6 RISK ASSESSMENT AND DISASTER MANAGEMENT PLAN

6.1 Introduction

The risks analysis was carried out in order to prepare the disaster management plan considering following steps:

- System Definition;
- Hazard Identification;
- Initiating Event Frequency Estimation;
- Consequence Analysis;
- Event Outcome Modeling; and
- Risk Summation.

6.2 Consequence Analysis of Hazards

The details of major hazards that are associated with exploratory drilling are

A] Fires and Explosions

- Hydrocarbon leak due to loss of containment;
- Non process hydrocarbon leaks (diesel, fuel oil, etc);
- Non-Process Fires;
- Storage Fires; and
- Control systems failure including electrical failure in control room.

B] Impact and Collisions

- Road traffic accidents; and
- Objects dropped near wellhead facilities.

C] Loss of Station-keeping/Loss of Stability

- Structural failure; and
- Equipment failure.

D] External Hazards

Failure due to extreme weather, strong vibrations, strong winds, dust storms, earthquakes and sabotage.

The effect of extreme environmental conditions, such as severe weather or earthquake is considered as part of the structural failure considerations.

The detailed description of the frequency, event analysis and consequence analysis of each hazard is discussed in following sections:

6.2.1 Blowouts during Drilling / Testing Operations

6.2.1.1 Causes of Drilling Blowouts

Well control can be lost as a result of:

- Formation fluid entry into the well bore;
- Loss of containment due to mal-operation (e.g. during wire lining); and
- Wellhead damage (e.g. by fires, storms, dropped objects, etc).

6.2.1.2 Causes of Production Blowouts

Blowouts during production are commonly caused by well interventions such as workovers, wire lining, snubbing and coiled tubing operations, although some production blowouts are initiated by the well equipment in normal operation.

6.2.1.3 Blowouts due to External Causes

Possible external causes of blowouts include:

- Escalation from process fire
- Structural collapse
- Military or pirate attacks

These should not be included in the analysis of blowouts if they are separately modelled under the other hazard categories. However, for simple studies that do not model such escalations in full, it is appropriate to include them as blowouts.

6.2.1.4 Blowout Frequencies

- Data Selection

Blowout frequency estimates are obtained from a combination of incident experience and associated exposure in a given area over a given time period. Ideally, a blowout frequency should be estimated from recent experience in the country's operations context and on the type of installation for which the risks are to be predicted. In practice, there have been so few blowouts that a large geographical area and a long time period are required to obtain statistically reliable frequencies. The problems of poor reporting of incidents in some parts of the world, or lack of previous analyses of reported data, also restrict the choice of data.

For QRAs of installations in the US Gulf of Mexico (US GoM), blowout experience in this area is suitable, since it provides a large dataset with good reporting of accidents.

Usually the Outer Continental Shelf (OCS) of the US Gulf of Mexico is used, because no well population data is available for the onshore US State Waters. In many cases, North Sea experience is combined with the US GoM OCS experience for consistency with North Sea analyses.

For QRAs of installations in the North Sea, blowout experience in the North Sea is limited, and differences to the US GoM frequencies are in general not statistically significant. Blowout frequency estimates are commonly obtained from combined experience in the North Sea and US GoM. This area has broadly uniform drilling procedures, and gives a larger dataset that is reasonably well reported.
Most other countries do not have sufficient experience to give blowout frequencies significantly different to the North Sea/US average.

- Severity of Events

The severity of the events included in the analysis has an influence on the resulting frequency. It is desirable to distinguish between full blowouts and more minor well control incidents, but the distinction is not always clear. Full blowouts are of the greatest concern, but may be too infrequent to give reliable frequencies. Well control incidents are more frequent, but are less well reported.

- Measures of Exposure

The measure of exposure determines the units of the resulting frequency. Which measure of exposure is appropriate depends on the requirements of the study. Blowout frequencies may be expressed in various forms:

- ♦ Blowout frequencies per installation year are useful for simple studies, where it is not necessary to take the number and type of wells into account, or the level of drilling activity on the platform. This measure is useful for drilling rigs, where drilling activities are in progress for most of the time;

- ♦ Blowout frequencies per well drilled are relevant to blowouts during drilling and completion. This measure is useful for integrated installation where the amount of drilling varies through the installation's life;

- ♦ Blowout frequencies per well year are relevant for blowouts during normal production;

- ♦ Blowout frequencies per well operation are relevant to blowouts during workover and wire lining. This measure is useful when it is necessary to take into account the level of workover and wire lining activity. Alternatively, the frequency may be included in the production blowout frequency per well year, using an average rate of workovers or wire lining per well year.

All these approaches are to be used where appropriate. The annual blowout frequency for the installation is obtained by multiplying the blowout frequencies per operation or per well year by the number of wells drilled, completed, in operation or being worked over each year. For a drill rig, this is a constant at a given level of activity. For a production installation, the blowout frequency is usually highest during the drilling years early in its life.

6.2.1.5 Blow-out Frequencies Based on Phase of Operation

Blow-out frequencies are often expressed in terms of the type of operations on the installation. The following phases of operation are distinguished:

- Exploration drilling (wildcat + appraisal wells)
- Development drilling
- Completion
- Production
- Work over
- Wire line perforation (sometimes included in production)

The different phases are exposed to different hazards and will have different safety measures in place. This split allows the analysis to take account of these features, and also to reflect the level of drilling, workover and wire lining activity and the number of wells in production.

The analysis of the SINTEF database for the US GoM OCS/North Sea for the period 1980-92 by Scand power (1995) gave the blowout frequencies given in **Table 6.1**. These are also presented by E&P Forum (1996). The analysis gives trend information but concludes that these are not statistically significant.

Table 6.1: Blowout Frequencies by Phase of Operation

Phase	Blowouts 1980-92	Exposure 1980-92	Blow-out Frequency
Exploration drilling	43	5781 wells	7.5×10^{-3} per well drilled
Development drilling	33	9513 wells	3.5×10^{-3} per well drilled
Completion	7	7041 wells	1.0×10^{-3} per well completed
Production	6	112,720 well years	5.3×10^{-5} per well year
Workover	19	23,200 work overs	8.1×10^{-4} per workover
Wire lining	4	193,700 wire line jobs	2.1×10^{-5} per wire line job

Source: Scand power, 1995

The results show that exploration drilling is much more hazardous than development drilling.

6.2.1.6 Blow-out Frequencies Based on Fluid Released

Blowouts may be categorised according to the source of the release:

- Deep blowouts occur from the intended target reservoir for the well; and

The overall proportion of incidents in drilling which involve shallow gas is approximately 60%. There is no significant difference in the proportion between exploration and development drilling (although the actual frequency is greater in exploration drilling).
Table 6.2 gives deep and shallow gas blowout frequencies from the analysis by Scand power (1995) of the SINTEF database. These are also presented by E&P Forum (1996).

For production wells, separate frequencies can be calculated for oil and gas wells, although the reduced numbers of events in each category gives less statistical confidence in the results. Results of this type from the SINTEF database for 1980-96 are given in **Table 6.3**. This shows that gas wells have higher blowout frequencies than oil wells.

Table 6.2: Drilling Blowout Frequencies by Fluid Released

Phase	Fluid Type	Blow-out Frequency (per well drilled)
Exploration drilling	Shallow gas	4.7×10^{-3}
	Deep	2.8×10^{-3}
	Total	7.5×10^{-3}
Development drilling	Shallow gas	2.0×10^{-3}
	Deep	1.5×10^{-3}
	Total	3.5×10^{-3}

Source: Scand power, 1995

Table 6.3: Blowout Frequencies by Fluid in Well

Phase	Fluid	Blow-out Frequency
Production	Gas	9.8×10^{-5} per well year
	Oil	5.7×10^{-5} per well year
	Total	7.5×10^{-5} per well year
Workover	Gas	1.8×10^{-3} per workover
	Oil	4.6×10^{-4} per workover
	Total	1.1×10^{-3} per workover
Wire lining	Gas	4.8×10^{-5} per wire line job
	Oil	1.1×10^{-5} per wire line job
	Total	3.2×10^{-5} per wire line job

6.2.1.7 Blowouts in Individual Drilling Operations

Holland (1996, 1997) gives a breakdown of blowouts according to the individual operations in which they occurred. Scand power (1995) summarised this data into the following major categories of operations:

- Drilling, i.e. the period when the bit is on the bottom
- Tripping, including time when the drill string is running into the hole (RIH), pulling out of the hole (POOH) and held out of the hole
- Running casing, including time when casing is being run, waiting for cement to harden, and pressure-testing the casing
- Other, including installing the BOP (nipple-up/nipple-down), milling, wire line lagging, waiting on weather etc.

These categories were further sub-divided into two phases:

- ♦ Prior to installing BOP, i.e. drilling the top hole
- ♦ After the BOP is installed

Table 6.4 shows the contributions of the individual operations to the total blowout frequency for exploration and development drilling.

Table 6.4: Contribution of Individual Operations to Blowout Frequencies

Operation	Exploration Drilling (%)	Development Drilling (%)
Before installing BOP		
Drilling	20.9	9.1
Tripping	14.0	24.2
Running casing	7.0	15.2
Other	20.9	9.1
After installing BOP		
Drilling	16.3	9.1
Tripping	7.0	15.2
Running casing	2.3	6.1
Other	11.6	12.1
TOTAL	**100.0**	**100.0**

Source: Scand power, 1995

The blow-out frequencies for the individual operations are uncertain due to the small number of total events (51 incidents overall) and uncertainty about how representative the chosen drilling programme was of average practice. Nevertheless, a sensitivity analysis indicated that the following conclusions were valid:

- The most hazardous operations (in declining order of incident frequency per hour) were:
- POOH from surface zone (i.e. prior to installing the BOP)
- POOH from intermediate zone (i.e. prior to reaching the expected reservoir)
- Drilling in surface zone: Their incident frequencies were between 20 and 10 times higher than average
- The least hazardous operations were coring and logging. Their incident frequencies were between 5 and 10 times less than average
- The incident frequencies of other operations (including drilling in the pay zone) were not significantly different from average

This analysis indicated that precautionary shut-down would be most effective during the most hazardous operations as indicated above.

6.2.1.8 Blowouts in Individual Wells

The procedures and protective measures that are in place to prevent blowouts will obviously influence the blow-out frequency. Quantification of this effect is difficult due to the complexity of blow-out causes, and the lack of data on the effects of preventative measures on them. Some studies have attempted to estimate the blow-out frequency for specific wells using fault tree analysis. This is necessarily based on judgement in many areas, but can give insight into the effectiveness of measures to reduce blow out frequencies. Other studies have modified generic frequencies using statistics on the causes of previous blowouts. Scand power (1995) describes a model that is able to adjust generic blow-out frequencies to reflect detailed features of design and management for an individual well. In most studies, the generic frequencies are applied to all wells without modification.

6.2.1.9 Thermal Radiations due to Blow-out – Jet Fire

A well blow-out can lead to uncontrolled release of oil into the atmosphere and a subsequent jet fire could result on availability of an immediate ignition source. Heat load generated by the flame depends upon the mass flow rate of the released material. Generally, 30 persons work in the drilling area, which could be exposed to the heat load in case of well blow out.

Damage distances are computed for the operating pressure of 290 psi and temperature of 70°C. Weather conditions 2A and 5D are considered while computing the damage distances. The damage distance of 73.6-m is obtained for the heat load of 4 kW/m^2 in case of well blow out for 5D conditions. The thermal radiation distances due to jet fire in the blowout are given in **Table 6.5**.

Table 6.5: Summary of Consequence Analysis for Jet Fire Scenario

Unit Name	Pressure (psi) / Temperature (°C)	Scenario	Mass Flow Rate (kg/s)	Weather	Damage Distance (m) for 4.0 kW/m^2 Heat load
Jet fire of Oil well	290/80	Blow Out	6	2A	52.0
				5D	73.6

6.2.2 Well Head Facilities

6.2.2.1 Hydrocarbon Leaks during Well Testing

This category includes releases that may be isolated from the reservoir fluids, typically release from the well testing equipment and mud line.

- **Testing Equipment**

Release frequencies and hole size distribution are presented for the following specific types of equipment.

- Pipe work;
- Flanged connections;
- Valves; and

- **Equipment**

Well testing equipment is brought to the site on a skid whenever required. It typically consists of a heater (optional), a test separator, a surge drum or holding tank, an oil pump, metering and all associated pipe work.

- **Historical Frequencies**

The data used in the analysis is presented in **Table 6.6**. The failure frequencies are taken from E & P Forum (Reference-1). No other data source could be traced for the estimation of testing equipment failure during well drilling. Hence, the failure frequencies as given in **Table 6.6** are considered for further analysis.

Table 6.6: Testing Equipment Failure Frequencies

Equipment	Failure Frequency	Hole Size (Release Rate) Distribution				
Piping between 4" and 11"	3.6×10^{-5} /m/pipe/yr	D_{hole}/D_{pipe}	0.05	0.22	0.45	1
		%	60	15	10	5
Flange	8.8×10^{-5} /flange/yr	D_{hole}/D_{pipe}	0.1	1	-	-
		%	96	4	-	-
Valve	2.3×10^{-4} /valve/yr	D_{hole}/D_{pipe}	0.05	0.10	0.20	1
		%	65	23	6	4

Each of the well drilled during that particular year has to be tested. It is roughly assumed that each test will last for about 5 days. If about 4 wells are drilled during a year and subsequently, 4 well head platforms are established, it will consume about 210 days of testing operations for about 4 well head platforms in a year.

Based on previous similar assessments, an overall leak frequency for the test separator and its associated pipe work and connections of 1.18×10^{-4} (average of the three above types) is used in the study. As indicated, total number of testing days may be about 210 days in a year. Thus, the frequency will be:

$(1.18 \times 10^{-4}) \times 210/365 = 6.8 \times 10^{-5}$ per year.

- **Event Analysis for Hydrocarbon Leak during Well Testing**

The value used for successful isolation of hydrocarbon leaks from process equipment is 0.95. This assumes that the leak is detected by personnel or automatic detection equipment and relates to the probability of single valve not closing. It is expected that the isolation could be possible through the wellhead master valve, the BOP or an ESD valve within the test equipment.

Well testing equipment is likely to contain flammable liquid and/or gas. Therefore, a leak could result in a liquid pool and/or vapour cloud depending upon which equipment the leak is emanated. There is a greater probability of liquid release being ignited than a gas leak in this block. The probabilities for ignition of a small oil leak and a blow out are 0.007 and 0.4 respectively (Reference-1). Most leaks from the process equipment are small. The probability of ignition is considered to be 0.01. If the oil is ignited immediately a pool fire is expected to occur.

Twenty five percent (0.25) of ignitions are likely to occur immediately. There is no possibility of jet fires or flash fires as the releases are basically liquid associated with some occasional gas. Further, in practice, the well site will have all the fire fighting equipment and the possibility of fire developing into a major hazard will be further less.

- **Consequences of Hydrocarbon Leak during Well Testing**

During the well testing, about 10 persons are assumed to be in the open area in the close vicinity and are expected to face the immediate consequences of hydrocarbon release.

The probability of immediate fatality is assumed to be zero for unignited releases and 0.1 for Pool Fires and BLEVE. There is no possibility of formation of jet fires or flash fires as the leakages will be only liquids. Hence, the jet/flash fires are not considered under consequence analysis. An isolated release will result in a short lived pool fire or BLEVE. For these outcomes, only one person is assumed to be exposed to the risk. During all these scenarios, the personnel will be evacuated to the TR. Precautionary evacuation by van/ambulance may be adopted if the situation does not prevent evacuation. As a pessimistic approach, this evacuation is assumed for all unisolated releases. The event tree analysis is given in **Table-1(A) of Annexure-III** and the expected fatalities are given in **Table-1(B) of Annexure-III**

- **Risk Summary Due to Hydrocarbon Leaks during Well Testing**

The AFR associated due to Hydrocarbon leakage during well testing is estimated to be about 3.11×10^{-6} **(Refer Table-1(B) of Annexure-III).** The AFR is reasonably less as there will be in-built precautionary systems and leak detection and leak containment systems.

6.2.2.2 Non-Process Hydrocarbon Fires

- **Fuel Oil Storage**

Non-process fires relate mainly to flammable material like diesel spills stored near the well head facilities. The only significant non-process hydrocarbon inventories are the fuel oil tanks. Should a fire occur, it is likely that there will be significant damage on and near the installation.

Moreover, there is a risk of fire associated with refuelling operations. At the site, the fuel will be supplied through oil road tankers. Diesel will be transferred from the tankers with the help of a hosepipe to the fuel oil tank. If the hose leaks during transfer and the pump does not shut down automatically, it is expected that large quantities of fuel will be released onto the ground. However, ignition of the oil is not considered likely and it is assumed that the well head facility crew has the procedures in place to deal with oil spillage. Moreover, the annual frequency of refuelling is likely to be low. Consequently, risks associated with fuel oil transfer are discounted from this study.

The diesel tank fire frequency is derived from historical data for atmospheric tank fires. It is estimated that the annual frequency of tank fires is 3×10^{-4} per year (Reference-2), i.e. approximately one fire every 3,000 years. Therefore, the likelihood of a fire of this type is negligible and this event has been discounted from the analysis.

6.2.2.3 Structural Failures

Structural failure is defined as breakage or fatigue failure of the structural support e.g., the legs. In the case of wellhead facility, it can be the Christmas tree or its branch pipelines. It can also be related with choosing a wrong design for the legs ends compared to the configuration of the soil; however, it is assumed in this analysis that the preliminary survey of the site has been properly accomplished and thus that correct choices were made beforehand.

- **Frequency Estimation**

There are many causes of structural failure. These include:

- Original design error;
- Fatigue failure;
- Modification error; and
- Operating outside design parameters.

The latter includes failures occurring as a result of extreme environmental conditions such as severe weather and earthquakes. The well sites fall in Zone-II seismically and this is considered to be stable.

- **Event Analysis for Structural Failure**

The small number of incidents means that it is difficult to predict the number of fatalities that can be expected in such an event from historical data. However, if any warning of impending severe weather is given it is expected that production will be stopped from the well head facility, the wellhead facility will be made safe and evacuation initiated. It is assumed that such precautionary evacuations will be possible 90 percent of the time.

Hence, the probability of no precautionary evacuation is only 10% (probability 0.1). Even when prior warning is not given, the total failure can take many hours. Half of all the failures (probability: 0.5) are assumed to occur over a prolonged time.

If any warning of impending severe weather such as dust storms or thunderstorms are given it is expected that production will be stopped and the wellhead facility will be made safe and evacuation initiated. Even when prior warning is not available, the total failure can take many hours. Half of all failures are assumed to occur over a prolonged period.

- **Consequence of Structural Failure**

If a warning of an impending problem is available, it is assumed that the personnel are evacuated by vehicle (van/car). In case of a slow progressive failure, it is assumed that all personnel can be evacuated in this way. The probability of fatality during evacuation is assumed to be 0.3.

6.2.3 Other Possible Areas of Potential Risk

The other possible areas of potential risk are DG sets, Storage of HSD for DG sets, Compressor units, Storage and Disposal of Produced Water, Structural failure in the Processing Plant and occupational hazards in the processing plants. These are discussed briefly:

- **DG Sets**

Usually, the DG sets are used at the well pad process facility to meet the power requirements of the facility. The facilities at the proposed well pad sites basically of skid mount type. The potential risk from the operation of the DG sets is fire and will also result in occupational hazard as far as noise levels are concerned. There is no documented historical data to estimate the frequency of fire in DG sets. However, it can safely be assumed on a conservative scale that the fire hazards may be in the order of 1 in 10,000 (i.e. 1×10^{-4}). The DG sets may have manpower of maximum 5 persons at each site. The probability of immediate fatalities is very negligible. In case of fire, the people will be evacuated to the TR.

The occupational hazard will be due to the noise levels from the DG set, which are likely to be in the range of 100-110 dB (A). However, suitable measures such as earmuffs, shuffling of employees frequently will reduce/avoid potential of an occupational hazard for the employees who are manning the DG sets.

- **Pool Fire Due to Failure of HSD Storage tank (20 KL)**

The maximum quantity of storage is 20 KL. As the worst case, it is assumed that the entire contents leak out into the dyke forming a pool, which may catch fire on finding a source of ignition.

A perusal of the above table clearly indicates that 37.5 kW/m^2 (100% lethality) occurs within the radius of the pool which is computed at 11.2 m in case of HSD tank on pool fire. This vulnerable zone will damage fuel storage all equipment falling within the pool radius.

The threshold limit for 50% and 1% lethality is 25.0 and 12.5 kW/m^2. From the results, it can be concluded that the vulnerable zone in which the thermal fluxes above the threshold limit for 50% and 1% lethality is restricted to 14.1 m and 21 m.

Similarly, the threshold limit for first degree burns is 4.5 kW/m^2, this vulnerable zone in which the thermal fluxes above the threshold limit for first degree is restricted to 37.5 m in case of HSD tank on pool fire.

- **Occupational Hazards**

Occupational hazards are defined as events, which can affect only one or two people and are unlikely to result in loss of asset. In the majority of cases they will cause no more than a single fatality. They include a wide variety of events such as falls and burns etc.

The occupational risks are considered to be similar for all conventional drilling and production operations worldwide. It is therefore considered that the most appropriate means of estimating the risk are to use generic drilling industry statistics for these risks. Three sources of data on occupational risks have been reviewed: The E & P Forum Report, The UK Department of Energy" Brown Book" (Reference-3) and the 'Norwegian Petroleum Directorate Report", 1987 (Reference-4).

The E & P Forum Accident reports give a breakdown of the Fatal Accident Rates (FAR) by type of accident, as presented in **Table 6.7**

Table 6.7: FAR by Accident Type

Accident Type	Percentage (%)
Falls	10.7
Motor Vehicle	14.3
Explosion/Fire	13.1
Struck by	16.6
Drowning	11.6
Caught between	3.9
Electrocution	4.1
Helicopters	13.1
All others	12.6

It can be observed that some of the types of accidents are not applicable to the production operations to be performed in the field or are already covered in the major hazard analysis. Therefore, the contributors such as drowning, helicopters are to be subtracted from the overall FAR. It may be noted that not all the workers are equally exposed to the risk at the well site. Personnel who handle the heavy equipment as part of their job description are more prone to accidents.

As the occupational risk is more individualistic in nature, no further quantitative consequence analysis is carried out.

- **Risk Mitigation Measures**

Risk involves the occurrence of an accident consisting of an event or sequence of events. The impact zones in case of such accidents are computed through Maximum Credible Accident (MCA) Analysis. Hazard identification step is a key in developing an understanding of the contributors to the risk of operating a particular system or process. Once the hazards are identified, safeguards can be recommended, which can either prevent an event from occurring or reduce the consequences, if at all the event occurs.

6.3 Recommendations

6.3.1 Drilling Operations

A majority of accidents occur during drilling operation on the drill floor and may be associated with moving heavy tubular, which may strike or crush personnel. Being struck by objects, falling and crushing make up maximum occupational risk of fatality. Mechanical pipe handling, minimizing the requirement of personnel on the drill floor exposed to high level of risk, may be an effective way of reducing injuries and deaths. Good safety management, strict adherence to safety management procedures and competency assurance will reduce the risk. Some of the areas in drilling operations where safety practices are needed to carry out jobs safely and without causing any injury to self, colleagues and system are given below:

6.3.1.1 Maintenance of Mud Weight

It is very crucial for the safety of drilling well. Drilling Mud Engineer should check the in-going & out-coming mud weight at the drilling well, at regular intervals.

If mud weight is found to be less, barytes should be added to the circulating mud, to raise it to the desired level. Failure to detect this decrease in level may lead to well kick and furthermore, a well blow out, which can cause loss of equipments and injury to or death of the operating personnel.

6.3.1.2 Monitoring of Active Mud Tank Level

Increase in active tank level indicates partial or total loss of fluid to the well bore. This can lead to well kick. If any increase or decrease in tank level is detected, shift personnel should immediately inform the Shift Drilling Engineer and take necessary actions as directed by him.

6.3.1.3 Monitoring of Hole Fill-up / return mud volume during tripping

During swabbing or pulling out of string from the well bore, the hole is filled with mud for metallic displacement. When this string runs back, the mud returns back to the pit. Both these hole fill up & return mud volumes should be monitored, as they indicate any mud loss or inflow from well bore, which may lead to well kick.

6.3.1.4 Monitoring of Inflow

Any inflow from the well bore during tripping or connection time may lead to well kick. So, it is needed to keep watch on the flow nipple during tripping or connection time.

6.4 Disaster Management Plan

The purpose of this DMP is to detail organizational responsibilities, actions, reporting requirements and support resources available to ensure effective and timely management of emergencies at, or affecting Block operator's operations associated in the exploratory block. The overall objectives of DMP are to:

- Ensure safety of people, protect the environment and safeguard commercial considerations
- Immediate response to emergency scene with effective communication network and organized procedures.
- Obtain early warning of emergency conditions so as to prevent impact on personnel, assets and environment;
- Safeguard personnel to prevent injuries or loss of life by protecting personnel from the hazard and evacuating personnel from an installation when necessary
- Minimise the impact of the event on the installation and the environment, by:

  - Minimizing the hazard as far as possible
  - Minimizing the potential for escalation
  - Containing any release.

This is achieved by:

- Describing procedures to deal with emergencies affecting personnel, equipment, third party contractors, local communities or the environment
- Defining the roles and responsibilities of supervisory personnel, and Emergency Response Group (ERG) and Crisis Response Team (CRT) personnel
- Describing the external resources available to the ERG for use in an emergency and how these resources will be co-ordinated.

6.4.1 Scope

This DMP will apply to all emergency situations related to the oil and gas handling and transportation operations associated with the AA-ONN-2004/4 block. This Plan recognizes that the Incident Controller is authorized to initially control and contains any and all emergency situations at the identified exploratory field incident site. The Emergency Response Group Leader (ERG Leader) is authorized to control all Block operator emergencies associated to the exploratory field operations.

The results of the Risk Assessment (RA) study are used in the preparation of this DMP.

The following hazards as applicable to the wells facilities in AA-ONN-2004/4 block have been considered in the RA study:

- Blowouts of wells; and
- Leaks in the outlets of oil/gas processing equipment like Separator and Compressor.

6.4.2 Disaster Management Plan: Key Elements

Following are the key elements of Disaster Management Plan:

- Basis of the plan;
- Accident prevention procedures/measures;
- Accident/emergency response planning procedures;
- Recovery procedure; and
- Onsite and offsite crisis management, communication, contact information etc.

6.4.3 Basis of the Plan

Hazard analysis or consequence analysis (in case of catastrophic release of hazardous chemicals) is considered as the basis of DMP.

Major hazards/accidents are categorised into the following events involving flammable materials:

- Hazards from spread of fire, explosion or release of flammable substances from the wells;
- Fire threatening items of pipeline/equipment section containing hazardous / flammable substances;
- Hazards from high levels of thermal radiation for limited duration;
- External interference such as excavation resulting in blow out of wells or large holes;

- At sectionalising valve stations, gas/vapour release due to failure of small-bore over-ground pipe work is a credible event. Gas/vapour fires, on ignition of releases, can occur;

- Controlled releases of gas through vents also occur at the sectionalising valve stations during pipeline depressurisation and pigging operations. If such operations are not properly carried out, accidents can occur; and

- Risk mitigation measures delineated based on consequence analysis also form an integral part of an organised Disaster Management Plan

6.4.4 Accident Prevention Procedures/ Measures

6.4.4.1 Operation and Maintenance

The oil and gas handling system will be fit for purpose after testing and commissioning. Oil and gas industry experiences throughout the world have shown that the main physical dangers a well or a pipeline faces during operation are mechanical damages caused by excavation works adjacent to them and corrosion resulting from breaks in the coating system, which leave the pipe wall steel exposed.

To guard the pipeline against damage, a system of regular surveillance and inspection to warn of mechanical or corrosion damage is employed.

6.4.4.2 Emergency Management Interface

The following details identify the interface between the Incident Response Team (Site) and Emergency Response Group (ERG).

6.4.4.3 Incident Response Team (IRT) – Operational Response

It is the Incident Response Team's responsibility to deal with the respective location or asset's incidents / emergencies of minor nature requiring no external assistance and which can be controlled with local resources. For emergencies where external assistance is required the Incident Controller at site must notify Emergency Response Group Leader for action.

6.4.4.4 Emergency Response Group (ERG) – Tactical Response

It is the Emergency Response Group's responsibility to respond and provide assistance to control the response to all major emergencies that occur.

6.4.4.5 Emergency Reporting

- When witnessing or receiving notification of an emergency, as much information as possible should be taken and/or conveyed to the relevant emergency activation authority. Where possible, all information should be logged in written form with time and date included and provided to the Incident Controller.

- Personnel working on the field may, at any time, be exposed to an emergency, which could take many forms, for example (but not limited to):

Injuries and/or fatalities	Exposures
Aggressive releases	Fires and/or explosions
Equipment hazards	Impacts
Extreme weather	Adverse environments

- When an emergency occurs, an appropriate and prompt response is required, providing precise action to control, correct and return the site to a safe condition. Timely action is also required to protect people, the environment and property from harm.

- Reporting Forms for actions to be considered, when witnessing an emergency or receiving a report of an emergency.

6.4.5 Within the Field

All near misses and unsafe acts will be written in logbooks / reported in the 'Near miss, unsafe acts, hazards and sub-standard conditions report' and verbally communicated to the concerned Supervisor / Superintendent / Installation Manager at an appropriate opportunity. All accidents and incidents will be immediately reported to the Installation Manager (Incident Controller), and appropriate forms completed.

6.4.6 Field to Emergency Control Centre

All accidents and incidents occurring within the Field facilities will be reported to the Production Manager and Chief HSE Manager as per Block operator Incident Reporting and Investigation Procedure. This includes both situations where there is actual damage to health or equipment and also where there has been a threat of danger or a near miss.

6.4.7 Incident Report

- One report form covers all accidents / incidents;
- Incident report should be submitted regardless of the severity of the injury, or whether the injured party is Block operator employee or a contractor;
- Form should be completed and faxed to the Chief HSE Manager and Production Manager for review and distribution; and
- All incident reports are to be followed up with the Block operator investigation report as per the procedure.

6.4.8 Incident Situation Report Form (SITREP)

To be completed and endorsed by the site Incident Controller and faxed to the Emergency Response Group (ERG) at the commencement of any significant incident. The SITREP is continually used to further update the ERG on incident activity.

6.4.9 Internal Distribution

The Chief HSE Manager will distribute copies of reports to all Managers. In the event of a major incident, distribution of various reports will be authorized by the ERG Leader.

6.4.10 Notification to Authorities

The ERG Leader is responsible to ensure that the following agencies are informed of any serious incident:

- Accident/Damage to Equipment
  - Director General Hydrocarbons, New Delhi

- Pollution
  - State Pollution Control Board, Local Regional office
  - Ministry of Environment and Forests, New Delhi

- Installation Manager to advise local District Collector, RDO and Police as appropriate.

- Contact details for the above agencies included in the contact list.

- The Asset HSE Manager is responsible to ensure that all reports listed below, and appropriate to the circumstances of an incident, are made to relevant Government agencies. These include:

  - Form IV A - To be completed for each serious occurrence and sent to DGMS within 24 hrs of occurrence of the event
  - Form IV B - To be completed in the event of injury or fatality and sent to DGMS within a week of the occurrence of the incident
  - Form IV C - To be completed within 15 days upon returns to duty of an injured person and sent to DGMS

6.5 Emergency Response Strategies

6.5.1 Introduction

This DMP has been prepared based on the Trigger Mechanism.

The Trigger Mechanism envisages that on receiving signals of a disaster happening or likely to happen, all activities required for the mitigation process are energized and activated simultaneously without loss of any time. The primary objective of this mechanism is to undertake immediate rescue and relief operations and stabilize the mitigation process as quickly as possible.

The main parameters of such a response plan include:

- Signal/Warning Mechanism
- Activities and their Levels

- Sub-Activities
- Command and Control Structure
- Individual roles and responsibilities of each specified authority to achieve the activation as per response time
- Response teams for each specified authority

- Emergency procedures
- Alternate plans and contingency measures.

6.5.2 Declaration of Emergency

To enable the appropriate level of response to be implemented, emergency incidents are to be categorized according to three levels as follows:

Tier 1

- The incident can be effectively and safely managed, and contained within the facility by operations staff
- The incident has no effect outside the site.
- There is unlikely to be serious danger to life, the environment or to company assets or reputation.

Tier 2

- The incident cannot be effectively and safely managed and contained at the installation or facility by operational staff and some form of additional assistance is required
- The incident may be "on site", have some effect beyond the "site" and an external emergency services will be involved
- There is likely to be danger to life, to the environment or to company assets or reputation.

Tier 3

- The incident has ESCALATED to a level where it begins, or has the potential to begin, to adversely affect the Company, its Joint Venture Partners, or the public on a broad front
- The incident will have technical, press, public affairs and personnel implications, which require immediate assistance
- There will be one or combination of the following:
    - Death and/or serious injury
    - Potential for significant pollution or environment damage
    - Substantial damage or property

Emergencies will initially be under the control of the Incident Controller whose main tasks are to locate the source and nature of the incident, to inform the ERG Leader, and activate the Site Security and Emergency Services.

During normal working hours the Incident Controller will keep the ERG Leader informed and jointly decide whether it's a Tier 1, Tier 2 or Tier 3 emergency. For a major emergency appropriate Emergency Control Centers will be set up, the site Emergency Support Team summoned and the ERG activated as required.

6.5.3 Emergency Alarm (Siren)

Personnel on site will know that a Major Emergency has been declared, if the site fire alarm siren and all local fire alarm systems are activated. The Emergency Siren Modes will be operated as per internationally accepted alarm codes.

6.5.4 Preparation for Emergencies

6.5.4.1 Command by Competent Persons

Effective command and control starts with a clear definition of the overall command and control structure, and description of the duties of key personnel with specific responsibilities for emergency response.

6.5.4.2 Number of Persons for Emergency Duties

The command/control of emergencies must identify the minimum number of persons required to provide an adequate response to emergencies. This includes having staffed trained and competent to fulfill the roles of other members of staff if they are not available.

6.5.4.3 List of Persons for Emergency Duties

A list of the staff in the field having emergency duties is displayed in the Control Room. It is the responsibility of the Incident Controller to ensure that these lists are kept up to date.

6.5.4.4 Control of Emergencies

The major systems for controlling emergencies and preventing escalation are detailed in this DMP, which gives the emergency procedures to be followed in case of an impending / occurring disaster. It should be noted that during any emergency while exploration in the block, this document would be referred. This would result in the most efficient emergency response strategy to combat the impending/occurring disaster.

6.5.4.5 Assembly Procedures

When personnel arrive on site, they are assigned to an assembly station.

♦ **Assembly Areas**

- Non-essential personnel assemble within the accommodation
- Fire Team at the Alert Team Station
- Emergency Response Team in the office of Incident Controller.

♦ **Lists**

Assembly lists should be kept up to date and are produced by a senior person. Copies are displayed at each Assembly Station.

♦ **Accounting for Personnel**

The person in charge at each Assembly Station checks the personnel according to the assembly list and relays the information to the site HSE Support and the Incident Controller. The HSE Support person conducts the final headcount and notifies the Incident Controller of the results and discrepancies if any.

♦ **Co-ordination**

The senior person in the Control Room is charged with co-ordinating the information/response measures from the various Assembly Stations and ensuring that all personnel are accounted for. He must refer to the HSE Support or the Incident Controller if any personnel are not accounted for or if there are impediments to carry out the response strategy.

6.5.5 Post Emergency

The post emergency phase is an important event in the long-term emergency response strategy for Block operator.

It is absolutely necessary for the Emergency Response Team (ERT) members (IRT, ERG) to review the ERP and the incident response events and provide their inputs for response improvements or ERP updates. All personnel involved in the emergency response actions during an incident will be debriefed by their superior officer.

It will be the responsibility of the designated ERT members to prepare a complete incident report collating incident reports/logs from the respondents and forward the same to higher authorities as appropriate or send notifications to the Government authorities as the case may be. It will be the responsibility of the ERG leader to develop a post emergency action plan with the assistance of Incident Controller.

6.6 Emergency Response Organization

6.6.1 Incident Response

The Incident Controller (IC) is responsible for co-ordinating the on-site tactical response to any emergencies arising out of the operations in the facility and will activate and direct emergency response personnel as appropriate to the emergency. The Incident Controller will notify and correspond with the ERG Leader.

If required, the following personnel or teams are available to be activated at the site:

Incident Controller	HSE Support
Site Medical Centre	Site Contractor Mgt. (as appropriate)
Fire Team Leader	Technical Support
Control Room	Scribe

6.6.2 Emergency Response Group

The Emergency Response Group (ERG) is responsible for co-ordinating the strategic response relative to any Tier 2 emergency arising out of the production activities in the facility. The ERG is activated and directed by the ERG Leader, and will assemble in the Emergency Coordination Centre (ECC).

If additional support is required for the Block operator response, the following personnel should be mobilized as required:

Operation and Technical Co-ordinator	QHSE Co-ordinator
Human Resources and Services Co-ordinator	Public Affairs Co-ordinator
Logistics Co-ordinator	Recorder
Security Co-ordinator	Reception Co-ordinator
Telecommunication Co-ordinator	

6.7 Emergency Response Action

6.7.1 Emergency Response Centers

6.7.1.1 Incident Control Centre (ICC)

The Incident Controller would set up the incident control centre. It is suggested that best location for incident control centre is the main control room. There will be radio, telephone or messenger contact with the Emergency Control Centre.
The incident area will be taped off and warning notices posted. The in-house Fire Team will cordon off the incident area (Inner Cordon). Route markings from Emergency Control Centre to the incident to aid the emergency services will be arranged.

6.7.1.2 Emergency Control Centre (ECC)

The Emergency Control Centre is to be set up at the oil and gas processing facility. The centre is equipped to receive and transmit information and directions from and to the Incident Controller as well from outside. ECC shall contain equipment for logging the development of the incident to assist the controllers to determine any necessary action.

The Emergency Control Centre should contain:

a) Adequate number of external telephones. At least one will be ex-directory or capable of use for outgoing calls only. This will avoid the telephone switchboard being overloaded with calls from anxious relatives, the press etc.;
b) Adequate number of internal telephones;
c) Radio equipment;
d) Plans of the works to show:

- Areas where there are large inventories of hazardous materials, including oil storage
- Sources of safety equipment

- The fire-water system and additional sources of water
- Stocks of other fire extinguishing materials
- Assembly points, casualty treatment centres
- Location of the works in relation to the surrounding community and
- Lorry parks
- Additional plans which may be marked up during the emergency to show:
- Areas affected or endangered;
- Deployment of emergency vehicles and personnel;
- Areas where particular problems arise;
- Area evacuated; and
- Other relevant information.

f) HAZCHEM sheets for the various hazardous materials used on-site
g) Note-pads, pens, pencils to record all messages received and sent by whatever means;
h) Nominal roll of employees or access to this information;
i) List of key personnel, addresses and telephone numbers.

Emergency Control Centre is located, designed and equipped to remain operational in an emergency.

6.8 Accident / Emergency Response Procedures

In order to deal with an emergency, a complete emergency procedure document will be prepared which identifies the key personnel involved with their specific duties and responsibilities.

This emergency plan will include all requirements for dealing with such a situation, so that all the equipments and personnel can be mobilised in the shortest possible time.

♦ **Basic Features**

In the development of emergency procedures, following factors should be kept in view:

- Identification of situations i.e. what can happen and how it can happen
- Identification of problem/ priority areas i.e. where it can happen
- Identification of individuals i.e. who is to take action
- Duties of individuals.
- System or equipment to be used and when to use it.
- Procedures for operating the system or equipment

♦ **Basic Actions**

The basic actions required to handle any emergency are as follows:

- Operation of emergency shut down systems
- Maintenance of telephonic communication
- Persons to be nominated for evacuation
- Effective internal communication by public address system and walkie-talkie sets

The purpose of this section is to provide "all Hazards" emergency response procedures to previously identified hazards and threats to Block operator areas of operation and activities in the AA-ONN-2004/4 block.

6.8.1 Blowout

6.8.1.1 Person Discovering Blowout

Person on the spot should do the following in case the kick is timely detected:

♦ **In case of string at the bottom of hole**

- Lift and clear tool joint out of rotary and stop pumps
- Close BOP and choke
- Record shut in drill pipe pressure(SIDP) and shut in casing pressure(SICP)
- Prepare kill sheet and make calculations for standard well killing procedure.

♦ **In case of while making trip**

- Stop tripping operations
- Position tool joint at rotary table and set slips
- Install safety valve and close safety valve
- Open choke line
- Close BOP and choke
- Record shut in SIDP and SICP
- Prepare the kill sheet and make calculations for standard well killing procedure

♦ **In case of string out of the well**

- If well condition permits attempt – run in hole and whenever situation is critical shut the well by following the steps as mentioned in case of while making trip.
- If the trip in is not possible then use volumetric method of well control.

♦ **In case of sudden kick**

- Close the BOP.
- Record SIDC and SICP.
- Prepare kill sheet and make calculations for standard well killing procedure.
- On detection of a kick, the Senior Tool pusher/ Supervisor is to be informed immediately

6.8.2 Fire / Explosion (General)

The following actions would be taken in case of the above emergency:

- Person first on the scene
- Rescue any personnel in danger (do not endanger yourself)
- Raise Alarm and evacuate the work area.

- Contain fire, close doors/windows to contain the fire
- Extinguish fire only if it is safe and you are trained to do so

6.9 Fire Prevention Planning and Measures

Fire prevention and code enforcement is the area of responsibility of the fire service.

Safe operating practices reduce the probability of an accident fire in the facility. Personnel should understand their duties and responsibilities and be attentive to conditions that might lead to fire. Following procedures are recommended:

- There should be provision for safe handling and storage of dirty rags, trash and waste oil. Flammable liquids and chemicals if spilled, should be immediately cleaned
- Containers of paints and hydrocarbon samples, gas cylinders for welding and cutting should be stored properly
- Cutting and welding operations should be conducted in accordance with safe procedures
- "No Smoking" areas should be clearly identified by warning signs
- Equipments should be maintained in good operating conditions and kept free from external accumulation of hydrocarbons. Particular attention should be given to crude oil pump, seals, diesel and gas engines which could be potential source of ignition in the event of a failure

The Disaster Management Plan will address the issue of a fire event and the procedure to be adopted in the very unlikely event of this occurring.

6.10 Communication

An essential component of a DMP is the Communication Links necessary for gathering information needed for overall co-ordination. Emergency Control Centre links with incident scene and with in-house as well as outside emergency services is necessary. Too much dependence on the Public Telephone system is insufficient, as it can soon be overloaded in an emergency situation. A multi-user wireless paging system with selective call facility is also useful for promptly locating key operating personnel in the plant, both during normal conditions and during emergencies. A public address (PA) system with loud speaker installed at vital installations can be extremely useful during emergencies. An additional location and transit communications can be addressed by using vehicle and well site installed VHF units.

6.11 Emergency Control Centre

The establishment of a 'focal point' or 'EMERGENCY CONTROL CENTRE' to co-ordinate emergency response activities within a relevant area is essential.

The emergency control centre will be sited in an area of minimum risk and will have easy and fast access to all major hazardous installations.

Emergency control centers will be equipped with the following:

- An adequate number of external telephones
- An adequate number of internal telephones (if required)
- Wireless communication system with adequate number of portable handsets

- Notepads, pens and pencils
- A list of external agencies likes Fire Brigade, Police, Hospitals, Port, neighbouring Industries, Telephone co. etc.
- Drawing of the Terminal and Pipeline network
- Source of safety and fire equipment
- List and location of 'LEAK' clamps
- A nominal role of employees
- First-aid kits
- A list of KEY PERSONNEL with addresses, telephone numbers, etc. with their roles and responsibilities

6.12 Recovery Procedure

Following an accident on the well, pipeline or equipment, there shall be a full recovery procedure as part of the Disaster Management Plan. The recovery procedure shall deal with two distinct situations described below.

6.13 Disaster Management Plan: Onsite Crisis

Identification of Personnel and Assessment of Responsibilities on specific functions of Co-ordinating Authority.

In order to effectively deal with onsite emergencies, following co-ordinators are required to co-ordinate for various activities during the emergency:

Incident Controller (IC)	:	Installation Manager
Operations Co-ordinator (IC)	:	Production Manager
Fire Fighting and Safety Co-ordinator	:	Fire and Safety Incharge
Medical Incharge	:	Medical Officer/Paramedic
Communications Co-ordinator	:	Electrical/Instrumentation
Services Co-ordinator	:	Maintenance Incharge
Logistics Co-ordinator	:	Administrative Incharge

6.13.1 Role of Incident Controller

He shall be the main guiding force in directing the emergency operations and will be in charge of overall control of the disaster. The actions include:

- On hearing the fire siren or on receiving information about the disaster, he will immediately take charge of the emergency control centre

- To declare the category of the emergency after discussing with other team members

- To instruct all the team members/ co-ordinators to make necessary arrangements

- To inform mutual aid partners about the disaster

- Instruct the safe shut down of system in consultation with emergency site incharge and key personnel

- If necessary, arrange for evacuation of population in the neighbouring villages
- Carry out search for causalities within the affected area and arrange for first aid/hospitalisation of victims, if required
- Ensure not to operate the plant/system unless it is declared safe by the competent person
- Provide local authorities, media and Govt. adequate factual information through in-company modalities.

6.14 Disaster Management Plan: Offsite Crisis

Offsite emergency preparedness is covered in the Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996. The following are the Block operator's responsibilities towards generation of the Offsite Emergency Plan:

To provide basic information on Risk and Environmental Impact Assessment to the Local/District Authority, Police, Fire Brigade, Doctors, surrounding industries and the public and to appraise them on the consequences and the protection/prevention measures and control plans and seek their help to manage the emergency.

To assist the District Authorities in preparing the Off-site Emergency Plan.

An off-site emergency plan organization has essentially two parts:

Formation of the Local Crisis Group: This Group is headed by the Deputy Collector or the Magistrate of the Industrial area and is responsible for the management of any industrial emergency confined to the local area.

Formation of the District Crisis Group: This Group is headed by the District Collector of the District and is responsible for any major Industrial emergency affecting Local and beyond any industrial area of the District.

The composition of the Off-Site Crisis Group is covered in. Since, the actual offsite plan requires the participation of outside agencies; this report does not dwell further on the issue. The typical structure of the offsite emergency planning group is provided in Fig 6.1

District Collector

↓

Off-Site EMP Teams

Each Team has:

1. *A Chair Person*
2. *Secretary*
3. *Coordinator*
4. *Members*

↓

Local Crisis Groups

(For each Industrial Area Headed by the Deputy District Collector or Magistrate)

↓

Off-Site EMP Teams

1. *Fire Brigade Team,*
2. *Experts,*
3. *SMC-Team,*
4. *IC-Team,*
5. *Toxic Gas Containment team,*
6. *Communication Team,*
7. *Transport and Evacuation Team,*
8. *Traffic Control Team,*
9. *Medical Team,*
10. *Mass Media and PR-Team.*

Fig. 6.1: Composition of Offsite Crisis Group

6.15 Communication Systems Network

An efficient and reliable communication system is required for the success of the emergency plan. The efficient communication system is required to alert:

- Emergency Authorities and Services
- Neighbouring area and public in the vulnerable zone
- The communication system requires the following:

- Communication between Control Room to other units in the terminal
- Hotlines between Control Room to Emergency Services, Meteorological Station and the mutual aid members
- Paging system and alarm for with the Control Room for alerting the employees
- P&T Telephone lines

A communication flow chart is to be prepared and kept in the Control Room. An up-to-date Telephone Directory of key personnel concerned with the emergency should be available at all times. These matters should be documented and kept within the Disaster Management Plan manual.

The Disaster Management Plan Manual is required to maintain a record of police stations, hospitals and fire brigade stations in the area to seek assistance in dealing with emergency situations. The emergency team of Block operator should liaise with these agencies and with district officials and furnish them information on the possible hazards, extent of damage and actions to be taken by them during such emergencies.

6.16 Role of External Services

6.16.1 Police

The Police should assist in cordoning off the accident site, organize evacuation and removing any seriously injured people to the hospitals. They shall divert traffic as and when necessary.

6.16.2 Fire Brigade

The fire brigade shall organise to fight fires other than gas fires and provide assistance as required.

6.16.3 Hospitals and Doctors

Hospitals and doctors should treat any injuries, which may primarily be burn injuries.

6.17 Mutual Aid from Neighboring Installations

Block operator may also depend on the local facilities handling emergencies. They will have to arrange with the local administration for providing services, such as fire fighting and medical needs during incident particularly in the nearby regions.

Telephone links with neighboring industries and customer facility control rooms should be established.

6.18 Public Information System

During a crisis following an incident, the people of the area and a large number of media representatives would like to know about the situation from time to time and the response of the district authority to the crisis. It is important to give timely information to the public in order to prevent panic and rumors. The emergency public information could be carried out in three phases.

6.18.1 Before the Crisis

This will include the safety procedure to be followed during an emergency through posters, talks and mass media in different languages including local language. Leaflets containing do's/don'ts should be circulated to educate the people in the vicinity

6.18.2 During the Crisis

Dissemination of information about the nature of the incidents, actions taken and instructions to the public about protective measures to be taken, evacuation etc. are the important steps during this phase

6.18.3 After the Crisis

Attention should be focused on information concerning restoration of essential services, travel restrictions, etc.

6.19 Fire Fighting System

Release of gas/vapours can lead to fire. In order to deal with such possible situations, there is a need for constant preparedness to mobilise fire fighting and control resources in minimum time. There should be control of all fire fighting resources in the affected areas under the Fire and Safety Officer. The operational response will be co-ordinated from the Central Control Room. The planning for fire fighting should be as follows:

6.19.1 Before the Crisis

- Proper road and means of escape should be identified
- Considering the possible hazards, there must be adequate water supply
- Training of the fire fighting personnel
- Provision of adequate availability of fire fighting facilities is important

6.19.2 During the Crisis

Immediate response to an incident should be co-ordinated by the Control Room by matching all the resources. In a major incident having wide off-site implications, more than one installation may be affected, necessitating concurrent fire fighting operations at a number of places. In this case, the whole area may be divided in different fire zones.

The task of the fire zone commanders is as under:

- Command and control of all fire fighting resources in the respective fire zones
- Deployment of additional fire resources allocated by Control Room
- Co-ordination of fire fighting teams

6.20 Relief to the Victims

Post-incident activities include the relief to the victims. The Public Liability Insurance Act indicates the owner, who has control over handling hazardous substances, to pay specified amounts to the victims as interim relief. The District Collector has a definite role in implementation of the PLI Act, 1991. After proper assessment of the incident, he may invite applications for relief, conduct an enquiry of the claims and arrange for payments of the relief amounts to the victims.

6.21 Checklist for Capability Assessment

The checklist will help in assessing the preparedness, prevention and response resources capabilities. The points included in the checklist are only indicative and there is a need to closely examine the local requirements while preparing the checklist.

For good control and management of an incident, there are three important requisites.

- Defined Organisation;
- Effective means; and
- Trained people.

The organisation has to be properly structured for routine as well as emergency purposes with clear understanding of duties and responsibilities. The structure has to consider an execution and speedy implementation of the response plans; while at the same time, it should be flexible enough to tune itself to the fast changing situations. All plans and procedures for emergency handling should be established.

Means include equipment and materials, transport and communication. Identification, storage and upkeep of these means are essential for speedy implementation of the response plans.

People form the vital element in emergency response. Experience, education and training should help make this vital element effective.

In general, the duties, responsibilities and competence of the individual team are defined by the description of the function.

A broad outline of responsibilities and duties of different managers concerning the emergency management plan are given below in **Table 6.8:**

Table 6.8: Roles and Responsibilities of Various Emergency Response Team Members

Role	Responsibility
Incident Controller (IC)	- Responsible for overall control of emergency - Liaise with external agencies for any additional help - Reports to statutory agencies about the emergency
Operations Co-ordinator (OC)	- Responsible for control of emergency at site - Liaise with fire and safety co-ordinator in effective control o emergency
Fire and Safety Co-ordinator	- Responsible for carrying out fire fighting and rescue work at th incident site - Co-ordinate with IC and other teams for effective control in minimur possible type

Role	Responsibility
Services Co-ordinator	- Responsible for upkeep of equipments and facilities - Provides necessary support for identifying and rectifying the faults an bring the systems online
Communication Co-ordinator	- Ensure proper working of the communication facilities during a emergency - Responsible for internal and external communication as instructed b CC - Log the sequence of events and actions taken
Logistics Co-ordinator	- Responsible for providing support for the transportation of men material, food etc. - Liaise with chief co-ordinator for mobilizing external emergenc services
Medical Incharge	- Responsible for treatment of casualties involved in the incident durin emergency control operation - Liaise with hospitals for future treatment

6.22 Warning System

In an off-site management plan, one of the most important prerequisites is a good 'Warning System'. Efficient warning system will save lives, prevent injuries and reduce losses. The Emergency Co-ordinator - Onsite in consultation with Emergency Co-ordinator Offsite will decide the appropriate warning system and implement it.

The warning systems are of the following types:

- Disaster Warning (Maximum Credible Loss Scenario) High pitched continuous wailing siren
- Fire/Toxic Release
- Long siren followed by short siren
- All Clear

Depending upon the nature of hazards and the area affected, other methods of warning may be used as follows:

- Out-door warning sirens
- Public address system with police
- ARP sirens
- Mass media
- Door to door visit by Civil/Defence Personnel
- Telephone contact with schools and other organisations/public institutions
- Information to be provided at common gathering places such as village canteens, shops, etc.

6.23 Services Support System

A major off-site incident may affect a number of units and the surrounding colonies. Hence in addition to the communication, warning, public information, fire fighting system, following additional service support will be required:

- Health and medical services
- Transportation services
- Security and police
- Media
- Mutual aid services

A telephone directory containing the contact numbers of all these support services should be documented and be part of the offsite disaster management plan.

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