPG vapour gives rise to potential fire and explosion hazards.

**b) Vapor Pressure**

The pressure inside a LPG storage vessel corresponds to the temperature in the storage vessel. This vapor pressure is dependent on temperature as well as the percentage composition of the mixture of hydrocarbons present in LPG. Beyond liquid full condition in cylinders any further expansion of the liquid will increase the cylinder pressure by 14 to 15 $kg/cm^2$. for each degree centigrade rise in temperature (The coefficient of expansion is around 0.00237 per deg C). This clearly indicates the hazardous situation, which may arise due to overfilling of cylinders or any storage vessel.

**c) Flammability**

LPG has an explosive limit range of 1.8% to 9.5% by volume of the gas in air. This is considerably narrower than other common gaseous fuel.

**d) Auto-ignition temperature**

The auto-ignition temperature of LPG is around 410°C-580°C and will not ignite on its own at normal temperature.

**e) Combustion**

Combustion of LPG increases the volume of products in addition to generation of heat. LPG requires about 24 to 30 times its own volume of air for complete combustion and yields 3-4 times of its own volume of $CO_2$. The heat of combustion is about 10,900 Kcal/kg.

**f) Colour**

LPG is colour less both in liquid and vapor phase. During leakage, vaporization of LPG cools the atmosphere and condenses the water vapor contained in it forming a white fog. This makes possible to see an escape of LPG.

**g) Viscosity**

LPG has a low viscosity (around 0.3 CS at 45°C) and can leak when other petroleum products cannot. This property demands a high degree of integrity in the pressurized systems handling LPG to avoid leakage.

**h) Odour**

Ethyl mercaptan is normally used as stanching agent for identifying the leakage as per IS : 4576, ethyl mercaptan is generally added in the ratio approx. 1 Kg of mercaptan per 100 m3 of liquid LPG (20 ppm).

**i) Toxicity**

LPG is slightly toxic. Although it is not poisonous in vapor phase, it suffocates when present in large concentrations due to displacement of oxygen. IDLH value of LPG is generally taken as 19000 ppm.

**j) Pyrophoric Iron**

Highly inflammable pyrophoric iron sulphide is formed due to reaction of loose iron/iron oxide with sulphur or its compounds. Formation of pyrophoric iron sulphide is prevented by totally eliminating $H_2S$, limiting the total volatile sulphur to 0.2% by mass and reducing loose iron oxide by thoroughly cleaning the storage vessels internally during outage.

However, pyrophoric iron sulphide will not spontaneously ignite in a Sphere or a cylinder due to high concentration of LPG, which is much above the upper flammable limit. When these vessels are aired (during opening to atmosphere or air entrapped condition) to within or below the range, it will ignite spontaneously unless steam/water is used to cut the sulphur iron reaction. Similar type of precaution is needed while opening the strainers of LPG pumps or any other location where loose iron oxide is expected.

## 7.3 HAZARDS OF LPG SPILLAGE/ESCAPE FROM CONTAINMENT

### 7.3.1 General

When LPG is released from a storage vessel or a pipeline, a fraction of LPG vaporizes immediately and the other portion forms a pool if the released liquid quantity is significant. LPG from the pool vaporizes rapidly entrapping some liquid as droplets as well as considerable amount of air, forming a gas cloud. The gas cloud is relatively

heavier than air and forms a thin layer on the ground. The cloud flows into trenches and depressions and in this way travels a considerable distance.

As the cloud formed in the area of spill moves downwind under influence of wind, it gets diluted. A small spark within the flammability limit can cause flash fire, explosion and if the liquid pool still exists and remains in touch of cloud under fire it can ignite the whole mass of liquid. However in case of non existence of any source of fire there will be no occurrence of hazardous event and the cloud may get diluted to such a level that the mixture is no longer explosive. But it can cause asphyxiation due to displacement of oxygen. The various phenomena that may likely to take place are listed as here under.

### 7.3.2 Jet Fire

Escaping jet of LPG from pressure vessels/piping, if ignited, causes a jet flame. The jet flame direction and tilt depend on prevailing wind direction and velocity. Damage, in case of such type of jet fires, may be restricted within the plant boundary. However, the ignited jet can impinge on other vessels and equipment carrying LPG and can cause domino effect.

### 7.3.3 Pool Fire

The liquid pool, if ignited, causes a "Pool Fire". In the pool fire, LPG burns with long smoky flame throughout the pool diameter radiating intense heat, which creates severe damage to the adjoining buildings, structures, other vessels and equipment causing secondary fires. The flame may tilt under influence of wind and may get propagated / blown several pool diameters down wind. Damage, in case of such fires, is restricted within the plant area and near the source of generation except causing a phenomenon, called BLEVE, which will be discussed and detailed below.

However, in case of plants having a good layout maintaining safe separation distances and other precautionary measures, the damage may be restricted to minimum distance.

### 7.3.4 Vapor Cloud Explosion (VCE)

Clouds of LPG vapour mixed with air (within flammability limit) may cause propagating flames when ignited. In certain cases flame may take place within

seconds. The thermal radiation intensity is severe depending on the total mass of LPG in the cloud and may cause secondary fires. When the flame travels very fast it explodes causing high overpressures or blast effects causing heavy damage at considerable distance from the release point. Such explosions are called vapour cloud explosion and is most common cause of such industrial accidents.

### 7.3.5 Boiling Liquid Expanding Vapour Explosion (BLEVE)

This phenomenon occurs when pressure inside a storage vessel increases above the design pressure due to receipt of heat radiation from fire in the adjacent area. Due to impingement of flame or due to radiant heat, temperature in the vapour portion of the storage vessel increases rapidly compared to the portion filled with liquid. Increase in temperature weakens the shell. With the rise in vapour pressure and inadequate vapor space for expansion, the shell of storage tank bursts causing fragments of the shell flying like projectiles with release of whole mass of pressurized boiling liquid. The released liquid flashes and atomizes immediately often resulting a large fire ball in contact with an ignition source. Although the fire ball lasts only a few seconds, its effect is devastating due to flame contact and intense thermal radiation. This phenomenon is called BLEVE. The effect of BLEVE may extend beyond the plant boundary in case of catastrophic failure of large pressurized storage vessels but occurrence of such phenomena is very rare and this is considered to be incredible in nature.

## 7.4 HAZARD ASSESSMENT AND EVALUATION

### 7.4.1 Methodology

An assessment of the conceptual design is conducted for the purpose of identifying and examining hazards related to stock materials, major process components, utility and support systems, environmental factors, proposed operations, facilities, past accident data and safeguards.

### 7.4.2 Preliminary Hazard Analysis (PHA)

A preliminary hazard analysis is carried out initially to identify the major hazards associated with storages and the processes of the plant. This is followed by consequence analysis to quantify these hazards. Finally, the vulnerable zones are

plotted for which risk reducing measures are deduced and implemented. The hazards involved in the LPG bottling plant are:

- Large scale release of LPG from bulk storage system leading to dispersion/ fire/ explosion.
- Leakage of LPG in unloading area due to unloading arm failure.
- 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.

### 7.4.3 Maximum credible accident analysis (MCAA)

Hazardous substances may be released into atmosphere as a result of failures of storage due to intrinsic reasons or due to a natural catastrophe causing loss of containment, which may cause damage to the surrounding area. This section deals with the question of how consequences of release of such substances and damage to the surrounding area can be determined by means of mathematical models. Major hazards posed by flammable storage can be identified taking recourse to MCA analysis. MCA analysis encompasses certain techniques to identify the hazards and calculate the consequent effects in terms of damage distances of heat radiation, toxic releases, vapour cloud explosion, etc. A host of probable or potential accidents of the major units in the complex arising due to use, storage and handling of the hazardous materials are examined to establish the credibility of failure event(s). Depending upon the effective hazardous attributes and their impact on the event, the maximum effect on the surrounding environment and the respective damage caused can be assessed. The reason and purpose of consequence analysis are many folds, like:

- Part of Risk Assessment;
- Plant Layout/Code Requirements;
- Protection of other plants;

- Protection of the public;
- Emergency Planning; and
- Design Criteria.

Results of consequence analysis are useful for getting information about all known and unknown effects that are of importance when some failure scenario occurs in the plant and also to get information as how to deal with the possible catastrophic events. It also gives the workers in the plant and people living in the vicinity of the area, an understanding of their personal threats and response/evacuation situation.

Radiations due to pool fire, jet fire or fire ball can also cause severe burns or fatalities of workers or fire fighters located within a certain distance. Also its effects on inanimate objects like equipment, piping, building and other objects need to be evaluated. This will help to decide the location of other storage/process vessels, decide the type of protective clothing the workers/fire fighters' need, the duration of time for which they can be in the zone, the fire extinguishing measures needed and the protection methods needed for the nearby storage vessels.

Damage due to various levels of incident thermal radiation, thermal exposure & lethality and overpressure has been given in table 7.1, 7.2 & 7.3. Table-7.1 tabulates the damage effect on equipment and people due to thermal radiation intensity.

**Table No. 7.1: Damage due to incident radiation intensities**

| Sr. No. | Incident Radiation ($kW/m^2$) | Type of Damage Intensity | |
|---|---|---|---|
| | | Damage to Equipment | Damage to People |
| 1 | 37.5 | Damage to process equipment | 100% lethality in 1 min. 1% lethality in 10 sec. |
| 2 | 25.0 | Minimum energy required to ignite wood at indefinitely long exposure without a flame | 50% Lethality in 1 min. Significant injury in 10 sec. |
| 3 | 19.0 | Maximum thermal radiation intensity allowed on thermally unprotected adjoining equipment | -- |
| 4 | 12.5 | Minimum energy to ignite with a flame; melts plastic tubing | 1% lethality in 1 min. |
| 5 | 4.5 | -- | Causes pain if duration is longer than 20 sec, however blistering is un-likely (First degree burns) |
| 6 | 1.6 | -- | Causes no discomfort on long exposures |

*Source: Techniques for Assessing Industrial Hazards by World Bank.*

The effect of incident radiation intensity and exposure time on lethality is given in **Table-7.2.**

**Table No. 7.2: Radiation exposure and lethality**

| Radiation Intensity ($kW/m^2$) | Exposure Time (seconds) | Lethality (%) | Degree of Burns |
|---|---|---|---|
| 1.6 | -- | 0 | No Discomfort even after long exposure |
| 4.5 | 20 | 0 | 1 st |
| 4.5 | 50 | 0 | 1 st |
| 8.0 | 20 | 0 | 1 st |
| 8.0 | 50 | <1 | 3 rd |
| 8.0 | 60 | <1 | 3 rd |
| 12.0 | 20 | <1 | 2 nd |
| 12.0 | 50 | 8 | 3 rd |
| 12.5 | Inst | 10 | -- |
| 25.0 | Inst | 50 | -- |
| 37.5 | Inst | 100 | -- |

- **Blast Overpressure Damages**

  In the event of dispersion of LPG vapour cloud, the cloud comes into contact with an ignition source between its upper and lower flammability limit an explosion may occur. The resultant blast wave may have damaging effect on the equipment, buildings, structures etc. The collapse of buildings & structures may cause injury or fatality. Damaging effect of blast overpressures are illustrated in the table no 7.3. Table no. 7.3 shows the damage effects due to various dose levels.

**Table No. 7.3**: **Damage effects of blast overpressure**

| Last Overpressure (Bar) | Damage Type |
|---|---|
| 0.30 | Major damage to structures (assumed fetal to the people inside structure) |
| 0.10 | Repairable Damage |
| 0.03 | Window Breakage |

### 7.4.4 Scenarios considered for MCA analysis

The mode of approach adopted for consequence analysis is to first select the failure cases and then to conduct the consequence analysis of the selected failure cases. The failure cases selected are listed in Table No.-7.4.

**Table No.-7.4: Selected failure cases**

| S. No. | Failure Case | Failure Mode | Consequence |
|---|---|---|---|
| 1. | Catastrophic Failure of 300 MT Mounted storage vessels | Random failure | Jet fire, Flammable Vapour Cloud Explosion, Flash fire |

The above listing is made keeping in view the worst scenarios occurred in the past and likely disasters that could occur on a major scale and managing such risks by drawing a precedential scale of approach to minimize any such effects in near future.

### 7.4.5 Model used for analysis

ALOHA® is the hazard modeling program for the CAMEO® software suite, which is used widely to plan for and respond to chemical emergencies.

ALOHA allows us to enter details about a real or potential chemical release, and then it will generate threat zone estimates for various types of hazards. ALOHA can model toxic gas clouds, flammable gas clouds, BLEVEs (Boiling Liquid Expanding Vapor Explosions), jet fires, pool fires, and vapor cloud explosions. The threat zone estimates are shown on a grid in ALOHA.

### 7.4.6 Catastrophic Failure of Proposed 3 x 300 MT Mounted Storage Vessel (MSV)

**Storage in MSV**

LPG is to be stored in three MSVs designed as per OISD 150, and to be located in a single cluster. The vessels will be provided with two pressure safety relief valves or safety relief valves (SRVs) on top of vents raised to 1.5-m from the top of the

mounded storage vessel, set at a pressure of 13.6 & 14.2 Bar. Cathodic protection is to be provided for each MSV to guard against corrosion.

The MSV is to be laid on a compacted sand bed with no raised support. This design protects the storage vessel from any source of fire impinging on it from any direction and virtually eliminates the possibility of failure of vessel and occurrence of fireball (BLEVE) scenario**.**

A retaining wall of reinforced concrete in front of the vessel protects it from effects of overpressure from blast waves and explosion.

Level, pressure and temperature are monitored and the instruments provided with redundancy. The level in the MSV is monitored during filling. The inlet to the vessel is provided with an ROV which closes on reaching 84% capacity.

The presence of Remote Operated Valves (ROV) on the pipeline connected to the MSV ensures that transfer operation to and from the bulk storage can be stopped from a remote location.

**Consequences/ failures of MSVs**

The extent of the consequences of an accident in a LPG storage facility depends on the type and quantity of the product stored and handled, mode of containment, and external factors like location, density of population in the surrounding area, etc. In many cases realization of hazard and its potential also depend on prevailing meteorological conditions and availability of ignition source.

Petroleum products such as LPG require interaction with air or oxygen and an ignition source for the hazard from loss of containment to be realized. Under certain circumstances, vapours of the product when mixed with air may be explosive, especially in confined spaces.

**Vapour Cloud Explosion (VCE)**: A Vapour Cloud Explosion (VCE) is a deflagration accompanied by a blast effect that occurs in the open air as a

consequence of the ignition of a cloud containing flammable vapour. In the event of release of LPG in substantial amounts, a flashfire or VCE could result if suitable ignition source is available. Leak (20%) of pipe section between ROV and vessel joint can be the scenario for the VCE.

**Jet Fire:** Leak (20%) of MSV vapour line may cause Jet fire.

**Flash Fire:** 2a Leak (20%) of pipe section away from MSV beyond ROV

**Jet Fire**

The outcomes like hazard distances due to Jet Fire of the LPG bullet has been presented in Tables-7.7 - 7.8 respectively.

**Table No. 7.7: Jet Fire details**

| Sl. No. | Items | LPG Content in the Bullet as 84 % of its Capacity |
|---|---|---|
| 01. | Max fire length (m) | 45 |
| 02. | Burn duration (min ) | 60 |
| Note: The chemical escaped from the tank and burned as Jet fire | | |

**Table No. - 7.8: Hazard distances due to Jet Fire in A/G bullet**

| Sl. No. | Thermal Radiation $KW/m^2$ | Max. Distances to Thermal Radiation, m |
|---|---|---|
| 01. | 10.0 | 68 |
| 02. | 5.0 | 98 |
| 03. | 2.0 | 153 |

From the above table it is evident that the hazard distance to thermal radiation level of 10.0 $KW/m^2$ (potentially lethal in 60 sec) for Jet Fire in Bullets may extend upto a max distance of 68 m and hazard distances due to thermal radiation level of 2 $KW/m^2$ (pain in 60 secs ) may extend upto a max distance of 153 m. The figure showing the distance and the threat zones is provided below in Figure 7.2

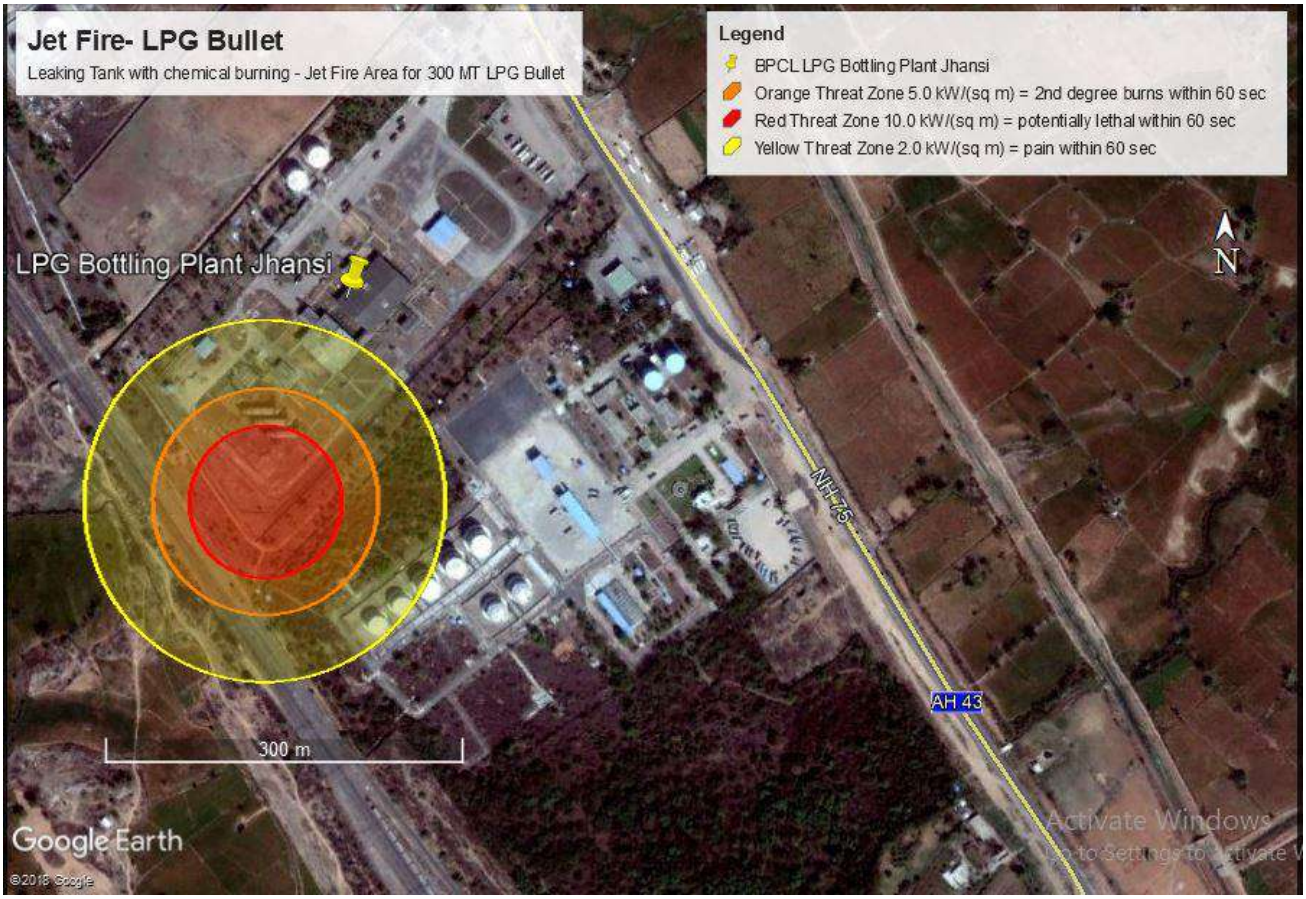



**Figure 7.2: Hazard distances due to Jet Fire in bullet**

## Blast Area

The outcomes Over pressure (blast force) from vapor cloud are presented in Table No-7.9.

**Table No. 7.9: Blast distances due to vapour cloud explosion**

| Sl. No. | Pressure (psi) | Max. Distances (m) |
|---|---|---|
| 1. | 1.0 (Shatters glass) | 464 |
| 2. | 3.5 (likely serious injury) | 262 |
| 3. | 8.0 (destruction of buildings) | LOC was never exceeded |

From the above table it is evident that the hazard distance to heavy damage i.e. overpressure of 3.5 psi may extend upto a max distance of 262 in case of failure due to a blast. The figure showing the threat zones is given below in **Figure 7.3.**

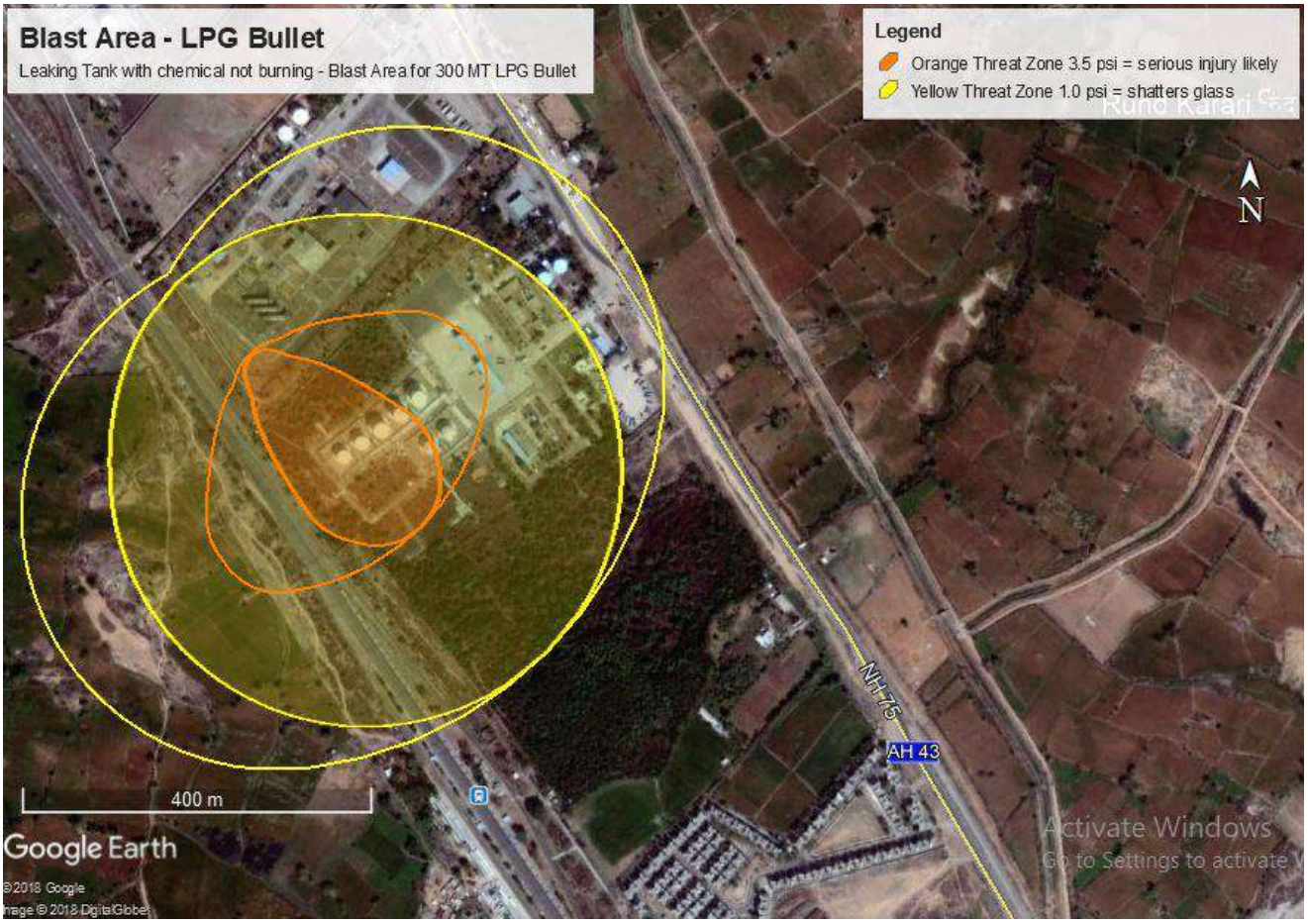



**Figure 7.3: Blast distances due to vapour cloud explosion**

## Flammable Threat Zone

The results showing the flammable area of the vapour cloud's threat zone occurring in an event gas leaking from the bullet are presented in Table no.-7.10.

**Table No. 7.10: Flammable Area Vapor Cloud**

| Sl. No. | Pressure (psi) | Max. Distances (m) |
|---|---|---|
| 1. | 2100 ppm = 10% LEL | 1100 |
| 2. | 12600 ppm = 60% LEL (Flame Pockets ) | 427 |

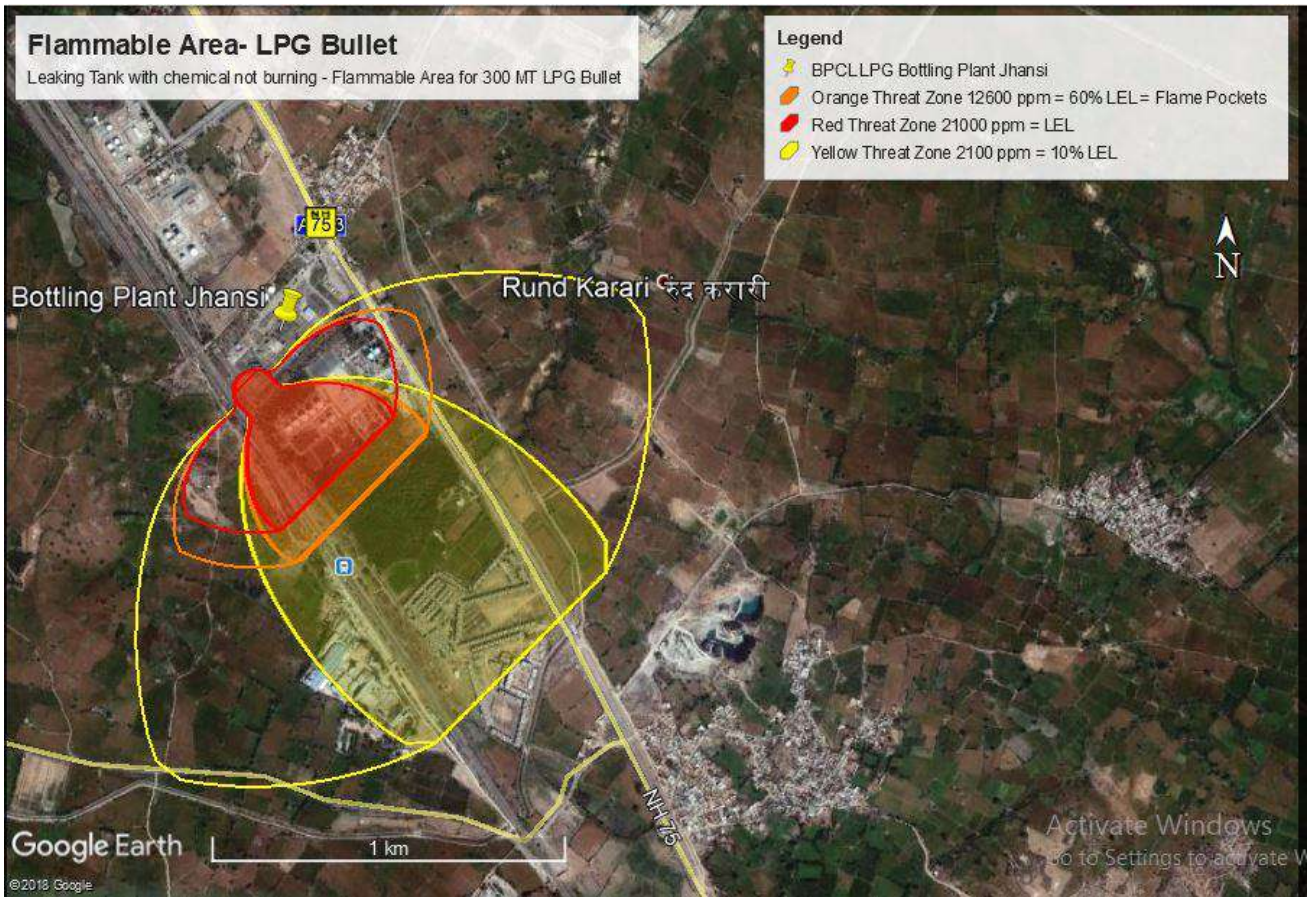



**Figure 7.4: Flammable Area Vapor Cloud**

## Toxic Area

The results showing the toxic area of the vapour cloud's threat zone occurring in an event gas leaking from the bullet are presented in Tables-7.11

**Table No. 7.11: Flammable Area Vapor Cloud**

| Sl. No. | Pressure (psi) | Max. Distances (m) |
|---|---|---|
| 1. | 33000 ppm = AEGL-3 (60 Min) | 258 |
| 2. | 17000 ppm = AEGL-2 (60 Min) | 367 |
| 3. | 5500 ppm = AEGL-1 (60 Min) | 649 |

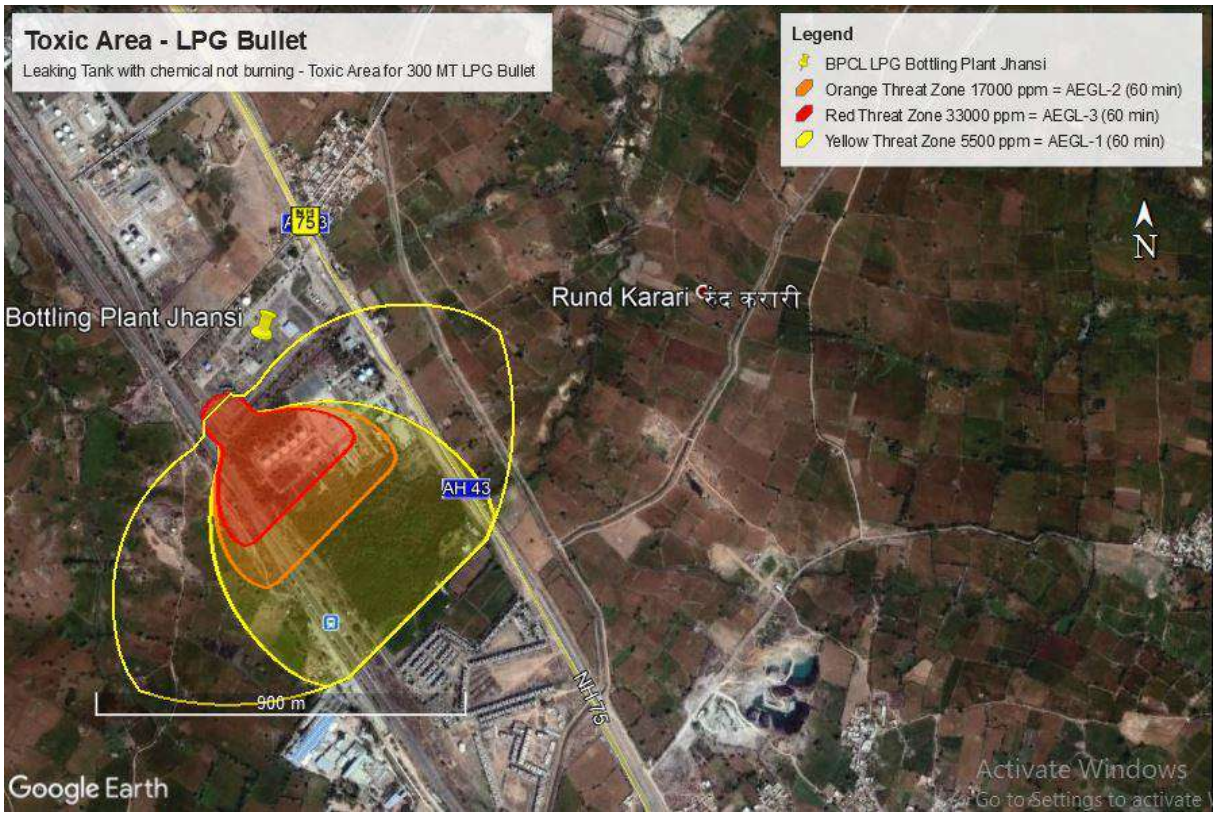



**Figure 7.5: Toxic Area**

## 7.5 RISK ASSESSMENT SUMMARY

The preliminary risk assessment has been completed for the LPG Storage / Bottling plant and associated facilities and the broad conclusions are as follows:

- There will be significant community impacts or environmental damage consequences if proper mitigation and management plan are not taken up. The population residing within 1 km from the plant should be evacuated in case of worst scenario.
- However, as far as fire consequences are concern the vulnerable area is restricted with the site and its immediate surroundings, the workers need to be evacuated.

- The hazardous event scenarios and risks at this facility reveals that the hazard rating is moderate to severe and can be adequately managed to acceptable levels by performing the recommended safety guidelines /studies as part of detailed design, applying recommended control strategies and implementing a Safety Management System which is already available and being implemented at site.

The overall summary of the consequence analysis is given in table 7.12 below:

**Table No. 7.12: Summary of Consequence Analysis**

| Sl. No. | Scenarios | Type | Consequence | Max. Hazard Distance (m) |
|---|---|---|---|---|
| 1. | Catastrophic Failure of 300 MT A/G Bullet | Non-Credible | Thermal Radiation due to Jetfire (10. 0 KW/$m^2$) | 68 |
| | | | 3.5 psi (likely serious injurious) | 262 |
| | | | Vapour Cloud - 33000 ppm | 258 |

### 7.5.1 Risk reduction / mitigation measures

The following opportunities will be considered as a potential means of reducing identified risks during the detailed design phase:

- Buildings and plant structures designed for cyclone and seismic events (where appropriate), to prevent structural collapse and integrity of weather (water) proofing for storage of dangerous goods;
- Provision for adequate water capacity to supply fire protection systems;
- Isolate people from load carrying/mechanical handling systems, vehicle traffic and storage and stacking locations;
- Containment of hazardous materials as per recommended standards;
- Security of facility to prevent unauthorized access to plant, introduction of prohibited items, and control of onsite traffic; and
- Development of emergency response management systems commensurate with site specific hazards and risks (fire, rescue and first aid).
- Gas detectors and alarm system to be provided at all areas if required as per HAZOP as major leak due to rupture may lead to LPG release.

- Fire extinguishers in the high-pressure section would be tested periodically and would always be kept in operational mode.
- Gas monitoring system should be monitored round the clock and interlocking system should be provided and maintained properly to close the system when need arises to control LPG release from various sections.

## 7.6 EMERGENCY ACTIONS FOR DIFFERENT SCENARIOS

### 7.6.1 Tank lorry decantation area

**1 IN CASE OF LPG LEAKAGE WITH OUT FIRE**

- Take immediate steps to stop LPG Leakage and raise alarm simultaneously.
- Initiate action as per the Fire Order, Disaster Management Plan.
- Stop all the operations & ensure closure of ROVs & Isolation Valves
- All efforts should be made to contain spread of leakage
- Saving of human life shall be of highest priority in comparison to stocks/assets
- Plant personnel without specific duties to assemble at nominated place
- All vehicles except those required for emergency use should be moved away as per the pre-nominated route.
- Electrical system except for control supplies, utilities, lighting & Fire Fighting System to be isolated.
- Start water spray system for dispersing of leaked LPG
- If the escaping vapors cannot be stopped, jet of water should be directed at the point of leakage to assist control release of vapour and water fog should be for dilution and rapid dispersion of vapour cloud.
- Personal Protective Equipment such as Low Temperature Suit, Fire Proximity Suit to be used for closing the Isolation Valves for stopping the LPG Leakage.
- In case of leakage from the Safety Relief Valve (SRV), cooling of the vessel to be continued.
- In case of spilled LPG liquid/vapours is contained in the Drain Channel or any enclosure, ensure that the drain valves are closed, so that the liquid/vapour does not move outside the Plant enclosures.
- All efforts should be made to avoid any source of ignition
- Ensure that static charge is not generated in the LPG vapour cloud
- Block all roads in adjacent area and contact Police for support and traffic control

- Contact local Fire Brigade and Mutual Aid Members.

## 2 IN CASE OF LPG LEAKAGE WITH FIRE

- Take immediate steps to stop LPG Leakage/Fire using DCP Fire Extinguishers, water spray and raise alarm simultaneously.
- Initiate action as per the Fire Order /Disaster Management Plan.
- Stop all the operations & ensure closure of ROVs & Isolation Valves
- All efforts should be made to contain spread of leakage & Fire
- Saving of human life shall be of highest priority in comparison to stocks/assets
- Plant personnel without specific duties to assemble at nominated place
- All vehicles except those required for emergency use should be moved away as per the pre- nominated route
- Electrical system except for control supplies, utilities, lighting & Fire Fighting System to be isolated
- Start water sprinkler spray system immediately for cooling of the vessels/affected area
- Start without delay the fixed water spray system through monitors, hydrants for cooling the vessel/affected areas for reducing the over pressurization
- Start water spray system at the nearby areas or exposed to fire risks also.
- If the feed to the fire can't be cut off, the fire must be controlled and not extinguished.
- Personal Protective Equipment such as Fire Entry Suit, Fire Proximity Suit to be used for closing the Isolation Valves for stopping the feed to the fire.
- Fire Fighters should advance towards fire down wind if possible.
- In case of leakage from the Safety Relief Valve (SRV), cooling of the vessel to be continued.
- In case of fire contained in the Drain Channel or any enclosure, ensure that the drain valves are closed, so that the fire does not move outside the Plant premises.
- Any rapid increase in pressure or noise level through Safety Relief Valve should be treated as a warning of over pressurization. In such cases all personnel should be evacuated immediately.
- Block all roads in adjacent area and contact Police for support and traffic control
- Contact local Fire Brigade and Mutual Aid Members

- If the situation is out of control and there is possibility of damaging/bursting of the storage vessels (BLEVE) the best way is to evacuate the area and implement off site Plan in consultation with the Local Administration.

### 7.6.2 LPG bullet storage area

#### A. IN CASE OF LPG LEAKAGE WITH OUT FIRE

- Take immediate steps to stop LPG Leakage and raise alarm simultaneously.
- Initiate action as per the Fire Order /Disaster Management Plan.
- Stop all the operations & ensure closure of ROVs & Isolation Valves
- All efforts should be made to contain spread of leakage
- In case of leakage through any fittings of the vessel viz., sharing of the pipe line, valve failure, gasket failure, thermo-well failure water shall be pumped into the vessel, so that leakage can be arrested.
- Saving of human life shall be of highest priority in comparision to stocks/assets
- Plant personnel without specific duties to assemble at nominated place
- All vehicles except those required for emergency use should be moved away as per the pre- nominated route
- Electrical system except for control supplies, utilities, lighting & Fire Fighting System to be isolated
- Start water spray system for dispersing of leaked LPG
- If the escaping vapors cannot be stopped, jet of water should be directed at the point of leakage to assist control release of vapour and water fog should be for dilution and rapid dispersion of vapour cloud.
- Personal Protective Equipment such as Low Temperature Suit, Fire Proximity Suit to be used for closing the Isolation Valves for stopping the LPG Leakage.
- In case of leakage from the Safety Relief Valve (SRV), cooling of the vessel to be continued.
- In case of spilled LPG liquid/vapours is contained in the Drain Channel or any enclosure, ensure that the drain valves are closed, so that the liquid/vapour does not move outside the Plant enclosures.
- All efforts should be made to avoid any source of ignition
- Ensure that static charge is not generated in the LPG vapour cloud
- Block all roads in adjacent area and contact Police for support and traffic control
- Contact local Fire Brigade and Mutual Aid Members

## B. IN CASE OF LPG LEAKAGE WITH FIRE

- Take immediate steps to stop LPG Leakage/Fire using DCP Fire Extinguishers, water spray and raise alarm simultaneously.
- Initiate action as per the Fire Order,' Disaster Management Plan.
- Stop all the operations & ensure closure of ROVs & Isolation Valves
- All efforts should be made to contain spread of leakage & Fire
- Saving of human life shall be of highest priority in comparision to stocks/assets
- Plant personnel without specific duties to assemble at nominated place
- All vehicles except those required for emergency use should be moved away as per the pre- nominated route
- Electrical system except for control supplies, utilities, lighting & Fire Fighting System to be isolated
- Start water sprinkler spray system immediately for cooling of the vessels/affected area
- Start without delay the fixed water spray system through monitors, hydrants for cooling the vessel/affected areas for reducing the over pressurization
- Start water spray system at the near by areas or exposed to fire risks also.
- If the feed to the fire can't be cutoff, the fire must be controlled and not extinguished.
- Personal Protective Equipment such as Fire Entry Suit, Fire Proximity Suit to be used for closing the Isolation Valves for stopping the feed to the fire.
- Fire Fighters should advance towards fire down wind if possible.
- In case of leakage from the Safety Relief Valve (SRV), cooling of the vessel to be continued.
- In case of fire contained in the Drain Channel or any enclosure, ensure that the drain valves are closed, so that the fire does not move outside the Plant premises.
- Any rapid increase in pressure or noise level through Safety Relief Valve should be treated as a warning of over pressurization. In such cases all personnel should be evacuated immediately.
- Block all roads in adjacent area and contact Police for support and traffic control
- Contact local Fire Brigade and Mutual Aid Members
- If the situation is out of control and there is possibility of damaging/ bursting of

the storage vessels (BLEVE) the best way is to evacuate the area and implement off site Plan in consultation with the Local Administration.

### 7.6.3 LPG pump house area

**A. IN CASE OF LPG LEAKAGE WITH OUT FIRE**

- Take immediate steps to stop LPG Leakage and raise alarm simultaneously.
- Initiate action as per the Fire Order;' Disaster Management Plan.
- Stop all the operations & ensure closure of ROVs & Isolation Valves
- All efforts should be made to contain spread of leakage
- Saving of human life shall be of highest priority in comparison to stocks/assets
- Plant personnel without specific duties to assemble at nominated place
- All vehicles except those required for emergency use should be moved away as per the pre nominated route
- Electrical system except for control supplies, utilities, lighting & Fire Fighting System to be isolated
- Start water spray system for dispersing of leaked LPG
- If the escaping vapors cannot be stopped, jet of water should be directed at the point of leakage to assist control release of vapour and water fog should be for dilution and rapid dispersion of vapour cloud.
- Personal Protective Equipment such as Low Temperature Suit, Fire Proximity Suit to be used for closing the Isolation Valves for stopping the LPG Leakage.
- In case of spilled LPG liquid/vapours is contained in the Drain Channel or any enclosure, ensure that the drain valves are closed, so that the liquid/vapour does not move outside the Plant enclosures.
- All efforts should be made to avoid any source of ignition
- Ensure that static charge is not generated in the LPG vapour cloud
- Block all roads in adjacent area and contact Police for support and traffic control
- Contact local Fire Brigade and Mutual Aid Members

**B. IN CASE OF LPG LEAKAGE WITH FIRE**

- Take immediate steps to stop LPG Leakage/Fire using DCP Fire Extinguishers, water spray and raise alarm simultaneously.
- Initiate action as per the Fire Order, Disaster Management Plan.
- Stop all the operations & ensure closure of ROVs & Isolation Valves
- All efforts should be made to contain spread of leakage & Fire
- Saving of human life shall be of highest priority in comparison to stocks/assets
- Plant personnel without specific duties to assemble at nominated place
- All vehicles except those required for emergency use should be moved away as per the pre nominated route
- Electrical system except for control supplies, utilities, lighting & Fire Fighting System to be isolated
- Start water sprinkler spray system immediately for cooling of the vessels/affected area
- Start without delay the fixed water spray system through monitors, hydrants for cooling the vessel/affected areas for reducing the over pressurization
- Start water spray system at the near by areas or exposed to fire risks also.
- If the feed to the fire can't be cut off, the fire must be controlled and not extinguished.
- Personal Protective Equipment such as Fire Entry Suit, Fire Proximity Suit to be used for closing the Isolation Valves for stopping the feed to the fire.
- Fire Fighters should advance towards fire down wind if possible.
- In case of fire contained in the Drain Channel or any enclosure, ensure that the drain valves are closed, so that the fire does not move outside the Plant premises.
- Block all roads in adjacent area and contact Police for support and traffic control
- Contact local Fire Brigade and Mutual Aid Members

### 7.6.4 LPG filling/filled shed area

**A. IN CASE OF LPG LEAKAGE WITH OUT FIRE**

- Take immediate steps to stop LPG Leakage and raise alarm simultaneously.
- Initiate action as per the Fire Order,' Disaster Management Plan.
- Stop all the operations & ensure closure of ROVs/Isolation Valves/Emergency Shut-off valves.
- All efforts should be made to contain spread of leakage

- Saving of human life shall be of highest priority in comparison to stocks/assets
- Plant personnel without specific duties to assemble at nominated place
- All vehicles except those required for emergency use should be moved away as per the pre- nominated route.
- Electrical system except for control supplies, utilities, lighting & Fire Fighting System to be isolated
- In case of leakage from the cylinder, the same should be approached from upwind and be removed to a safe remote place from the sources of ignition and safety cap should be placed on the cylinder valve to prevent further leakage.
- Start water spray system for dispersing of leaked LPG .
- If the escaping vapors cannot be stopped, jet of water should be directed at the point of leakage to assist control release of vapour and water fog should be for dilution and rapid dispersion of vapour cloud.
- Personal Protective Equipment such as Low Temperature Suit, Fire Proximity Suit to be used for closing the Isolation Valves for stopping the LPG Leakage.
- In case of spilled LPG liquid/vapours is contained in the Drain Channel or any enclosure, ensure that the drain valves are closed, so that the liquid/vapour does not move outside the Plant enclosures.
- All efforts should be made to avoid any source of ignition
- All efforts should be made to avoid any source of ignition
- Ensure that static charge is not generated in the LPG vapour cloud
- Block all roads in adjacent area and contact Police for support and traffic control
- Contact local Fire Brigade and Mutual Aid Members

## B. IN CASE OF LPG LEAKAGE WITH FIRE

- Take immediate steps to stop LPG Leakage/Fire using DCP Fire Extinguishers, water spray and raise alarm simultaneously.
- Initiate action as per the Fire Order / Disaster Management Plan.
- Stop all the operations & ensure closure of ROVs & Isolation Valves
- All efforts should be made to contain spread of leakage & Fire
- Saving of human life shall be of highest priority in comparison to stocks/assets
- Plant personnel without specific duties to assemble at nominated place
- All vehicles except those required for emergency use should be moved away' as

per the pre- nominated route

- Electrical system except for control supplies, utilities, lighting & Fire Fighting System to be isolated
- If a filled cylinder is involved in fire, internal pressure shall raise and rupture of cylinder may happen. No attempt should be made to extinguish the burning gas, but the nearby cylinders shall be kept cool by water spray.
- Start water sprinkler spray system immediately for cooling of the vessels/affected area
- Start without delay the fixed water spray system through monitors, hydrants for cooling the affected areas/surrounding cylinders to avoid bursting of cylinders
- Start water spray system at the nearby areas or exposed to fire risks also.
- If the feed to the fire can't be cut off, the fire must be controlled and not extinguished.
- Personal Protective Equipment such as Fire Entry Suit, Fire Proximity Suit to be used for closing the Isolation Valves for stopping the feed to the fire.
- Fire Fighters should advance towards fire downwind if possible.
- In case of fire contained in the Drain Channel or any enclosure, ensure that the drain valves are closed, so that the fire does not move outside the Plant premises.
- Block all roads in adjacent area and contact Police for support and traffic control
- Contact local Fire Brigade and Mutual Aid Members
- If the situation is out of control and there is possibility of damaging/bursting of the cylinder (BLEVE) the best way is to evacuate the area and implement off site Plan in consultation with the Local Administration.

## 7.7 PREVENTIVE MEASURES FOR LEAKAGES AND ACCIDENT

Safety precautions and preventive measures have been incorporated right from the design/selection of the equipment, lay-out of facilities, construction of the plant and compliance with various statutory rules and regulations. Based on the experience over a period of time, safe operating practices have been envolved. Strict adherences to these are ensured at LPG Bottling Plant.

1. **Statutory Rules and regulations**

The present guidelines for plant design and layout of the facilities are prepared taking into account provision of the following statutory codes/standards:

1. OISD standard 144
2. OISD standard 150
3. SMPV (U) Rules -2016
4. Gas cylinder Rules -2016
5. Relevant ASME/API/BIS Codes
6. Factories Act-1948
7. OISD 118
8. Electrical installation as per IEC standard

## 2. Design

The lay out and various facilities of the plant have been designed in accordance with relevant OISD standards-IS codes, ASME codes, latest NEFA standards etc.

## 3. Design of Plant / Equipment.

All equipments are designed and constructed according to established standards and codes of practice.

## 4. Other Design Features

Some of the other safety features of the plant are as under: -

- All electrical fittings within hazardous zone are flameproof.
- Thermal safety valves are provided on pipeline for relieving excessive pressure in the pipeline.
- Safety relief valves are provided on the pressure vessels for relieving excessive pressure.
- Remote operated valves ( ROVs) are provided on inlet / outlet of storage pressure vessels which can be operated from control panel as well as locally . Also for all in instrument air pressure in case of fire etc. due to melting of thermal fields, ROV will automatically close.
- LPG storage bullets are provided with level indicators, high level alarm and safety relief valves.
- Excess Flow Check Valves (EFCVs) are provided on liquid and vapour pipelines

connected to flexible hoses to close on high velocity flow and rupture of LPG hose.

- Mastic flooring is provided in sheds to avoid generation of spark during handling of cylinders.
- Thermal Detectors; and Q.B. Detectors are provided in storage vessels, filling shed, empty shed, LPG pump shed, CR shed and tank lorry bay to automatically switch on the fire protection system in case of fire / emergency.
- Vapour seal has been provided on the drain near boundary valve to prevent LPG vapour / liquid travel outside the plant.

**5. Other Design Features**

B.P.C.L. has a comprehensive health safety and environmental policy, The Policy reflects and continuing commitment to protect lives and health of employees, safeguard plant and Building and avoid adverse environmental effects.

**6. Safe Operating Practice**

For day-to-day operation, safe operating practices have been formulated for all operations and these are strictly adhered to. Some of them are:

- Periodic statutory testing of cylinders.
- Earthing of all Bulk TTs during unloading.
- Proper stacking / destacking of Cylinders inside the sheds and in Pack Trucks
- Spark arrestors provided entering inside the licensed area of the plant.
- Speed of vehicles inside the plant restricted to 8 Kms. Per hour.

**7. Preventive maintenance**

Regular preventive maintenance is carried out for excellent upkeep of equipment's and reduced downtime. History Cards are maintained for all important equipments.

1 Filling Machines / Check Scales / SQC Scale are checked daily for correctness and regular maintenance done by M/s. A very India Limited under AMC.

2 Testing of all bulk unloading LPG hoses done quarterly along with continuity and elongation test.

3 Hydro-testing of fire Extinguishers, refilling and inspection done every month.

4 Cylinders are hydro-tested initially after 7 years and subsequently after every 5 years.

5 Fire Engines are checked daily by starting and maintenance done as per recommendations of the manufacture by the approved / authorized dealer under AMC.

6 Hydro-testing and inspection of pressure vessels done once in 5 years.

7 Pressure testing of relief valves done once in a year.

8 Electrical Earth Audit done by third party once in a year as per OISD 137 standard and Indian electricity rules.

9 Electrical Earth Test and Continuity Test done once in a year. Dielectric Strength test done on transformer oil once in a year.

10 Interlocking and tripping devices provides inside the plant are checked as and when required.

11 On-stream inspection of all facilities done daily and any deviation are recorded.

**8. Training of Manpower**

Training programmes are conducted regularly for company for employed, contract workmen including Security Guards and PCVO crews to ensure prevention of hazards and competent handling of emergencies. First Aid Training Certificate Course was also conducted by St. Johns Ambulance (Red Cross Society) at our plant for company employees.

**9. Safety Audit**

From time to time, inspections are undertaken by various agencies such as officers from regional office, head office OISD, CCOE, Electrical Inspector and Director of Industrial Safety and Health.

Apart from these, following major audits are undertaken annually.

1. Electrical Safety Audit.
2. Safety Audit As per factory Act
3. Internal Safety Audit

## 7.8 DISASTER MANAGEMENT PLAN

### 7.8.1 Disasters

A disaster is a catastrophic situation in which suddenly, people are plunged into helplessness and suffering and, as a result, need protection, clothing, shelter, medical and social care and other necessities of life.

Disasters can be divided into two main groups. In the first, are disasters resulting from natural phenomena like earthquakes, volcanic eruptions, storm surges, cyclones, tropical storms, floods, avalanches, landslides, forest fires. The second

group includes disastrous events occasioned by man, or by man's impact upon the environment. Examples are armed conflict, industrial accidents, radiation accidents, factory fires, explosions and escape of toxic gases or chemical substances, river pollution, mining or other structural collapses, air, sea, rail and road transport accidents which can reach catastrophic dimensions in terms of human loss.

There can be no set criteria for assessing the gravity of a disaster in the abstract since this depends to a large extent on the physical, economic and social environment in which it occurs. What would be consider a major disaster in a developing country, ill equipped to cope with the problems involved, may not mean more than a temporary emergency elsewhere. However, all disasters bring in their wake similar consequences that call for immediate action, whether at the local, national or international level, for the rescue and relief of the victims. This includes the search for the dead and injured, medical and social care, removal of the debris, the provision of temporary shelter for the homeless, food, clothing and medical supplies, and the rapid re-establishment of essential services.

### 7.8.2 Objectives of Disaster Management Plan [DMP]

The Disaster Management Plan is aimed to ensure safety of life, protection of environment, protection of installation, restoration of production and salvage operations in this same order of priorities. For effective implementation of the Disaster Management Plan, it should be widely circulated and personnel trained through rehearsals/drills.

The Disaster Management Plan should reflect the probable consequential severalties of the undesired event due to deteriorating conditions or through 'Knock on' effects. Further the management should be able to demonstrate that their assessment of the consequences uses good supporting evidence and is based on currently available and reliable information, incident data from internal and external sources and if necessary the reports of outside agencies.

To tackle the consequences of a major emergency inside the plant or in the immediate vicinity of the plant, a Disaster Management Plan has to be formulated and this planned emergency document is called "Disaster Management Plan".

The objective of the Industrial Disaster Management Plan is to make use of the combined resources of the plant and the outside services to achieve the following:

- Effect the rescue and medical treatment of casualties;
- Safeguard other people;
- Minimize damage to property and the environment;
- Initially contain and ultimately bring the incident under control;
- Identify any dead;
- Provide for the needs of relatives;
- Provide authoritative information to the news media;
- Secure the safe rehabilitation of affected area; and
- Preserve relevant records and equipment for the subsequent inquiry into the cause and circumstances of the Emergency.

In effect, it is to optimize operational efficiency to rescue, rehabilitate and render medical help and to restore normalcy.

### 7.8.3 Emergencies

1 **General, Industrial, Emergencies**

The emergencies that could be envisaged in the plant and fuel storage are as follows:

- A situation of fire at the LPG Plant;
- A situation of fire at the tank farm of all storages;
- Slow isolated fires;
- Fast spreading fires;
- Structural failures;
- Contamination of food/water; and
- Sabotage/Social disorder.

**2 Specific Emergencies Anticipated**

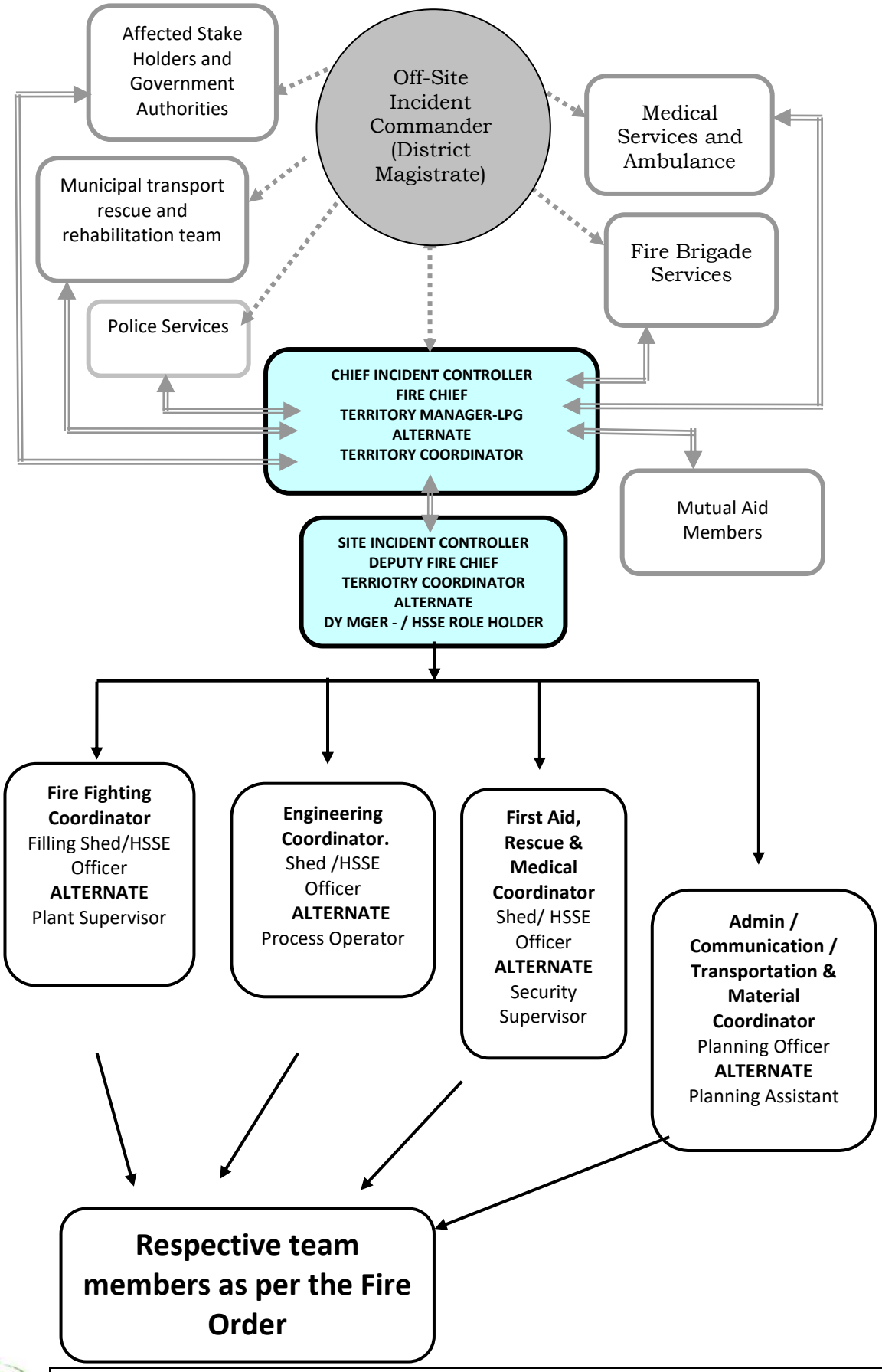
**Fire and Explosion**

Fire consequences can be disastrous, since they involve huge quantities of chemicals either stored or in dynamic inventory in pipe lines or in nearby areas. Preliminary hazard analysis has provided a basis for consequence estimation. Estimation can be made by using various pool fire, tank fire, BLEVE, UCVE consequence calculations. During the study of Risk Assessment, the nature of damages is worked out and probability of occurrence of such hazards is also drawn up.

### 7.8.4 Emergency Organization

No plan will succeed without effective emergency organization. Emergency organization is a part and parcel of a good On Site & Off-Site Emergency Plan, without which all resources, facilities etc., even available with us can't be put into service at a right time, and time is the key factor in tackling an emergency. As it is not possible to envisage & detail every action which should be taken in emergency and to harness the basic elements of emergency preparedness such as risk of emergency, communication of information, action on site for both process & emergency controls, assessment of mobilization of internal & external resources for fire & toxicity control, warning people at right time, evacuation, medical preparedness, pollution control etc. Emergency organization is set up specifying duties & responsibilities of all to make best use of all resources and to avoid confusion and to tackle the emergency in its incipient stage thereby minimizing the damage to property & neighboring environment. Emergency organization chart for On-site & Off-site Emergency is given below.

## ON AND OFF SHIFT FIRE ORDER FLOW CHART



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**Note:**

(1) Above is a typical and basic Organogram for control of emergency. Entity can merge the functions as per their other statutory requirements and based on level of risk and range of operations. The organization shall have to address all services and support system required and available to it.

(2) Support Services Include Communication Services, Engineering/Maintenance Services, Medical and Occupational Health, Human Resource and Welfare Service, Security, Media/Public Relations, Transport and Logistics, Finance, Contract and Procurement and Environmental Services.

(3) Role of both CIC and SIC can be merged depending upon the requirement.

**EMERGENCY ORGANISATION INCLUDES**

- Territory Manager/ Territory Co-ordinator
- Deputy Fire Chief Coordinator (Safety Officer)
- Fire Fighting Coordinator (Filling Shed Officer)
- Rescue, Medical, Communication & Transportation Coordinator (Planning Officer)
- Engineering & Utilities Coordinator (Engineering Officer)

## 1 DUTIES & RESPONSIBILITIES

### A. FIRE CHIEF CO-ORDINATOR

He is the final authority for implementation of the plan.

- Assess the magnitude of the situation and declare state of emergency.
- Declare the danger zone and set up on Emergency Control room at Gate II
- Mobilize co-coordinators and exercise direct operation control of areas, other than those affected.

- Activate DCMP & ensure implementation.
- Inform all statutory authorities; mutual aid members, emergency organization, territory officer and regional officer, Co. about the magnitude of the disaster, causalities & resume operation.
- Vet information for conveying to Press, Radio, TV etc. will advise about the possible impact on the surroundings.
- Authorize procurement of emergency material.
- Presence material evidence for investigation purpose.
- Log important developments.
- Authorize evacuation of people from the vicinity of the plant.
- To determine and declare all clear.

**B. DEPUTY FIRE CHIEF CO-ORDINATOR (SAFETY OFFICER)**

1. Supervise firefighting activities at the site of emergency.
2. Supervise medical support.
3. Mobilize co-coordinators and exercise direct operation control of areas, other than those affected.
4. Activate DCMP & ensure implementation.
5. Inform all statutory authorities; mutual aid members, emergency organization, territory officer and regional officer, Co. about the magnitude of the disaster, causalities & resume operation.
6. Shall advice group leaders to organize rescue operations on need basis affected people to safe zone.
7. Raise Indent for procurement of emergency material.
8. Presence material evidence for investigation purpose.
9. Log important developments.
10. Initiate for the evacuation of people from the vicinity of the plant.
11. Make coordination with Fire Chief and leaders to control the emergency situation.

**C. FIRE FIGHTING CO-ORDINATOR (FILLING SHED OFFICER)**

1. Mobilize the fire fighting crew and coordinate the fire operations
2. Implement DCMP in consultation with chief coordinator.
3. Effectively deploy manpower both internal and external
4. Demarcate danger and safe zones by putting Red and Green Flags
5. Monitor the requirements of firefighting equipment and coordinate for procurement of spares
6. Arrange flood lighting of the affected area and de-watering of the fire fighting area if required
7. Arrange replacement of various fire fighting squads from mutual and external aid members on need basis
8. Direct and utilize the fire brigade personnel on need basis
9. To assume the role of chief co-coordinator in his absence.

**D. RESCUE, MEDICAL, COMMUNICATION & TRANSPORTATION CO-ORDINATOR**
**(PLANNING OFFICER)**

1. Initial rescue operation and log causalities.
2. Activate the medical center and mobilize the medical team.
3. Arrange ambulance and, transfer the casualties to hospital
4. Arrange food, water etc for all those involved in fire fighting
5. Arrange for refreshment at the evacuation center if required

6 Provide first Aid & remove injured persons.

7 Organize search team for people not traceable.

8 Divide and give safe routes to lorries and rescue personnel's

10. Liaise with various co-coordinators and monitor emergency control activities.
11. Take over charge of entire communications i.e. external & internal.
12. Check whether all coordinators, have taken up position & inform chief.
13. Arrange distribution of VHF sets to coordinator.
14. Inform Police, Hospitals etc. in consultation with chief.
15. Ensure all lorries are parked in safe area.

16. Regulate the traffic inside the location
17. Mobilize the transport, required by various co-ordinators
18. Control and disperse the crowd from disaster site
19. Monitor, arrange and supply all fire fighting equipments/necessary spares etc

## E. ENGINEERING & UTILITIES CO-ORDINATOR (ENGINEERING OFFICER)

1. Liaise with all coordinators to extend technical help.
2. Ensure that the ring main pressure is maintained
3. Keep raising the siren in DISASTER Mode.
4. Switch off main instruments shut off valves on product pipelines and isolate the affected area.
5. Stop all operation / activities at the LPG pump house.
6. Ensure all ROVs are closed.
7. Ensure that Power is cut off.
8. Ensure that all engineering & maintenance activities have stopped and contractor staff has assembled at fire pump house.
9. Assess water level in reservoir and arrange for replenishment in advance.

## 2. ASSEMBLY POINTS

- In affected and vulnerable Deptt., all non essential technical workers (who are not assigned any emergency duty) shall evacuate the area & proceed to assembly points located near Weigh Bridge/Gate 2. The need to evacuate non - essential technical workers will be determined by the severity of emergency and the foreseeable rate at which the incident may escalate.
- The workers of Tank Lorries & Trucks shall assemble at GATE – II.
- First Aid centre – Workers rest Room will be another assembly point for the affected persons.
- Security Inspector / Guards will be available round the clock. They will record the names and departments of those reporting to the assembly points.

## 3. EMERGENCY CONTROL ROOM

The Emergency Control Room is the place from which the operations to handle the emergency are directed and co-coordinated. It will be attended by the Main Incident Controller, Factory Inspectorate, District authorities and emergency services.

Office of S&F Officials is the Emergency Control Room (ECR). All communication facilities are provided in ECR. It is manned round the clock by Fire Personnel.

Our ECR is situated in an area of minimum risk and close to the road for easy access.

**THE ECR SHOULD CONTAIN**

1.External telephones facility. The latest telephone directory.

2.Internal telephones, walkie-talkies, Wireless communication set.

3.List of telephone nos. of MAS members & Key personnel.

4.Plans of the factory to show:

a. Location of the hazardous plants/areas.

b. Location of sirens

c. The firewater system and additional sources of water.

d. Assembly points and canteen.

e. Factory Medical Unit

f. Location of the factory with respect to the surrounding community.

5. Note pads, pens, pencils, rubber and stationery to record all messages received and sent by whatsoever means.
6. More copies of this on site & offsite emergency plan.
7. Torches, raincoats & personnel protective Appliance.
8. Copy of DCMP
9. Copy of Fire Order
10. Explosive meter

## 7.8.5 FIRE CONTROL ARRANGEMENTS

Jhansi LPG Plant is constructed on a total plot area of 26 acre (10.52ha.) out of which around (2.96 ha. - existing + 0.84 ha. proposed) is the Plant area and 3.56 ha. is the green belt area.

The proposed bottling capacity of the plant is 3x300(900) MT and the existing total bulk storage is 150MT. The bulk LPG is received by Road Bulk TTs.

We have 1x (carousel) i.e. 24 Nos. of Electronic Manual Filing machines each to fill 14.2 Kg cylinders and 19 Kg cylinders

### A. Firefighting facilities

The Plant is fully equipped with most modern / latest fire fighting facilities. We shall be having automatic Fire Protection medium velocity sprinkler system. Details are as follows :

- Tank Lorry Bay/Storage Vessels / filling, filled, empty LPG pump, CR sheds are having Quartzoid Bulb Detectors (QBDs) and Thermal detector which will actuate the sprinkler system automatically in case of fire.
- We have Fire Pump with 2Nos. Diesel Fire Engine Pumps of capacity 616 KL per hour each and 3 nos(2 Main + 1 standby.
- The Fire Hydrant system is always kept at the Flow rate of 36 Kl/Hr per mouth by electric Jockey Pumps.
- We have Water Storage capacity of 2 nos. X 2600 KL (A/G Tank) for fighting fire in case of most credible accident.
- As per OISD 115 (Guidelines on Fire Fighting Equipment and Appliances in Petroleum Industry) We are having 10 Kg. and 75 Kg. DCP Fire Extinguishers placed around the plant. Also, $CO_2$ Fire Extinguishers are placed wherever required as per standard.

THE FACILITIES PROVIDED ARE AS FOLLOWS:

a) Hydrants : 25 Nos.

b) Monitors : 20 Nos.

c) Deluge valves : 14 Nos.

Water replenishment is done through bore well.

## 7.8.6 Medical arrangements

**Within the Plant**

First Aid facilities has been provided inside the plant at the following locations;

- Filling Shed
- Administrative Block

In addition to this, first aid boxes and stretchers are available at Fire Water Pump House to be used during Emergency and Evacuation.

## Outside the Plant

| | | |
|---|---|---|
| 1. | Primary Health Centre | 850m |
| 2. | District Hospital Jhansi | 13 Km |
| 3. | Meva Chaudhary Memorial | 11.0 km towards South East |
| 4. | Maa Sherawali Hospital | 18 km towards South East |

**Transport and evacuation arrangements**

Fire Rescue Team will provide necessary first aid at site to the affected persons and bring them on stretchers to the medical aid center located in near vicinity of the plant. One Officer designate (Planning Officer) will coordinate transfer of persons and records details.

Transport Officer designate (Planning Officer) shall arrange to move the affected persons to the hospital.

**Evacuation centers**

If people in the neighboring village are affected, their evacuation will be done by POLICE. The Police will also arrange for guarding the property, shelter, and food for the affected people. After the emergency situation has been controlled, the Police will make arrangement to take the people back to their residence. For providing Shelter to affected persons we have to provide necessary assistance in case of an emergency.

| Place | Distance | Facilities |
|---|---|---|
| Jhansi | 1500m | Large open area which can accommodate 10000 persons |

## 7.8.7 EMERGENCY COMMUNICATION SYSTEM

For the purpose of ON-SITE and OFF-SITE Emergency Plan, we should have quick and effective communication system to make the emergency known to everybody concerned.

We have quick and efficient communication system which is kept always in readiness to make the emergency known

- Inside the factory
- To key personnel outside after normal working hrs.
- To the outside emergency services and authorities.
- To neighboring factories and public in vicinity.

The communication system beginning with raising the alarm, declaring the major emergency and procedure to make it known to others is explained below in brief:

- **Raising the siren making the emergency known**
- **Detection of an emergency**

  All the departments are provided with internal telephones/ external telephones, the plant control rooms.

  Field operator of the plant, while taking round of the plant, can easily notice an untoward incident that has taken place. He by virtue of his close association with his plant will be able to convey the message through internal telephone very promptly & clearly. In case he can't convey the message through above said communication media, he can rush to the control room & inform shift in charge of the plant.

  In case other persons detect about the emergency, they will communicate to officer in charge or Security department & Security department in turn communicate to concerned plant control room.

- **Information and warning**

  After detection of an emergency it is very much essential to have the communication in three tiers as follows:

  - To the emergency services department like Fire, Safety, Security, Medical, etc.
  - To the neighboring plants/departments.
  - To the Plant Manager & above of the plant under emergency.

For this we have already assigned this responsibility to the Supervisor/Senior Operator/panel operator/field operator of the sections which will not likely to be affected due to emergency.

For quick information to Fire, we have Fire alarm system which will help in taking early fire fighting measures by Fire Services.

- **Other communication facilities**

We have fixed wireless system available with Security, Safety & Fire and Utility Services department. Moreover, our Fire tenders are equipped with wireless. Sr. Executives and key personnel are also provided with Mobile Phones. This will help a lot in emergency communications.

The Fire Tenders equipped with loud phone system and Jeeps with PA systems which can also be utilized for warning / evacuation purpose.

All the communication Media will help in

- Rendering emergency help quickly
- Warning & Evacuation
- Medical treatment to the victims which will intern help containing the incident & bring it under control at its incipient stage, minimize the damage to property & neighboring environment & safeguard the human lives.

- **Siren**

When the area of plant site and the number of installations are more, siren has to be installed for general communication media. It can be used for declaring the ON SITE as well as OFF SITE major emergency and making the major emergency known to the people. Siren will not communicate about the emergency to the plant personnel only but also to the surrounding areas.

All the sirens are operated on automatic mode. It has facility to blow the siren as follows:

**On - Site Emergency -** FIRE SIREN = 2 MINUTE WAILING

**Disaster - Off site Emergency -** DISASTER SIREN = 2 MINUTE WALING / 10 SEC STOP AND REPEAT AGAIN ATLEAST 3 TIMES.

**Close of emergency -** CLEAR SIREN = 2 MINUTE STRAIGHT SIREN

- **Internal telephones**

  All plant control rooms, electrical substations, maintenance sheds, Instrument, Civil & all emergency services department, all 'offices / sections / units / departments' are connected with Internal telephone network which act as easy & immediate means of communication.

- **External telephones**

  We have mutual aid scheme with nearby industries along with Municipal Corporation etc. for obtaining their help in fire fighting & toxicity control for which external telephones facility with them is very much essential. External telephones with Govt. Offices, Factory Inspectorate offices etc are also very essential for getting advice, guidance & help from them.

  All senior officers have been provided with the external telephone connections in their offices as well at their residences along with mobile phone.

  List of Internal & external telephones are given below.

| S.No. | NAME | DESIGNATION | Mobile no. |
|---|---|---|---|
| 1. | Nishant Kumar | Territory Manager | 7044075460 |
| 2 | Ajay Patel | Territory Coordinator | 7617007261 |
| 3. | Mahesh Chand Kumawat | Asst. Manager -Operation | 961609955 |
| 4. | Tarsem Chand Ragho | Executive -Operation | 9454310577 |
| 5. | Rahul Chandel | Management Trainee | 9816158218 |
| 6. | Anil Halvi | Management Trainee | 7678367583 |
| 7. | Deependra Varma | Management Trainee | 8574715183 |
| 8. | Varun Singh | Manager Sales | 9720600521 |
| 9. | Adarsh Shukla | Executive Sales | 979523388 |

**Jhansi STD Code : 0510**

**Important Telephone Numbers**

| Name | | Designation | Office | Residence |
|---|---|---|---|---|
| 01 | Commissionary | Commissioner, Jhansi Division | 2443313 (O)<br>2443311 Fax | 2443310 (R)<br>2452500 (R) |
| 02 | Collectorate & Others | D.M. Camp. Office | 2470556 (O)<br>2333348 Fax | 2443324 (R)<br>2331520 (R) |
| | | Chief Development Officer | 2440335 (O) | 2447799 (R) |
| | | ADM | 2470630 (O) | 2443325 (R) |
| | | City Magistrate | 2470553 (O) | 2443322 (R) |
| | | Dist. Information Officer | 2441334 (O) | - |
| 03 | J D A | Secretary | 2441787 (O) | 2443355 (R) |
| 04 | Health | CMO | 2440521 (O) | 2440225 (R) |
| 05 | Police | D I G | 2333351 (O) | - |
| | | S S P | 2333341 (O | 2333304 (R)<br>2330366 (R) |
| 06 | Emergency Services | Police | 100 | |
| | | Fire Station | 101 | |
| | | Fire Service Police Line | 2471455 | |

- **Declaring the major emergency**

  The declaration of major emergency puts many agencies in action and the running system may be disturbed which may be very costly at times or the consequences may be serious, therefore such declaration should not be decided on whims or immature judgment or without proper thoughts.

  Because of the scale of activities which will be performed after the declaration of a major emergency, it is advisable to restrict the authority to declare it.

  In our case, Chief Coordinator in consultation with Dy. Chief Coordinator will assess the situation & declare emergency.

- **Communication of emergency**

  There should be an effective system to communicate emergency.

- **Inside the factory to the workers**

  The statutory information of the Factories Act is made known to the workers in the form of safety booklet and in safety bulletin so that they can prepare themselves to prevent or control the emergency, such information includes:

1. Hazardous chemicals - their physical & chemical properties, Toxicity & fire & explosion risks.
2. Action in case of fire / explosion or LPG gas released - First Aid etc.
3. Measures to be taken by the workers in case of spillage / leakage of hazardous substances.
4. Role of workers vis-à-vis the emergency of plan of the factory, in particular the evacuation procedures.

- **The outside emergency services and the authorities**

  Once the declaration is made, it is essential that the outside emergency services, if they have not been called in, are to be informed in the shortest possible time.

  We have a facility of wireless connection with following:-

  Communication with Police Commissioner, Medical Superintendent of Hospital, and Director of Industrial Safety & Health etc. can be made with land line and mobile telephones.

- **Neighboring firms and the general public**

  A major emergency may affect areas outside the works. Police with their PA system provided in their jeep will warn the surrounding public.

  Head of the neighboring firms will be informed by Chief Coordinator in case of a major emergency. This can serve a dual purpose (i) to enable them to take prompt action to protect their own employees & to take measures to prevent further escalation of the emergency & (ii) to provide assistance/help to the industry under emergency.

  The statutory information to the general public in which

  1) Hazardous processes carried out in the factory
  2) Hazardous chemicals used / handled / stored in the factory & which can create an emergency
  3) Brief description of the measures to be taken to minimise the risk of such an accident
  4) Material Safety Data Sheets of chemicals.
  5) Measures taken by the occupier to ensure safety & control of physical & health hazards.
  6) Measures to be taken by the workers to ensure safe handling, storage & transportation of hazardous substances.

7) Personal protective equipments required to be used in case of a particular job/emergency.

## 7.9 OFF-SITE EMERGENCY PREPAREDNESS PLAN

The task of preparing the Off-Site Emergency Plan lies with the District Collector; however, the off-site plan will be prepared with the help of the local district authorities. The proposed plan will be based on the following guidelines.

### 7.9.1 Introduction

Off-site emergency plan would follow the on-site emergency plan. When the consequences of an emergency situation go beyond the plant boundaries, it becomes an off-site emergency. Off-site emergency is essentially the responsibility of the public administration. However, the plant management will provide the public administration with the technical information relating to the nature, quantum and probable consequences on the neighboring population.

The off-site plan in detail will be based on those events, which are most likely to occur, but other less likely events, which have severe consequence, will also be considered. Incidents which have very severe consequences yet have a small probability of occurrence would also be considered during the preparation of the plan. However, 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 roles of the various parties who will be involved in the implementation of an off-site plan are described below. Depending on local arrangements, the responsibility for the off-site plan would either rest with the plant management or with the local authority. Either way, the plan would identify an emergency coordinating officer, who would take the overall command of the off-site activities. As with the on-site plan, an emergency control center would be setup within which the emergency coordinating 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:

- In the case of a major fire but without explosion risk, only houses close to the fire are likely to need evacuation, although a severe smoke hazard may require this to be reviewed periodically; and
- If a fire is escalating and in turn threatening a store of hazardous material, 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.
- Although the plan will have sufficient flexibility built in to cover the consequences of the range of accidents identified for the on-site plan, it will cover in detail the handling of the emergency to a particular distance from each major hazard works.

### 7.9.2 Aspects Proposed to be considered in the Off-Site Emergency Plan

The main aspects, which should be included in the emergency plan are:

- **Organization**

  Detail of command structure, warning systems, implementation procedures, emergency control centers. Names and appointments of incident controller, site main controller, their deputies and other key personnel.
- **Communications**

  Identification of personnel involved, communication center, call signs, network, list of telephone numbers.
- **Specialized Knowledge**

  Details of specialist bodies, firms and people upon whom it may be necessary to call e.g. those with specialized fuel knowledge, laboratories.
- **Voluntary Organizations**

  Details of organizers, telephone numbers, resources etc.
- **Fuel Information**

  Details of the hazardous substances stored and a summary of the risk associated with them.
- **Meteorological Information**

  Arrangements for obtaining details of weather forecasts and weather conditions prevailing at that time.

- **Humanitarian Arrangements**

  Transport, evacuation centers, emergency feeding, treatment of injured, first aid, ambulances and temporary mortuaries.

- **Public Information**

  Arrangements for

  (a) dealing with the media press office;

  (b) informing relatives, etc.

- **Assessment of Emergency Plan**

  Arrangements for:

  a) Collecting information on the causes of the emergency;

  b) Reviewing the efficiency and effectiveness of all aspects of the emergency plan.

### 7.9.3 Role of the emergency coordinating officer

The various emergency services would be coordinated by an emergency co-ordinating officer (ECO), who will be designated by the district collector. The ECO would liaison 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 would be passed to a senior local authority administrator or even an administrator appointed by the central or state government. The ECO will be equipped with address and phone numbers of important agencies.

### 7.9.4 Role of the Local Authority

The duty to prepare the off-site plan lies with the local authorities. The emergency planning officer (EPO) appointed should carry out his duty in preparing for a whole range of different emergencies within the local authority area. The EPO should liaison with the plant, to obtain the information to provide the basis for the plan. This liaison should ensure that the plan is continually kept upto 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 should be organized by the EPO.

### 7.9.5 Role of Police

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

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

### 7.9.6 Role of Fire Authorities

The control of a fire should be 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 should also have a similar responsibility for other events, such as explosions. Fire authorities in the region should be apprised about the location of all stores of flammable materials, water and foam supply points, and fire-fighting equipment. They should be involved in on-site emergency rehearsals both as participants and, on occasion, as observers of exercises involving only site personnel.

### 7.9.7 Role of Health Authorities

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

For major fires, injuries should 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.

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 neighboring authorities to be obtained in the event of an emergency.

### 7.9.8 Role of Government Safety Authority

This will be the factory inspectorate available in the region. Inspectors are likely to satisfy themselves that the organization responsible for producing the off-site plan has made adequate arrangements for handling emergencies of all types including major emergencies. They may wish to see well-documented procedures and evidence of exercise undertaken to test the plan.

In the event of an accident, local arrangements regarding the role of the factory inspector will apply. These may vary from keeping a watching brief to a close involvement in advising on operations.

The action plan suggested for control of the off-site emergencies is given in **Table-7.13.**

**Table No.-7.13: Off-Site action plan**

| Sr. No. | Action required to be taken to mitigate disaster by aid giving agency | Responsible agencies for taking action | Equipments/material facilities required at site to mitigate emergency |
|---|---|---|---|
| 1 | Arrangements for evacuation/rescue of persons from zone of influence to predetermined camps | Police Department | Self Breathing apparatus with spare cylinder<br>Vehicle with PA system<br>Transportation for evacuation of people |
| 2 | Caution to public by announcement | - | |
| 3 | Traffic and Mob control by cordoning of the area | - | - |
| 4 | Law & order | - | - |
| 5 | Request to railway authority for keeping the nearest by railway gate open & to stop the up & down trains at the nearest railway station | - | - |
| B1 | Control of fire | District Fire Brigade | Self breathing apparatus with spare cylinders<br>Foam/water fire tenders<br>Gas mask with spare canisters |
| 1 | Scrubbing of the flashed off gas cloud with water curtain | | |
| 2 | To rescue trapped persons | | |

| Sr. No. | Action required to be taken to mitigate disaster by aid giving agency | Responsible agencies for taking action | Equipments/material facilities required at site to mitigate emergency |
|---|---|---|---|
| 3 | If fire is big, keep surrounding area cool by spraying water | | Lime water<br>Neck to toe complete asbestos suit, PVC hand gloves, gumboots, safety goggles |
| 4 | Communication to SEB to continue or cut off electric supply | | |
| 5 | Communication to water supply department for supplying water | | |
| C1 | Medical facilities for affected persons (first aid and treatment) | Hospital and public health | Ambulance with onboard resuscitation unit, first aid, stretchers |
| D1 | Identification of concentration of gas in zone of influence | Pollution control board | Gas detector |
| E1 | Removal of debris and damaged structures | Municipal corporation | Provide bulldozers<br>Provide cranes |
| F1 | Monitor the incoming and outgoing transports | Transport department | Provide traffic police at site<br>Provide emergency shifting vehicles at site<br>Provide stock of fuel for vehicles |
| 2 | Arrange emergency shifting of affected persons and non affected person to specified area | - | - |
| 3 | Arrange diesel/petrol for needed vehicles | - | - |
| G1 | Give all information related to meteorological aspects for safe handling of affected area for living beings | Meteorological Department | Provide wind direction and velocity instruments with temperature measure<br>Mobile van for meteorological parameter measurements |
| 2 | Forecast if any important weather change | | |

| Sr. No. | Action required to be taken to mitigate disaster by aid giving agency | Responsible agencies for taking action | Equipments/material facilities required at site to mitigate emergency |
|---|---|---|---|
| H1 | Representatives of all departments are in the local crisis group; therefore, they are expected to render services available with them. Since it is a group of experts with authority, the mitigating measures can be implemented speedily. The representatives from locals are also there so that communication with local people is easy and quick | Local Crises Group | Must have all resources at hand, specially disaster management plan and its implementation method.<br>All relevant information related to hazardous industry are generally available with crisis group<br>News paper editor is a part of the group so that right and timely media release can be done |
| 2 | The district emergency or disaster control officer is the president and he is used to mock drill etc. so action can be taken in right direction in time | - | |
| I1 | Collector is the President of District Crisis Group therefore all district infrastructure facilities are diverted to affected zone | District Crisis group | All necessary facilities available at district can be made available at affected zone |
| 2 | All other functions as mentioned for local crisis group | - | Control of law and order situation |

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