# RISK ASSESSMENT STUDY

# Final Environmental Impact Assessment Report for Exploratory Drilling (3 Wells) under NELP VII Onshore Block WB-ONN-2005/3, West Bengal


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ONGC

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# ONGC NELP VII BLOCK:WB-ONN-2005/3

## 1.0 Introduction

Oil and Natural Gas Corporation (ONGC) has been awarded Exploration (onshore) Block WB-ONN-2005/3, in Bengal Basin, West Bengal State for exploration of hydrocarbons. The block WB-ONN-2005/3 is located in the SW part of state of West Bengal. The block lies in Hugli, Bankura & Midnapur districts & is bordered by Howrah District to the south & Bardhaman District to the north.

Environment Appraisal Committee (EAC) Industry-II of MoEF during 27th Expert Appraisal Committee, (Industry) meeting held during 21st to 22nd September' 2011, granted TOR for the project "Exploratory drilling (3 wells) under NELP VII Block: WB-ONN-2005/3, West Bengal by M/s ONGC vide F.No. J-11011/391/2011- IA (I).

ONGC has proposed to drill three exploratory wells in NELP VII, Block-WB-ONN-2005/3 in Amdai, near Village & Panchayat: Laugram, P.S: Katulpur in Bankura District, West Bengal and also in Hugli district. The latitude and longitude of the identified drilling locations are 23°00'57.25"N & 87°39'27.22"E, 22°44'53.59"N & 88°05'32.35"E and 22°45'31.43"N & 87°03'53.43" E respectively.

## 1.1 Risk Assessment

Accidental risk involves the occurrence or potential occurrence of some accident consisting of an event or sequence of events resulting into fire, explosion or toxic hazards to human health and environment.

Risk Assessment (RA) provides a numerical measure of the risk that a particular facility poses to the public. It begins with the identification of probable potential hazardous events at an industry and categorization as per the predetermined criteria. The consequences of major credible events are calculated for different combinations of weather conditions to simulate worst possible scenario. These consequence predictions are combined to provide numerical measures of the risk for the entire facility.

## 1.2 Objectives

Following are the objectives of Risk Assessment studies:

- Generation of release scenarios for proposed exploratory drilling
- Estimation of damage distances for the accidental release of hazardous chemicals based on different scenarios
- Suggestion of risk mitigation measures for well blow out scenarios, diesel storage, mud system and falling objects
- Approach to Disaster Management Plan

## 1.3 Scope of Work

The scope of this study is to carry out risk assessment for drilling of exploratory wells in the West Bengal Onshore Block WB-ONN-2005/3. Standard industry practices of risk assessment are considered in the study.

The hazard potential of various fuels/chemicals and estimation of consequences in case of accidental release are the issues of immediate relevance to be considered. It is therefore, imperative to carry out Maximum Credible Accident (MCA) analysis at the first stage, which identifies vulnerable areas of the facility and suggests a set of recommendations for improved safety.

The work undertaken consists of the following stages:

- Collection of relevant data on project description and proposed activities.
- Damage distance computations

MCA analysis is carried out to arrive at the hazard distance for the worst case scenario. The consequences of all the scenarios are computed and hazard distances are worked out and listed for flammable materials and possible explosion effects. Risk mitigation measures, based on MCA analysis and engineering judgements are suggested in order to improve overall system safety.

Suggestions for risk mitigation measures and delineation of approach to Disaster Management Plan (DMP) for minimizing the risks which are of concern and can be practically implemented are documented. International standard operation practices and Indian regulatory requirements are considered while giving suggestions / recommendations.

## 1.4 Maximum Credible Accident (MCA) Analysis

MCA stands for Maximum Credible Accident or in other words, an accident with maximum damage distance, which is believed to be probable. MCA analysis does not include quantification of the probability of occurrence of an accident. In practice, the selection of accident scenarios for MCA analysis is carried out on the basis of hazards and past accident analysis.

Risk involves the potential occurrence of some accident consisting of an event or sequence of events. A disastrous situation is the outcome of fire or explosion or toxic hazards in addition to other natural causes that eventually need to loss of life, property and ecological balances. Depending on the effective hazardous attributes and their impacts, the maximum effect to the surrounding could be assessed.

The MCA analysis involves ordering and ranking various sections in terms of potential vulnerability. The data requirements for MCA analysis are:

- Operation procedures
- Detailed design parameters
- Physical and chemical properties data
- Detailed information about onshore wells, terminal facilities platform.

- Past accident data

Following steps are involved in the general MCA analysis:

- Identification of potential hazardous sections
- Visualisation of release scenarios with recourse to consequence analysis
- Damage distance computations for the released cases

## 1.5 Past Accident Data Analysis

Analysis of events arising out of the unsafe conditions is one of the basic requirements for ensuring safety in any facility. The data required for such an analysis has either to be generated by monitoring and/or collected from the records of the past occurrences. This data, when analysed, helps in formulation of the steps towards mitigation of hazards faced commonly. Trends in safety of various activities can be evaluated and actions can be planned accordingly, to improve the safety.

Data analysis helps in correlating the causal factors and the corrective steps to be taken for controlling the accidents. It is, therefore, of vital importance to collect the data methodically, based on potential incidents, sections involved, causes of failure and the preventive measures taken. This helps to face future eventualities with more preparedness.

## 1.6 Consequence Analysis

Quantification of the damage can be done by means of various models, which can then be translated in terms of injuries and damage to the exposed population and buildings.

Gas may be released and result into jet fire and less likely unconfined vapour cloud explosion causing possible damage to the surrounding areas. The extent of the damage depends upon the nature of the release. The release of flammable material and subsequent ignition results in heat radiation, pressure wave or vapour cloud depending upon the flammability and its physical state. **Table 1.1** depicts the metrological conditions considered for consequence analysis.

It is important to visualize the consequence of the release of such substances and the damage caused to the surrounding areas. An insight into physical effects resulting from the release of hazardous substances can be had by means of various models.

Vulnerability models can also be used to translate the physical effects occurring in terms of injuries and damage to exposed population and buildings.

### 1.6.1 Factors influencing the use of Physical Effect Models

In order to calculate the physical effects of accidental releases of hazardous substances, following steps must be carried out in succession:

- Determining the form in which the hazardous substances occur e.g. gas, gas condensed to liquid or as a liquid in equilibrium with vapour
- Determination of the way in which the release takes place; for example intermittent or continuous release
- Determination of the outflow volume (as a function of time) of the gas, vapour or liquid. In the event of liquid outflow, possible two-phase outflow and the determination of the evaporation from any pool of liquid formed
- Dispersion of the released gas or vapour which has formed into the atmosphere
- In case of flammable substances, the heat radiation is computed for the following scenarios:
    - Torch, if vapors are ignited
    - Pool fire, if pool of liquid is ignited
    - Boiling Liquid Expanding Vapour Explosion (BLEVE) which is a physical explosion

In the distribution model, account is taken of the atmospheric stability, the so called Pasquill classes (A to F), as given in **Table 1.2**, and a wind velocity. The model is based on a point source. In practice, however, a point source will never exist; for example, a surface source in case of pools. Further, account should be taken of the nature of the release. For example, vapour may be released in a continuous manner in the form of a jet.

## 1.7 Scenario Identification

### 1.7.1 Release from Well

Release of well fluid can cause hazard to the environment. The extent of the hazard is dependent upon the nature of the release and the physical state of the material. **Figure 1.1** provides a flowchart that can be followed to evaluate the consequences of a release of a hazardous chemical. The chart in the figure is general in nature and as such, not all of the branches events in the chart may be applicable to well fluid. However, it provides a useful guide to the steps involved in scenario generation.

The quantification of the damage can be done by means of various models, which can then be translated in terms of injuries and hazard to exposed population and buildings. The release of flammable materials and their subsequent ignition results in heat radiation, pressure wave or vapour cloud explosions depending upon the flammability and physical state arising after the release. An insight into physical effects resulting from the release of hazardous substances can be seen by means of various models. Vulnerability models are used to translate the physical effects occurring in terms of injuries and damage to exposed population and buildings.

### 1.7.2 Failure Case Listing

The hazards posed by the oil and gas wells are the same as those possessed by any gas well carrying high methane content in natural gas. Historical evidence demonstrates that, although unlikely, the most significant hazard arises from the thermal radiation produced by an ignited gas release. Releases from the wells could arise in the form of blow out. Partial and full rupture in case for diesel storage has also been considered as failure case in the study.

### 1.7.3 Models for the Calculation of Heat Loads

If a flammable gas or liquid is released, damage resulting from heat radiation may occur on ignition. The models used in this study for the effects in the event of immediate ignition (torch and pool fire) will be discussed in succession. These models calculate the heat radiation as a function of the distance from the torch or the ignited pool as given in **Table 1.3**. Types of damages at various heat loads are given in **Table 1.4**.

### 1.7.4 Burning Torch (Flare)

If a release of a gas is ignited then a stable, diffusion torch or jet fire may be produced. This study uses a model with which the length of torch and the thermal load for the surrounding area can be calculated. For the flammable gas, in this model, an ellipse is assumed for the shape of a torch. The volume of the (torch) flare in this model is related to the outflow. Humidity in air has a relatively high heat-absorbing capacity.

In order to calculate the thermal load, the center of the flare is regarded as a point source. This center is taken as being half a flare-length from the point of outflow.

## 1.8 Injuries to Human Population

### 1.8.1 Vulnerability Models

Vulnerability models are used in order to determine how people are injured by exposure to a heat load. Such models are designed on the basis of animal experiments or on the basis of the analysis of injuries resulting from accidents, which have occurred. Vulnerability models often make use of a probit function. In a probit function, a link is made between the load and percentage of the people exposed to a particular type of injury. It is represented as follows:

$$Pr = k1 + k2 \ln (V)$$

In which,

Pr = Probit function; the measure of the percentage of people exposed to a particular injury

K1 = a constant depending on the type of injury and type of load

K2 = a constant depending on the type of load

V = load

The response percentage is plotted on the left and the probit linearly on the right; the S-shaped curve belongs to the left-hand axis and the straight line to the right-hand axis.

In the following sections, vulnerability models are given for heat radiation making use of probit functions.

### 1.8.2 Health Injuries Resulting from Flammable Liquids and Gases

In case of flammable gases or liquids, on immediate ignition, a jet fire or pool fire will occur. The injuries in this case are mainly caused by heat radiation. If the gas is not ignited immediately, it will disperse into the atmosphere. Explosive combustion will only occur if the cloud is enclosed to some extent between buildings and obstacles.

## 1.9 Results and Discussions

Accidental scenarios visualized for the consequence analysis of the wells considering operating pressures greater than atmospheric are jet fire for well blowout scenario. Scenarios have been generated by using DNV based PHAST 1.51 software.

***Well Blowout***

The release of well fluid due to well blowout can lead to a jet fire if the released gas ignites immediately since the operating pressure is very high. Length of jet flame and heat load generated by the flame depends upon the mass flow rate of released material.

The damage distances due to well blowout at heat load of 4 kW/m² are 335.2 m, 358.2 m and 371.2 m for stability class 2F, 3D and 5D respectively. Similarly, the damage distances for other heat radiations levels are also computed as shown in **Table 1.5**.

***Pool Fire***

This scenario was visualized by considering leak sizes of 10 mm, 25 mm and 50 mm and catastrophic rupture of Fuel Storage Tank at various heat radiation levels under the different atmospheric stability classes and wind velocities. The damage distances due to 50 mm leak for stability class 2F are 9.25 m, 20.47m, and 33.19 m at heat load of 37.5 kW/m², 12.5 kW/m² and 4.0 kW/m² conditions respectively.The computed damage distances for Fuel Storage Tank for 10 mm, 25 mm and 50 mm leak sizes and catastrophic rupture at heat loads of 37.5 KW/m², 12.5 KW/m² and 4.0 kW/m² is given in **Table 1.1**.

## 1.10 Risk Mitigation Measures

Risk involves the occurrence of an accident arising out of an event or sequence of events. The impact zones in case of such accidents are computed through Maximum Credible Accident (MCA) Analysis. Based on consequence analysis mitigation measures are recommended which can either prevent an event from occurring or reduce the consequences, if the event occurs.

A number of recommendations are made regarding measures that should be taken to reduce the risks of any hazardous event occurring or, if it did, of mitigating the hazards arising. The following risk mitigation measures at various locations are suggested

### 1.10.1 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. Falling and crushing make up maximum occupational risk of fatality due to striking of objects. 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 & without causing any injury to self, colleagues and system are:

***Maintenance of Mud Weight***

It is very crucial for the safety of drilling well. Drilling Mud Engineer should check the ingoing and outcoming 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 & furthermore, a well blow out, which can cause loss of equipments & injury to or death of the operating personnel.

***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 & take necessary actions as directed by him.

***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.

***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.

***Monitoring of Background / Trip Gas***

Increase in background gas or trip gas indicates insufficient mud weight against drilled formation. Such indications should be immediately brought to the notice of the Shift Drilling Engineer.

For total safety of such operations, each team member must religiously follow the safety aspects pertaining to respective operational area. If every team member starts working with this attitude, zero accident rates are not a distant dream.

Drilling operation is a team effort and success of such an operation depends upon the sincerity, efficiency & motivation of all team members. Safety in such operations is not the duty of a single person, but it is everyone's job.

The use of protective fireproof clothing and escape respirators will reduce the risk of being seriously burnt. In addition, adequate fire fighting facilities and first aid facilities should be provided, in case of any emergency.

Risk reducing measures include kick simulation training for personnel, presence of well trained drillers and mud engineers, and strict adherence to safety management procedures and good well control procedures.

### 1.10.2 Wells

- Proper insulating joints should be provided on well head
- Co-ordination with local authorities, such as port, police, fire, ambulance, nearby industries should be ensured to meet any eventuality
- The well should be physically inspected regularly

***Well Blow Out***

A blow out, though rare, is the worst accident that can occur in a drilling operation that is often accompanied by fire and explosion exposing workers to serious danger to their lives, burns and poisoning. To understand the failure modes resulting to formation of kick and subsequent blow outs we have to understand the safety systems installed for blow out prevention.

Prevention of blow outs rests primarily on control of any kick in the well bore. A kick means entry of formation fluids into well bore in large enough quantity to require shutting in the well under pressure. Once a kick is detected, steps can be taken to control entry of formation fluids into the well bore by over balancing the expected bottom hole pressure with properly conditioned mud and operation of safety valves i.e. BOP, whereby the space between the drill pipes and the casings can be closed and well itself shut off completely. If the early signs of a lick in the well are ignored, it may lead to a blow out, which is a violent and uncontrolled flow of gas from a well bore. Several instruments are provided on a drilling rig for detection of kicks.

***Blowout Preventor***

Blowout preventer is a large, specialized valve used to seal, control and monitor oil and gas wells. Blowout preventers were developed to cope with extreme erratic pressures and uncontrolled flow (formation kick) emanating from a well reservoir during drilling. Kicks can lead to a potentially catastrophic event known as a blowout. In addition to controlling the downhole pressure and the flow of oil and gas, blowout preventers are intended to prevent tubing e.g. drill pipe and well casing, tools and drilling fluid from being blown out of the wellbore when a blowout threatens. Blowout preventers are critical to the safety of crew, rig and environment, and to the monitoring and maintenance of well integrity; thus blowout preventers are intended to be fail-safe devices.

The blowout preventers are instrumental in reducing the incidence of oil gushers, blowouts, which are dangerous and costly. Blowout preventers come in a variety of styles, sizes and pressure ratings. Several individual units serving various functions are combined to compose a blowout preventer stack. Multiple blowout preventers of the same type are frequently provided for redundancy, an important factor in the effectiveness of fail-safe devices.

The primary functions of a blowout preventer system are to:

- Confine well fluid to the wellbore;
- Provide means to add fluid to the wellbore;
- Allow controlled volumes of fluid to be withdrawn from the wellbore.

Additionally, and in performing those primary functions, blowout preventer systems are used to:

- Regulate and monitor wellbore pressure;
- Center and hang off the drill string in the wellbore
- Shut in the well (e.g. seal the void, annulus, between drill pipe and casing);
- "Kill" the well (prevent the flow of formation fluid, influx, from the reservoir into the wellbore) ;
- Seal the wellhead (close off the wellbore);
- Sever the casing or drill pipe (in case of emergencies).

In a well, after the surface casing is in place the following blow-out prevention equipment is installed and maintained before resuming drilling.

- Annular preventer for closing the well regardless of size / shape of the drill string in the hole or no string in the hole.
- Double ram preventer, blind ram for closing against open hole as well as pipe ram for closing against drill pipes.
- Drilling spool located below the double ram preventer. The spool is provided with choke and kills lines which are connected to the choke and kill manifold. A non-return valve is provided in the kill line. Arrangements are made for circulating the kick out.

The blow out preventer, including its pipes and control values is pressure tested. Standard testing procedure is as below:

- During initial installation and after all subsequent installations, the equipments are tested to full working pressure. The testing pressure for BOP mentioned in the Geo Technical Order (GTO) provides necessary guidance. Bag type preventer are however subjected to only 70% of the working pressure.
- Before drilling out cement from ant string or casing, the BOP is tested to the maximum calculated pressure that the casing can be subjected to.
- In case of repairs of BOP involving disconnecting a pressure seal, the BOP is tested to the working pressure but the bag type preventers is subjected only to 70% of working pressure.
- The BOP and its pipes and control values is “ function” tested – once in each trip of blind ram type preventer.
- Once daily in case of pipe ram preventer.
- Once every week in case of annular preventer on drill pipe.

If during test, any blow out prevention equipments is found to be detective, drilling operation is not resumed until the BOP has been made serviceable.

### 1.10.3 Preventive measures for spillage and accident due to Storage of Chemicals

- Fire is one of the major hazards, which can result due to the spillage from storage tanks. Fire prevention and code enforcement is one of the major areas of responsibility for the fire service. Hence the site should be equipped with:
    - Water supply
    - Fire hydrant and monitor nozzle installation
    - Foam system
    - Water fog and sprinkler system
    - Mobile Firefighting equipment
    - First aid appliances

- Storages of chemicals should be designed, fabricated, inspected and maintained so that there is no release possibility while it is kept within design conditions.
- Protective systems of quantified high reliability and availability should be designed to ensure that these physical conditions are maintained. Impurities should be controlled to obviate abnormal corrosion.
- These measures should be backed up by relief systems such that the combination of design, protection, quality control and relief eliminates the possibility of complete failure. Storages of chemicals should be sited, or given protective barriers such that they are fully protected from external damage
- Surrounding population should be made aware of the safety precautions to be taken in the event of any mishap. This can effectively be done by conducting the training programs
- Safety escape routes should be provided at strategic locations and should be easily accessible
- Grating and vent panels should be provided to minimize Domino Effects
- Fire extinguishers should be tested periodically and should be always kept in operational mode
- Shut off and isolation valves should be easily approachable in emergencies
- The fire protection equipment shall be kept in good operating condition at all time and fire fighting system should be periodically tested for proper functioning and logged for record and corrective actions

### 1.10.4 Flow Sensor

- A flow sensor is provided to detect any change in the rate of flow of mud in the flow line. In case of any sudden increase in the rate of flow, it gives an automatic alarm at the drillers control panel as also at the geologist's instrument cabin

### 1.10.5 Control Panel

There are two control panels for the BOP stack. One of them is on the derrick floor near the drillers stand, another at the accumulator (Koomy). The accumulator unit is located outside the safety perimeter. The control panel is equipped with pressure and flow indicators and suitable markings for close and open positions.

### 1.10.6 Instrumentation in Mud System

Continuous monitoring of condition of mud in the well provides information useful for well control. The following instruments and equipments are used in the drilling mud system for this purpose:

- A pit level indicator registering increase or decrease in drilling mud volume. It is connected with an audio-visual alarm near the drillers control panel.
- A trip with float-marking device to accurately measure the volume of mud going in to the well. This is useful to keep the well feed with required quantity of mud at all times.
- A gas detector or explosimeter installed at the primary shale shaker together with an audio-visual alarm at the drillers control panel to indicate the well presence of gas-cut mud in the well.

The kick in the well is prevented by keeping the hydrostatic head of the drilling fluid greater than the formation pressure. The primary control can be lost in the following situations:

- While tripping, if the well is not kept full with the required volume of mud.
- If there is reduction in hydrostatic pressure in the well due to swabbing, which may be caused if the drilling string is pulled out too fast or by a balled-up or clogged bit, which is indicated by insufficient filling of mud.
- If the specific gravity of the drilling fluid is not maintained as per the requirement.

- If there is loss of circulation, which may be caused either due to running in too fast, thereby, causing the weak horizons of the well to break or while drilling through a formation with cracks or cavity.

### 1.10.7 Risks to Personnel

Good safety management, strict adherence to safety management procedures and competency assurance will reduce the risk. Safety practices are needed to carry out jobs safely and without causing any injury to self, colleagues and system. For total safety of any operation, each team member must religiously follow the safety practices / procedures pertaining to respective operational area. If every team member starts working with this attitude, zero accident rate is not a distant dream.

Any operation is a team effort and its success depends upon the sincerity, efficiency and motivation of all team members. Safety in such operations is not a duty of a single person, but it is everyone's job. Use of protective fireproof clothing and escape respirators will reduce the risk of being seriously burnt. In addition, adequate fire fighting facilities and first aid facilities should be provided, in case of any emergency.

### 1.10.8 Precautionary Measures for Falling Objects

Following are the mitigation measures suggested to avoid or minimize risk due to falling objects

- Provide safety helmets to protect the workers below against falling objects
- Barriers like a toe boards or mesh guards should be provided to prevent items from slipping or being knocked off the edge of a structure
- Secure objects to the structure like lashing of scaffold boards
- Ensure that there are no loose objects and all tools are properly secured;
- Create an exclusion zone beneath areas where work is taking place.
- Danger areas should be clearly marked with suitable safety signs indicating that access is restricted to essential personnel wearing hard hats while the work is in progress.

## 1.11 Disaster Management Plan (DMP)

Several Government agencies, both at the Central and State levels, are entrusted with the responsibility of ensuring safety and management of hazardous chemicals under acts and rules made for the purpose. Despite these measures, the possibility of accidents can not be ruled out. In order to face risk of accidents during drilling operations, a disaster management plan is prepared to mitigate the impact.

### 1.11.1 Objectives

The DMP is prepared with the objective that ONGC can respond effectively in a rapid and systematic manner to any of the technical or natural calamities related incidents in order to:

- Minimize or eliminate any further danger or risk to individuals
- Minimize or eliminate any further risk to company's operations and asserts
- Minimize or eliminate any adverse publicity and to ensure all external inquiries are handled consistently by a nominated spokes person
- Ensure that all legal aspects of response are considered.

### 1.11.2 Key Elements

Following are the key elements of Disaster Management Plan:

- Basis of the plan
- Accident / emergency response planning procedures
- Accident Prevention Procedures / Measures for Drilling
- On-site Disaster Management Plan
- Off-site Disaster Management Plan

### 1.11.3 Basis of the Plan

Identification and assessment of hazards is crucial for on-site emergency planning and it is therefore necessary to identify what emergencies could arise in transportation of hydrocarbons. One of the emergencies is due to hazards from spread of fire or release of flammable chemicals during transportation. Hazard identification is the basis of the Disaster Management Plan to tackle the unforeseen events.

***Emergency Planning and Response Procedures***

Emergency rarely occurs therefore activities during emergencies require coordination of higher order than for planned activities. To effectively coordinate emergency response activities, an organizational approach to planning is required. The important areas of emergency planning are organization and responsibilities, procedures, communication, transport, resource requirements and control center. Offsite emergency requires additional planning over and above those considered under onsite plans, which should be properly integrated to ensure better coordination.

The emergency planning includes anticipatory action for emergency, maintenance and streamlining of emergency preparedness and ability for sudden mobilization of all forces to meet any calamity.

### 1.11.4 Accident Prevention Procedures / Measures for Drilling

***General***

OISD standard 174 gives the codes for well control and standard 189 sets out engineering requirement for fire fighting equipment for drilling rigs. Standard Industry practice is to be adopted.

A separate plan is provided to deal with the situations, which necessitate emergency action. The emergency response plan includes details of the organizational response to emergencies and the safety precautions to be observed in preventing loss of life and damage to property.

***Operation and Maintenance***

Oil and Gas industry experiences throughout the world have shown that the main physical dangers that well faces during operation are mechanical damages caused by excavation works adjacent to the well. To guard the well against damage, a system of regular surveillance and inspection to warn of mechanical or corrosion damage is employed.

Following are the main factors, which determine whether the well will stay free of significant defects:

- The well Protection against external interference such as caused by nearby excavations
- Changes in the well environment
- Adequate well markers

***Protecting the Well from External Interference***

It is essential to protect the well from being struck or damaged by third parties. The primary defence against this occurrence will be:

- Liaisons with third parties likely to excavate near the well. ONGC shall identify, then make them aware of the well and gather advance notifications of their activities
- Regular Patrolling of the well to monitor third party activities nearby to the wells.

***Fire Prevention Planning and Measures***

Fire is one of the major hazards, related to Oil and Natural Gas well. Fire prevention and code enforcement is the area of responsibility of the fire service. Safe operating practices reduce the probability of an accidental fire on a platform. Personnel should understand their duties and responsibilities and be attentive to conditions that might lead to fire. The following precautions are recommended

- There should be provision for safe handling and storage of dirty rags, trash and waste oil. Flammable liquids and chemicals spilled on platform should be immediately cleaned
- Containers of paints and hydrocarbon samples, gas cylinders for welding and cutting should be stored properly. Gas cylinders should be transported in hand-carts

- Cutting and welding operations should be conducted in accordance with safe procedures
- Smoking should be restricted to designated platform areas and "no smoking" areas should be clearly identified by warning signs
- Platform equipment should be maintained in good operating condition and kept free from external accumulation of dust and 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 at any location on the well and the procedure to be adopted in the very unlikely event of this occurring. If a fire starts in any well, that section of the well will be isolated by closing the section (block) valves, as quickly as possible and surrounding facilities will be cooled with water.

### 1.11.5 On-site Disaster Management Plan

On-site and off-site Disaster Management Plan can be extended as a contingency plan for methane explosion. It elaborates emergency procedures in case of fire and explosion due to accidental release of hazardous chemicals.

***Purpose***

- To inform people at the site about above happening if it is likely to adversely affect them
- To inform authorities including helping agencies in advance, and also at the time of actual happening
- To identify, assess, foresee and work out various kinds of possible hazards, their places, potential and damaging capacity and area in case of above happenings.

***Activities***

- Preparation of a plan showing therein the areas of various hazards like fire, explosion and toxic releases.

- The fire protection equipment shall be kept in good operating condition at all time and fire fighting system should be periodically tested for people functioning logged for record and corrective action
- The fire fighting training shall be provided to all officers and other employees who are likely to be present in installation
- There should be regular mock fire drills once in a month. Record of such drills shall be maintained
- Assign key personnel and alternate responsible for safety transportation
- Describe risk associated with transportation facility..
- Reporting procedure should be followed according to guidelines
- In the event of fire from accidental release of flammable gas or liquid, a person seeing the incident will follow the laid down procedure in the plant and report as follows:
    - Will dial the nearest telephone
    - Will state his name and exact location of emergency
    - Will contact concerned officers on duty
    - People reporting the accident will remain near the location to guide emergency crew arriving at the scene
- Report injuries or blood or body fluid exposures to the appropriate supervisor immediately
- Workers should be seen as soon as possible by a health professional.

### 1.11.6 Off-site Disaster Management Plan

Emergency is a sudden unexpected event, which can cause serious damage to personnel life, property and environment as a whole, which necessitate to evolve off-site emergency plan to combat any such eventuality. Emergencies can be handled by an organized multidisciplinary approach.

If it becomes necessary to evacuate people, then this can be done in orderly way. The different agencies involved in evacuation of people are civil administration (both state and central) and police authorities.

***Purpose***

- To save lives and injuries and to prevent or reduce property losses
- To provide necessary assistance for quick resumption of normal situation or operation
- To make explicit inter related set of actions to be undertaken in the event of an accident posing hazards to the community
- To plan for rescue and recuperation of casualties and injuries. To plan for relief and rehabilitation
- To plan for prevention of harms, total loss and recurrence of disaster. It will be ensured that absolute safety and security is achieved within the shortest time

Following are the activities of the government, Non-Government organizations and concerned personnel involved in off-site disaster management plan:

- 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 vicinity
- Medical Help consisted of doctors and supporting staff for medical help to the injured persons because of disaster should be formed. Functions and duties of the committee include, to provide first Said treatment for injured at the spot or at some convenient place and shift them to nearby hospitals for further treatment if required
- The police will assist in controlling of the accident site, organizing evacuation and shifting of injured people to nearby hospitals.
- The fire brigade shall organize to put out fires other than gas fires and provide assistance as required. Approach roads to accident site and means of escape

should be properly identified. Chief fire officer should co-ordinate entire fire control measures. Routine training of fire fighting equipments and special rescue equipments should be carried out. Concerned officer should ensure adequate supply of fire water and fire fighting agents at the site of emergency. Maintenance of standby equipment / personnel for fire fighting should be ready at any given time.

## 1.12 Oil Spill Response Plan

Spills of oil to land require immediate response action to stop the source of the discharge and to limit the spread of material. Immediate response actions and notification procedures shall be developed. Attention must be paid to fire and safety hazards. For terrestrial areas, selection of appropriate control and containment techniques is dependent on the:

- Nature of the substrate,
- Slope of the terrain,
- Amount of product, and
- Time available to implement the response action.

The quantity and time parameters reflect the reality of constructing a barrier of appropriate size in the time available. These factors can only be judged in the field at the time of the incident. Should it be impossible to implement the desired method at a desired location due to a lack of time or access, a new control point would be selected further down the slope. If containment is still impossible and human safety is in question, the threatened area would need to be evacuated.

Spill response strategies would vary significantly attributed by the location of the spill. Herein the spills have been envisaged in two areas as listed below:

- On-site Spills
- Off-site Spills

The various methodologies that can be adopted for spill control is described below:

### 1.12.1 Response Strategies – Onsite Spills

In case of spills / leaks of hydrocarbons within the fence line of property one of the following techniques could be used for the control of spill.

***Sorbents and Drip Pans***

Sorbent materials, drip pans, and drainage mats are used to isolate and contain small drips or leaks until the source of the leak is repaired. Material handling equipment, such as valves and pumps, often have small leaks and are applications for using sorbents, drip pans, or drainage mats. Although sorbents are usually used to control small isolated spills, they can also be used to contain and collect large-volume spills before they reach a watercourse. Sorbents include clay, vermiculite, diatomaceous earth, and man-made materials.

Drip pans are widely used to contain small leaks from product dispensing containers (usually drums), uncoupling of hoses during bulk transfer operations, and for pumps, valves, and fittings. Drip pans are typically 5 to 15 gallons and may be plastic or metal, depending upon the type of chemical handled. They may be single pans for individual dispensing drums or gutter-type continuous pans built into multiple drum dispensing racks. Drip pans must be checked regularly and emptied when necessary so an overflow spill does not occur.

Drainage mats are sometimes used to prevent spilled product from entering into an uncontrolled drainage or sanitary sewer system. The mat is placed over a storm drain, sealing the drain against the entry of spilled material. Drainage mats are especially applicable in areas where constructing a secondary containment or diversion structure is impractical, such as a congested tanker truck unloading area. Drainage mats are typically made of synthetic rubber materials and can be stored on site or carried on a fuel delivery truck. The use of drainage mats is a low-cost solution to providing a degree of containment; however, it is not as fail-safe as the other containment techniques, since it is dependent upon the operator properly placing the mat.

Materials such as foams and gelling agents are commonly used to contain small spills in areas where physical secondary containment is not available. Foams that solidify to form a physical barrier or dike are highly effective forms of emergency secondary containment.

***Spill Diversion Ponds or Retention Ponds***

Spill diversion or retention ponds should be constructed with an impervious base utilizing HDPE sheets or geo-membranes to prevent soil and / or groundwater contamination. These ponds should not be constructed in areas prone to flooding.

### 1.12.2 Response Strategies – Off-Site Spills

The objective of surface containment is to prevent the spread of oil on the soil or substrate surface and to prepare it for recovery or treatment. This usually can be achieved using easily available materials (i.e., shovels, earth-moving machinery, trucks, damming materials, sorbents, etc.) to construct berms, dams, barriers, and trenches to divert and contain the flow. Containment and damming to pool the oil are important if the oil is to be pumped and / or sucked up. Several techniques are also discussed to contain and divert subsurface flow.

***Strategies***

- Act quickly.
- Contain and control as near source as possible.
- Protect resources in oil pathway.
- Prevent oil reaching streams, rivers, or groundwater.
- Use the natural features to contain and control flow whenever possible.

***Strategies for Spill Fires - Ground Level***

- Operators should determine the source of leakage or spill immediately and stop it, if possible. If is a continuous leakage which can not stopped, the particular piece of equipment involved should be taken out of service, depressurised and steamed, if necessary.
- Blanket small fires with steam or dry powder but avoid scattering burning materials.
- In case of large spill fire, direct high pressure water fog into the source of leakage. Protect surrounding structures with water spray. Maintain the water flow unit the operators control the flow of fuel.
- Apply foam to extinguish fires in oil pools or trenches.
- Maintain adequate drainage of the fire area.
- Avoid working above sewer drains or near fire traps.

***Points to Remember***

- Always pay attention to fire and health hazards.
- Start containment operations immediately to prevent oil from reaching a watercourse, the groundwater, or otherwise sensitive area or object.
- Evaluate logistical factors (safety, access, availability, etc.) to assess feasibility and to ensure effective and efficient implementation.
- Consider the type of equipment that can be used, as different equipment has different operational capabilities. It is necessary to match planned activities with the available equipment and personnel.
- As much as possible, do not allow vehicles to run over oil-saturated areas.
- Do not flush the oil down clean drains and other inlets.
- Do not use excavators on areas with free oil on the surface.
- Containment is easier on land than on open water.

***Methods***

A decision guide for choosing containment methods is provided in **Figure 1.1**. The terrestrial containment techniques are summarized below:

- Earth containment or diversion berm
- Containment or diversion trench
- Sorbent barrier
- Culvert and drain blocking
- Soil interceptor trench

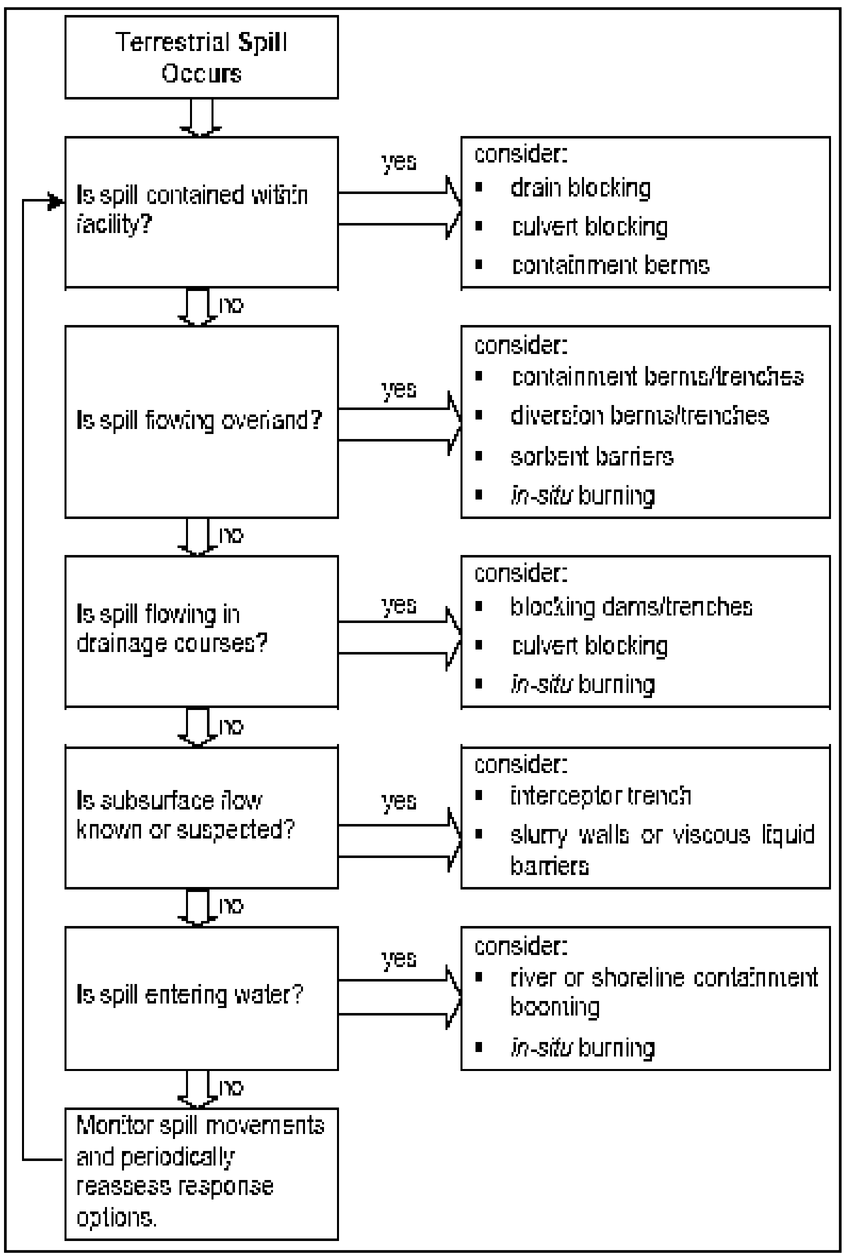

**Figure 1.1: Decision Tree**

**Table 1.1: Metrological Conditions for Consequence Analysis**

| Parameter | Case |
|---|---|
| Ambient Temperature | 32°C |
| Atmospheric stability | F and D |
| Relative humidity | 71% |
| Wind speed | 2 m/s for stability class F<br>3 m/s for stability class D<br>5 m/s for stability class D |

**Table 1.2: Pasquill – Giffard Atmospheric Stability Classes**

| S. No. | Stability Class | Weather Conditions |
|---|---|---|
| 1. | A | Very unstable - sunny, light wind |
| 2. | A/B | Unstable - as with A only less sunny or more windy |
| 3. | B | Unstable - as with A/B only less sunny or more windy |
| 4. | B/C | Moderately unstable – moderate sunny and moderate wind |
| 5. | C | Moderately unstable-very windy / sunny or overcast / light wind |
| 1. | C/D | Moderate unstable – moderate sun and high wind |
| 7. | D | Neutral – little sun and high wind or overcast / windy night |
| 8. | E | Moderately stable – less overcast and less windy night thand |
| 9. | F | Stable – night with moderate clouds and light / moderate wind |
| 10. | G | Very stable – possibly fog |

## Table 1.3: Damage Criteria in kW/m² for Heat Load

| Exposure time | T = 10 seconds | | t = 30 seconds | | t = 10 seconds | |
|---|---|---|---|---|---|---|
| | With Protection | Without Protection | With Protection | Without Protection | With Protection | Without Protection |
| 1% lethal injury | 21.2 | 11.5 | 9.3 | 7.3 | 5.5 | 4.3 |
| First degree burns | 8.5 | 1.9 | 4.0 | 3.0 | 2.2 | 1.8 |

## Table 1.4: Damage Caused at Various Heat Loads

| S. No. | Heat loads (kW/m²) | Type of Damage Intensity | |
|---|---|---|---|
| | | Damage to Equipment | Human Injury |
| 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 | 50% Lethality in 1 min. Significant injury in 10 sec |
| 3 | 19.0 | Maximum thermal radiation intensity allowed on thermally unprotected equipment | -- |
| 4 | 12.5 | Minimum energy required to melt plastic tubing | 1% lethality in 1 min |
| 5 | 4.0 | -- | First degree burns, causes pain for exposure longer than 10 sec |
| 1 | 1.1 | -- | Causes no discomfort on long exposures |
| Source: techniques for assessing industrial hazards by world bank | | | |

## Table 1.5: Summary of Consequence Analysis for Well Blowout Scenario

| Scenario | Weather Category | Maximum Damage Distance (m) | | |
|---|---|---|---|---|
| | | 37.5 kW/m² | 12.5 kW/m² | 4.0 kW/m² |
| Blow out of Well | 2F | - | 101.31 | 335.2 |
| | 3D | - | 140.94 | 358.2 |
| | 5D | - | 178.31 | 371.2 |

## Table 1.1: Consequence Analysis for Pool Fire Scenario

| Scenario Considered | Leak Size (mm) | Source Strength (kg/sec) | Pool Radius (m) | Weather | Damage Distance (m) for Various Heat Loads | | |
|---|---|---|---|---|---|---|---|
| | | | | | 37.5 kW/m² | 12.5 kW/m² | 4.0 kW/m² |
| Fuel Storage Tank | 10 | 0.21 | 3.31 | 2F | 7.80 | 11.41 | 25.29 |
| | | | | 3D | 8.89 | 17.91 | 21.42 |
| | | | | 5D | 9.45 | 18.17 | 21.82 |
| | 25 | 1.35 | 5.75 | 2F | 9.14 | 20.35 | 33.08 |
| | | | | 3D | 9.11 | 22.03 | 33.75 |
| | | | | 5D | 9.21 | 23.81 | 34.88 |
| | 50 | 5.42 | 5.75 | 2F | 9.25 | 20.47 | 33.19 |
| | | | | 3D | 9.21 | 22.07 | 33.80 |
| | | | | 5D | 9.44 | 24.04 | 35.01 |
| | Catastrophic Rupture | - | 5.75 | 2F | 7.11 | 18.38 | 31.10 |
| | | | | 3D | 7.22 | 20.08 | 31.81 |
| | | | | 5D | 7.53 | 22.13 | 33.15 |