Report on Risk Assessment for Exploratory Drilling of 134 wells in 32 ML Blocks in Western Onshore Basin in Vadodara, Anand, Kheda, Ahmedabad, Mehsana, Gandhinagar, and Sabarkantha Districts

1 INTRODUCTION

1.1 Identification of project and project proponent

1.1.1 Identification of the project

ONGC Plan to drill 134 exploratory wells in Western Onshore Basin in Gujarat.

1.1.2 Identification of project proponent

- Founded on August 14, 1956, Oil and Natural Gas Corporation Limited (ONGC) is the largest Indian public sector company.
- Ranked 14th among global Oil and Gas Operations industry in Forbes Global 2000 list, 2017 of the World's biggest companies for 2017; Ranked 443 in the overall list, 2017 - based on Sales (US$ 19.89 billion), 288 on Profits, 470 in Assets and 300 Market Value.
- ONGC has been conferred the Maharatna status by the Central Government.
- ONGC is engaged in hydrocarbon exploration and production activities. Major functions of ONGC are to plan, promote, organize and implement programs for development of petroleum resources and the production and sale of petroleum and its products.
- ONGC is the only fully–integrated oil and gas company in India, operating along the entire hydrocarbon value chain. It has single-handedly scripted India's hydrocarbon saga. Some key pointers:
- ONGC has discovered 6 out of the 7 oil and gas producing basins in India:
- This largest energy company in India has established 8.70 billion tonnes of in-place hydrocarbon reserves. It has to its credit more than 570 discoveries of oil and gas with Ultimate Reserves of 3.02 Billion Metric tonnes (BMT) of Oil plus Oil Equivalent Gas (O+OEG) from domestic acreages.
- It has cumulatively produced 998 Million Metric Tonnes (MMT) of crude and 645 Billion Cubic Meters (BCM) of Natural Gas.
- ONGC produces over 1.26 million barrels of oil equivalent per day, contributing around 70% of India's domestic production. Of this, over 75% of crude oil produced is Light & Sweet.
- The Company holds the largest share of hydrocarbon acreages in India (61% in PEL Areas & 81% in ML Areas).
- ONGC possesses about one tenth of the total Indian refining capacity.
- This E&P Company has a well-integrated Hydrocarbon Value Chain structure with interests in LNG and product transportation business as well.
- A unique organization in world to have all operative offshore and onshore installations (403) accredited with globally recognized certifications.

1.2 Brief description of the project and Location

Table 1-1: Brief Description of Nature, size and Location of Project

S No.	Details	Description	
1	Nature	Drilling of exploratory wells.	
2	Land requirement	110 m X 110 m for each well	
3	Location	**District**	**Taluka**
		Sabarkantha	Prantij

S No.	Details	Description	
		Mehsana	Kadi, Mehsana
		Gandhinagar	Gandhinagar, Dehgam, Kalol, Mansa
		Ahmedabad	Ahmedabad City, Daskroi, Dholka, Sanand, Bavla
		Kheda	Mahudha, Kathalal, Mehmdabad, Kheda, Matar, Nadiad
		Anand	Umreth, Anand, Khambhat, Borsad, Anklav, Tarapur
		Vadodara	Padra, Vadodara
4	Cost of the project	1447 Crore Indian Rupees	
5	Project Completion	Drilling period of each well would be 30-60 days	

2 PROJECT DESCRIPTION

2.1 Type of Project

Proposed project is onshore exploratory drilling of wells covered under schedule 1(b) of EIA notification 14th September 2006.

2.2 Need for the Project

Facing an environment of increasing consumption, static reserves, increasing imports and decreasing value of the Indian Rupee vis-à-vis the US Dollar, it follows that any accretion of hydrocarbon reserves in the country, is welcome.

Consequently, the need for the project is evident

2.3 Location of the Project

The 32 ML blocks are located in Sabarkantha, Mehsana, Gandhinagar, Ahmedabad, Kheda, Anand, and Vadodara Districts.

Table 2-1: Number of Wells in each Block

S. No	Name of Block	Area in km^2	Number of wells
1	Ahmedabad- Bakrol	30.16	1
2	Ahmedabad EXT I to V	85.98	4
3	Balasar	12.00	1
4	Gamij and Gamij EXT I to III	252.013	5
5	Halisa	143.441	4
6	Hirapur	87.918	8
7	Kadi EXT III to V	34.35	3
8	Kalol (Main) and Kalol EXT I & II	211.262	4
9	Kalol North East	9.44	1
10	Kalol West and Kalol West EXT I & II	88.78	4
11	Limbodra and Limbodra EXT I	30.71	2
12	Motera and Motera EXT-I	65.366	3
13	Nandej, Nandej East and Nandej Ext I	167.28	5
14	Nawagam & Nawagam Ext I & III	145.66	5
15	Paliyad – Kalol - Limbodra	161.479	6
16	Rajpur and Rajpur Ext I	15.46	2
17	Rupal	14.06	2
18	Sanand and Sanand EXT I to III	129.54	6
19	Wamaj and South Wamaj	37.73	3
20	Valod and Valod EXT I & II	148.85	7
21	Varsoda-Halisa and Varsoda- Halisa EXT I	324.00	6
22	Viraj	17.49	2
23	Wadu and Wadu Ext I	70.58	7
24	Kathana and Kathana Ext –I	33.94	3
25	Siswa	37.78	5
26	Akhaljuni	8125	5

S. No	Name of Block	Area in km²	Number of wells
27	Anklav Ext-I	61.00	2
28	Chaklasi-Rasnol and Chaklasi-Rasnol Ext -1	133.29	4
29	Vasad Kathol Ext III	103.18	3
30	Asmali	43.25	2
31	Nawagam South Ext I to III	128.53	4
32	Padra and Padra Ext I to IX	172.4	15

2.3.1 Approach to the Project Site

The nearest major landmark for approaching the Blocks area is Mehsana City, Ahmedabad City and Vadodara City which is well connected by road and rail from Mumbai and New Delhi

Road

Site is well connected to Kadi, Kalol, Gandhinagar, Ahmedabad, Dholka, Kheda, Nadiad, Anand, Khamb hat and Vadodara via adjacent roads. National Highway No. 8 (NH8) and Express Highway (NE-1) are the major connectivity to project site while NH 8A, NH 8C, NH 59, SH 3, SH 4, SH 218, SH 138, SH 55, SH 130, SH 71, SH 17, SH 142, SH 59, SH 88, SH 41, etc.

By Rail

Major railway station for public transportation is Ahmedabad Junction and Vadodara Junction. However, Nadiad, Anand and Mehamdabad are also important junctions located from project site.

By Air

Nearest airport from project site is Sardar Vallabhbhai Patel International Airport, Ahmedabad and Vadodara International Airport, which operate flights to most of the large cities in India & Abroad.

3 RISK ASSESSMENT

3.1 Risk Assessment

Environmental Risk Assessment is a scientific analysis for identification of credible risk and thereafter estimating the safe distances from any hazardous installations/processes in the eventuality of an accident. Estimation of near-accurate safe distances is absolutely necessary to protect the public, property and environment.

'Risk Assessment' also known as 'Hazard Analysis' and 'Vulnerability Assessment' is a procedure for identifying hazards and determining their possible effects on a community and environment. Risk or hazard by itself is not an event - it is the potential for an event.

3.1.1 Approach to the Study

Risk involves the occurrence or potential occurrence of various type accidents consisting of an event or sequence of events. The main objectives of the risk assessment of the proposed project are illustrated schematically in Figure 3-1.

Standard industry practices of risk assessment are considered in the project. Maximum Credible Accident analysis is carried out to arrive at the hazard distance for the worst case scenario.

3.1.2 Maximum Credible Accident Analysis (MCAA)

Maximum Credible Accident (MCA) is a probable accident with maximum damage distance. In practice, the selection of accident scenarios for MCAA is carried out on the basis of engineering judgement and past accident analysis. MCAA does not include quantification of the probability of occurrence of an accident.

Risk involves the potential occurrence of some accident consisting of an event or sequence of events. Accidental release of oil and gas to the atmosphere from well or processing equipment is studied by visualising scenarios on the basis of their properties and the impacts are computed in terms of damage distances. A disastrous situation is the outcome of fire or explosion of the released gas in addition to other natural causes, which eventually leads to loss of life, damage to property and/or ecological imbalance.

Depending on the effective hazardous attributes and their impacts, the maximum effect to the surroundings could be assessed.

The steps of MCA analysis along with data requirement are shown in Figure 3-1

3.1.3 Past Accident Data Analysis

The data required for MCA 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.

3.1.4 Hazard Identification

A major hazard is defined as an event, which may have the potential to cause one or more fatalities and also the potential to affect the integrity of the facility as a whole. The aim of this step is to create a complete tabulation of identified hazards.

Hazards are identified in terms of safety and/or environmental impact. The hazard in terms of blowout has been identified from well pad in the present proposed project. It is noted that some hazards are incorporated within other hazards.

Identification of hazards in the proposed project campaign is of primary significance in the analysis, quantification and cost effective control of accidents involving chemicals and process. Hence, all the components of a system/process need to be thoroughly examined to assess their potential for initiating or propagating an unplanned event/sequence of events, which can be termed as an accident.

Typical schemes of predictive hazard evaluation and quantitative risk analysis suggest that hazard identification step plays a key role. The hazard in terms of blowout has been identified from well pad in the present proposed project.

Major accident hazards considered are:

- Hydrocarbon escapes due to high geological pressures lead to possibility of fire, explosion, gas ingress to sensitive areas, contamination or toxic hazards arising from wells, test equipment fuel supply systems, storage, pipe work systems, etc.;
- Structural or foundation failure, including effects of corrosion, fatigue, extreme weather, overloading, seismic effects, abuse or accidental loading;
- Possibility of H_2S release while drilling; and
- Fire, including fires in accommodation, electrical fires, hot work, oxygen enrichment

The complete list of hazards and Occupational Hazards applicable to onshore drilling are presented in Table 3-1 and Table 3-2.

Table 3-1: LIST OF MAJOR HAZARDS

Sr. No.	Hazard Source/Reason	Description	Impacts
1	Fire and explosion	Occurrence of blow out	Topsides blow out
		Non hydrocarbon fires	Electrical fire in control room
			Fire in accommodation
2	Impacts and collisions	Objects dropped from a crane/ derrick	Fatal accidents
			Loss of materials and equipment
3	Loss of station/ stability	Loss of stability	Structural failure Tug failure (during towing)
4	Extreme weather conditions	Extreme winds	Loss of lives and material
			Temporary withdrawal of well operations
5	Earthquakes	Sudden ground movement	Strong vibrations, failure
6	War, crisis	Crisis situation	-

Table 3-2: OCCUPATIONAL HAZARDS

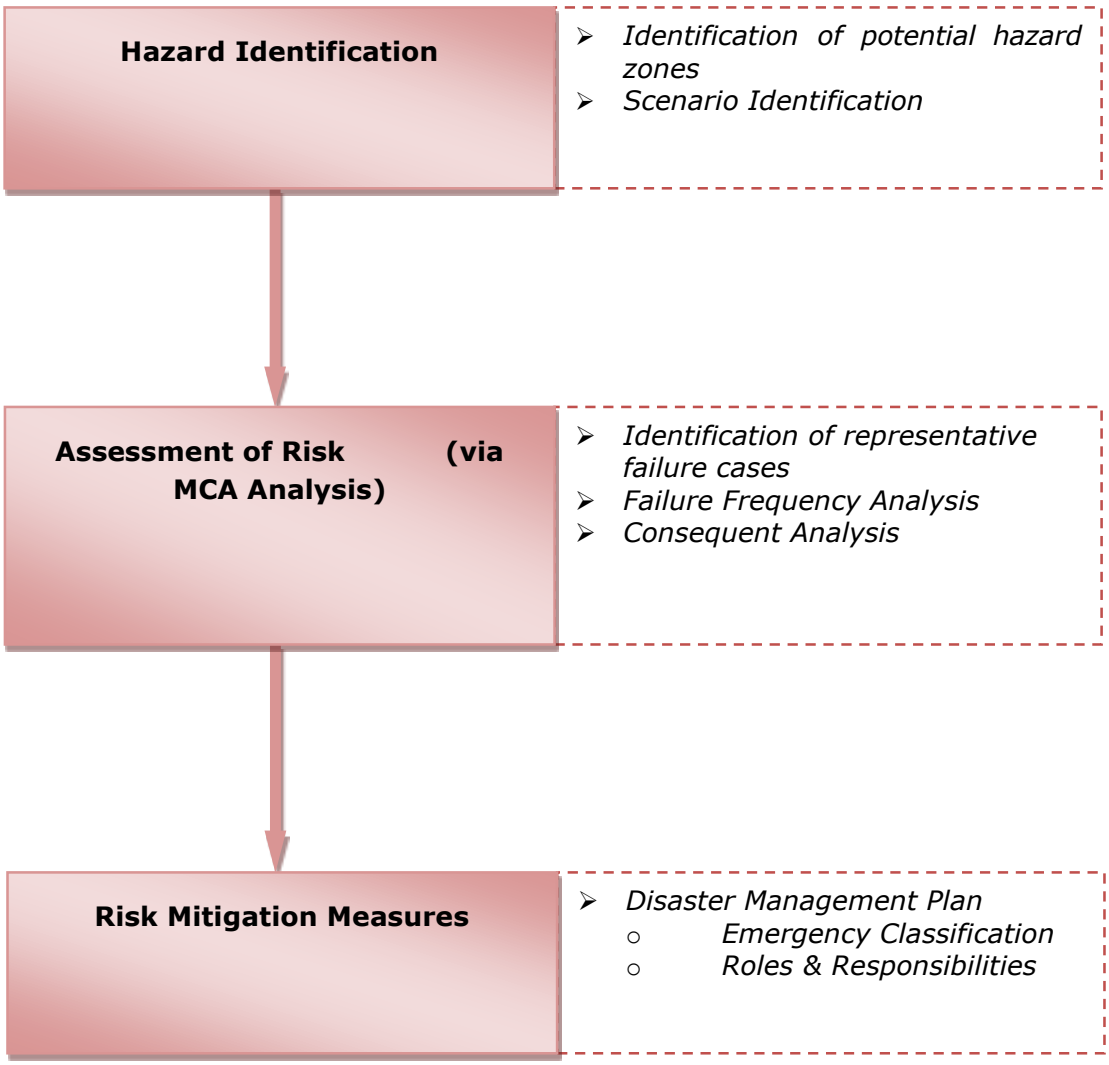
Sr. No.	Hazard	Description	Specific Hazard
1	Working at heights	Fall	Fall
			Man overboard
2	Disease/ Illness	Illness	Medical evacuation
3	Storage of chemicals	Release of chemicals	Exposure to chemicals, inhalation, ingestion, body contact etc

3.1.5 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. Oil and gas may be released and result into jet fire & less likely unconfined vapour cloud explosion causing possible damage to the surrounding areas. Extent of the

damage depends upon the nature of 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.

An insight into physical effects resulting from the release of hazardous substances can be had by means of various models. The results of consequence analysis are useful for getting information about all known and unknown effects that are of importance when some failure scenario occurs and also to get information as how to deal with the possible catastrophic events.



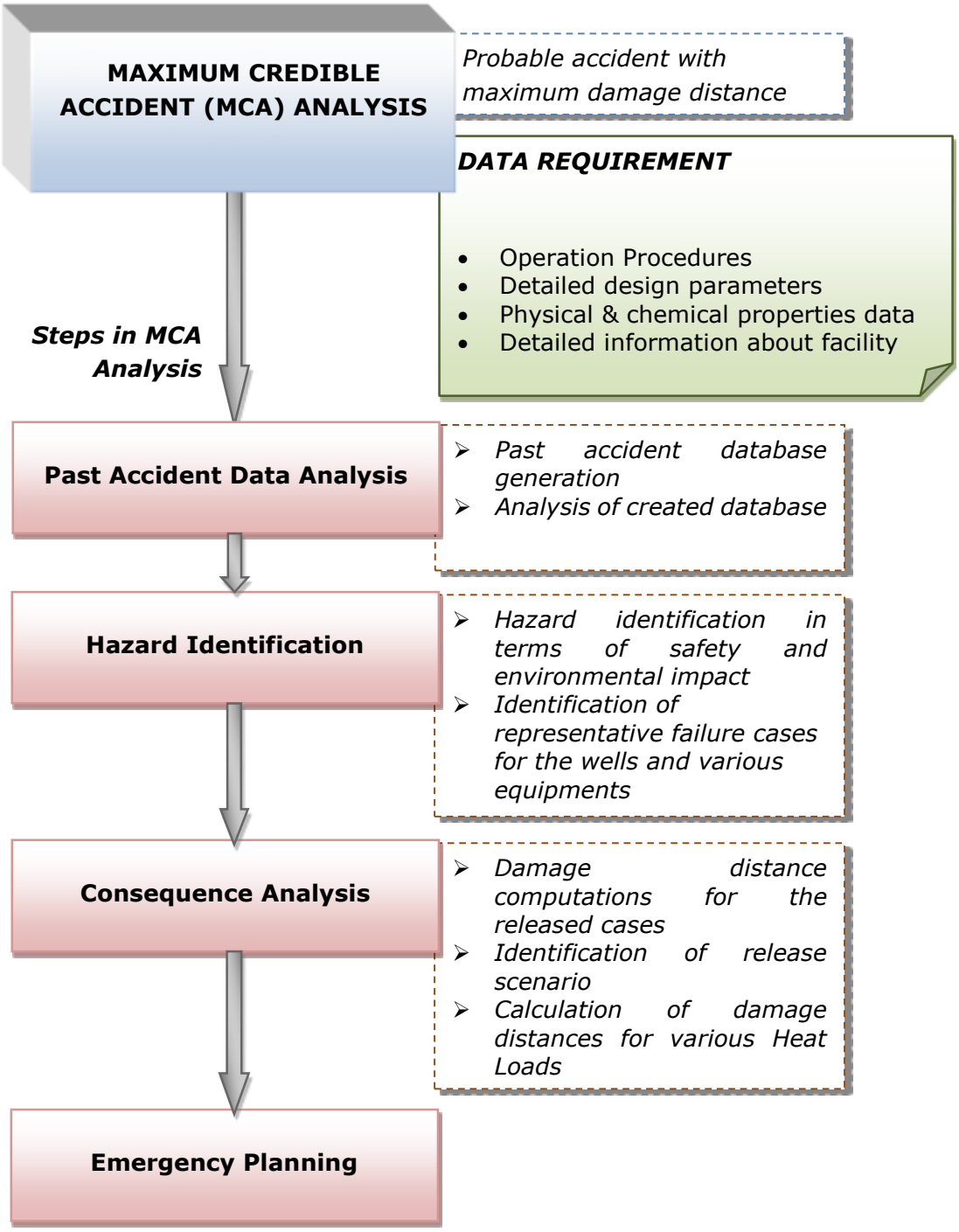


Figure 3-1: Methodology for MCA analysis

3.1.6 Damage Effects of Various Heat Loads

Damage effects of various peak over pressures and incident radiation intensities are detailed in Table 3-3 and Table-3.4 respectively.

Table 3-3: Damage due to Peak over Pressure

Human Injury		Structural Damage	
Peak Over Pressure - bar	**Type of Damage**	**Peak Over Pressure- bar**	**Type of Damage**
5 - 8	100% lethality	0.3	Heavy (90% damage)
3.5 - 5	50% lethality	0.1	Repairable (10% damage)
2 - 3	Threshold lethality	0.03	Damage of Glass
1.33 - 2	Severe lung damage	0.01	Crack of Windows
1 - 11/3	50% Eardrum rupture	-	-

Source: Marshall, V.C. (1977) 'How lethal are explosives and toxic escapes'

Table 3-4: Damage due to incident radiation inetsity

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

Source: Techniques for Assessing Industrial Hazards by World Bank

3.1.7 Scenario Identification

Emergency scenario is identified based on past experiences and historical evidences. A flowchart that can be followed to evaluate the consequences of the release of a flammable or toxic chemical is given in Figure 3-2.

Historical evidence demonstrates that although unlikely, the most significant hazard arises from the thermal radiation produced by an ignited liquid or gas release. Releases from the wells could arise in the form of blowouts. This may lead to release of gas into the atmosphere. An availability of ignition source can lead to jet fire.

3.1.8 Model for the Calculation of Heat Loads and Shock Waves

If a flammable gas or liquid is released, damage resulting from heat radiation or explosion may occur on ignition. Humidity of the air (water vapour) has a relatively high heat-absorbing capacity. The orientation (horizontal / vertical) of the object irradiated with respect to the fire is an important factor to be considered. If a jetted release of the oil & gas mixture is ignited, a stable diffusion torch or jet fire may be produced. 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. In order to calculate the thermal load, the centre of the flare is regarded as a point source. This centre is taken as being half a flare-length from the point of outflow.

A flash fire is the non-explosive combustion of vapour cloud resulting from release of a flammable material in the atmosphere, which after mixing with air, ignites. A flash fire results from the ignition of a released flammable cloud, in which there is essentially no increase in combustion rate. The ignition source could be electric spark, a hot surface, and friction between moving parts of a machine or an open fire.

Part of the reason for flash fire is that flammable fuels have a vapour temperature less than ambient temperature. Hence as a result of spill, they are dispersed initially by the negative buoyancy of the cold vapours and subsequently by atmospheric turbulence. After the release and dispersion of a flammable fuel, the resulting vapour cloud is ignited and when the fuel vapour is not mixed with sufficient air prior to ignition, it results in the diffusion fire burning. Therefore, the rate at which the fuel vapour and air are mixed together during combustion determines the rate of burning in the flash fire.

The main dangers of flash fires are radiation and direct flame contact. The size of the flammable cloud determines the area of possible direct flame contact effects. Radiation effects on a target depend on several factors including its distance from the flames, flame height, flame emissive power, local atmospheric transitivity and cloud size. Most of the time, flash combustion of a flash lasts for no more than a few seconds.

3.1.9 Input Data for Consequence Analysis

The data used for the consequence analysis is depicted in Table 3-5: Input Data for consequence Analysis

Table 3-5: Input Data for consequence Analysis

Parameter	Case
Ambient Temperature	350C
Atmospheric stability	A & D
Relative humidity	70%
Wind speed	2 m/s for stability class A 5 m/s for stability class D

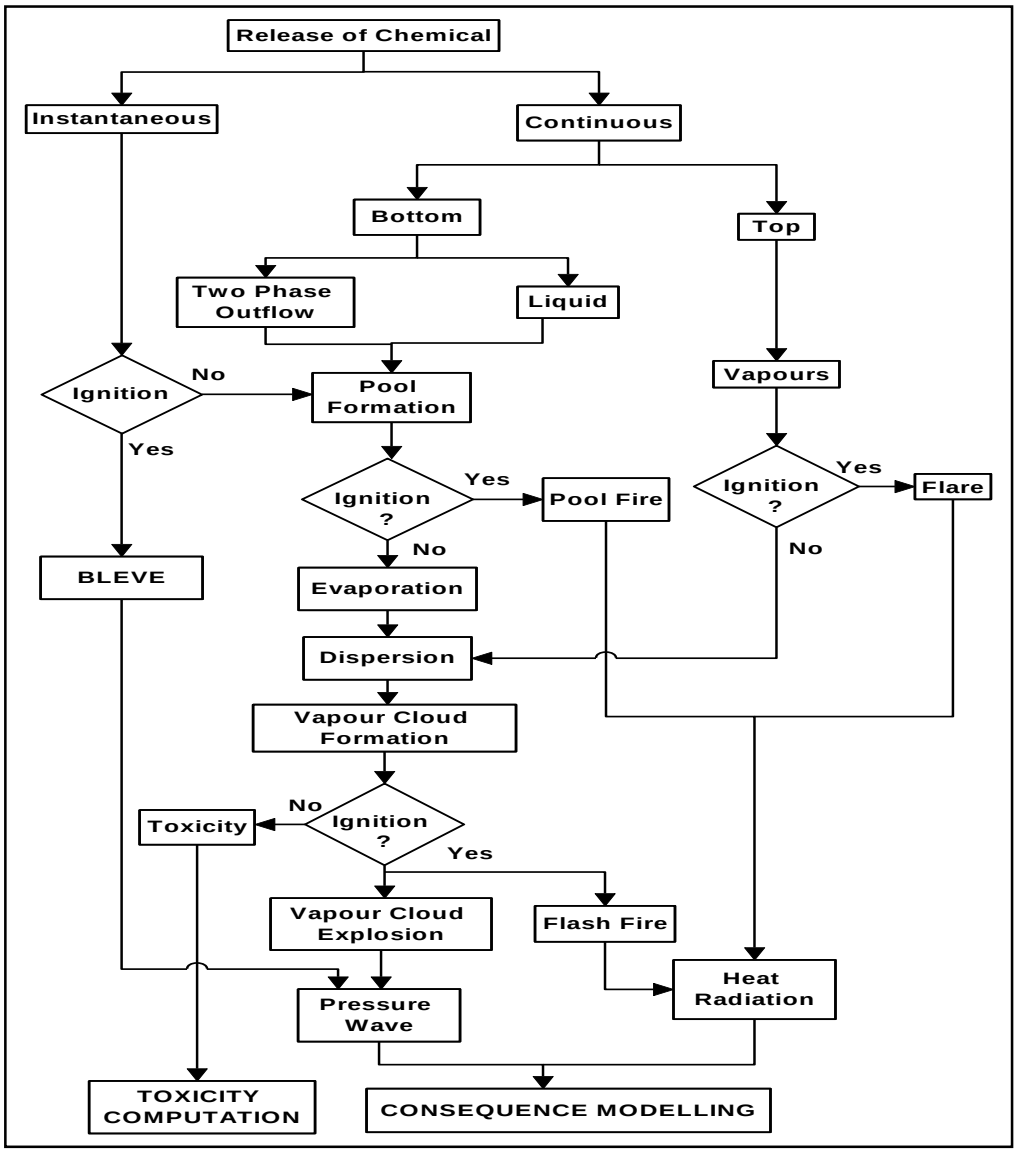


Figure 3-2: Flow Chart for evaluation of consequnces during the release of flammable or toxic chemical

3.1.10 Results and Discussions

Jet Fire from Well (Oil) Blowout is visualised for carrying out the consequence analysis. A well blow out can lead to uncontrolled release of oil into the atmosphere. 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. Damage distances are computed for the operating pressure of 290 psi and temperature of 70^{0}C. Weather conditions 2A and 5D are considered while computing the damage distances. The damage distance of 95.7m is obtained for the heat load of 4 kW/m2 in case of well blow out for 5D conditions. Results are shown in Table 7.6. The calculations of Pool Fire is given in ***Annexure 1.***

Table 3-6: Summary of Consequnce Anaysis for jet fire scenario at well

Pressure (psi) / Temp (°C)	Scenario	Mass Flow Rate (kg/s)	Weather	Damage Distance (m) for various Heat loads		
				4.0 kW/m2	12.5 kW/m2	37.5 kW/m2
290 / 70	Blow out	16	2A	82.5	-	-

Pressure (psi) / Temp (°C)	Scenario	Mass Flow Rate (kg/s)	Weather	Damage Distance (m) for various Heat loads		
				4.0 kW/m2	12.5 kW/m2	37.5 kW/m2
			5D	95.7	-	-

3.1.11 Failure Frequency Analysis

A blowout is defined as an uncontrolled release of fluid, viz., hydrocarbon (oil and/or gas), but drilling mud, completion fluid or water from a well. It is most hazardous when the fluid is hydrocarbon. Blowouts are important because they have the potential to release large amounts of hydrocarbons and are very difficult to control.

A well control incident is one in which a high potential release which may result in blowouts either does not occur or is quickly stopped. They typically involve formation fluid accidentally entering the wellbore, but controlled by the available barriers such as the blowout preventer (BOP). These incidents usually have relatively minor consequences, and are not well reported.

For some events, it is unclear whether they should be counted as a full blowout or as a well control incident. Different databases categorise events in different ways, and some analyses use the term "blowout" to refer to all well control incidents.

3.1.12 Historical Data Sources

The main compilations of secondary data on blowouts are:

SINTEF blowout database - An internal SINTEF compilation sponsored by 6 operators and 2 consultants (Holand 1995), including 319 blowouts for the period 1970-94, of which 128 occurred in the US GoM OCS or North Sea during 1980-94. It is an update of the Marintek blowout database, for which the full list (SINTEF 1983) and an analysis (NSFI 1985) were published. Detailed analyses have been published for the period 1980-93 (Holand 1996, 1997). Scandpower (1995) analysed the data for the period 1980-92, and included a full list of the events.

E&P Forum database - Frequencies from BLOWOUT for the period 1970-85 were published by OCB / Technica (1988) and E&P Forum (1992).

The secondary data on Failure Rate Frequency is given in ***Annexure 2.***

3.1.13 Probability of Immediate Ignition and Individual Risk Assessment Criteria

The information available on probability of ignition is mostly in the form of expert estimates. The details of immediate ignition probabilities used in this analysis are given in Table 3-7. This data has been obtained from E&P Forum. Similarly, the ADNOC individual risk assessment criteria are given in Table-7.8.

Table 3-7: Probability of Ingnition for leaks of Flammable fluids

Leak Rate	Probability of Ignition	
	Gas	Liquid
Minor (< 1kg/s)	0.01	0.01
Major (1 to 50 kg/s)	0.07	0.03
Massive (>50 kg/s)	0.30	0.08

Source: E&P Forum

Table 3-8: THE ADNOC INDIVIDUAL RISK ASSESSMENT CRITERIA

DNOC Acceptability Criteria	Maximum Individual Risk Criteria for Workers		Maximum Individual Risk Criteria for Public
	Existing Installation	New Installation	
Benchmark	IR < 2 x 10^{-4}	IR < 2 x 10^{-5}	IR < 1 x 10^{-5}

DNOC Acceptability Criteria	Maximum Individual Risk Criteria for Workers		Maximum Individual Risk Criteria for Public
	Existing Installation	New Installation	
Unacceptable	IR > 1 x 10^{-3}	IR > 1 x 10^{-3}	IR > 1 x 10^{-4}
Acceptable	IR < 1 x 10^{-5}	IR < 1 x 10^{-5}	IR < 1 x 10^{-6}

Source: E&P Forum

3.1.14 Individual Risk Assessment

The Individual risk due to well blowout is calculated with the help of Software. 20 persons were considered as a population present within the well pad in a shift and frequency of well blowout. The individual risk due to well blowout varies from 1E-06 to 1E-09 and it is concluded that the risk due to well blowout is acceptable for workers as well as for the public as per Table 3-7.

3.1.15 Geo-hazards

Geo-hazards include landslides, flooding, land subsidence and earth quakes. The major geo-hazard associated with oil production is land subsidence. Land subsidence is termed as the sudden sinking or gradual downward settling of land with little or no horizontal motion, caused by a loss of subsurface support which may result from a number of natural and human caused occurrences including subsurface mining or the pumping of oil or ground water. Land subsidence events, depending on where they occur, can pose significant risks to health and safety or interruption to transportation and other services. Land subsidence is effected by characteristic of the reservoir rocks, pressure of overburden, relationship between compaction and pressure gradient in the reservoir, pressure decline dynamic and its influence on the compaction rate and the surface subsidence.

Drilling activities do not involve any extraction of hydrocarbon and thus in this case, any possibility of subsidence is ruled out. In the event of a successful discovery leading to production activities, geo-technical investigations, geological impacts assessment will be carried out and appropriate measures will be undertaken.

3.1.16 Recommendations to Mitigate Risk/Hazards

The recommendations to mitigate risk at the well site during the drilling operation are given in Table-7.9.

Table 3-9: Recommendtation to mitigate blow out risk/hazrd

Sr. No.	Mitigative Measures	Remarks
1	Maintenance of mud weight	Drilling Mud Engineer should check the ingoing & 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 & furthermore, a well blow out.
2	Monitoring of active mud tank level	Increase in active tank level indicates partial or total loss of fluid to the well bore, which 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.
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 which returns back to the pit when the string runs back; Both the 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.
4	Monitoring of inflow	The flow nipple during tripping or connection time should be monitored for any inflow from the well bore

Sr. No.	Mitigative Measures	Remarks
5	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.
6	Team Coordination	Each team member must religiously follow the safety aspects pertaining to respective operational area. 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. Adequate firefighting 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.

3.2 Disaster Management Plan

In view of the hazardous nature of products / process handled by the ONGC, a Disaster Management Plan (DMP) has been prepared. These plan is based on various probable scenarios like well blow out, fire, explosion, natural calamities etc. The consequence arising out of such incidents are accurately predicted with the help of latest technique available by various risk analysis studies. To minimize the extent of damage consequent to any disaster and restoration of normalcy is the main purpose of DMP.

3.2.1 Objectives of Disaster Management Plan

The purpose of DMP is to give an approach to detail organizational responsibilities, actions, reporting requirements and support resources available to ensure effective and timely management of emergencies associated to production and operations in the site. The DMP process flow diagram is shown in Figure 3-3.

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
- Minimize 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
- To provide guidance to help stack holders take appropriate action to prevent accidents involving hazardous substances and to mitigate adverse effects of accidents that do nevertheless occur.

3.2.2 Different Phases of Disaster

Warning Phase

Many disasters are preceded by some sort of warning. For example, with the aid of satellites and network of weather stations, many meteorological disasters like cyclones and hurricanes can be predicted and actions can be taken to eliminate/reduce their effect to counteract them.

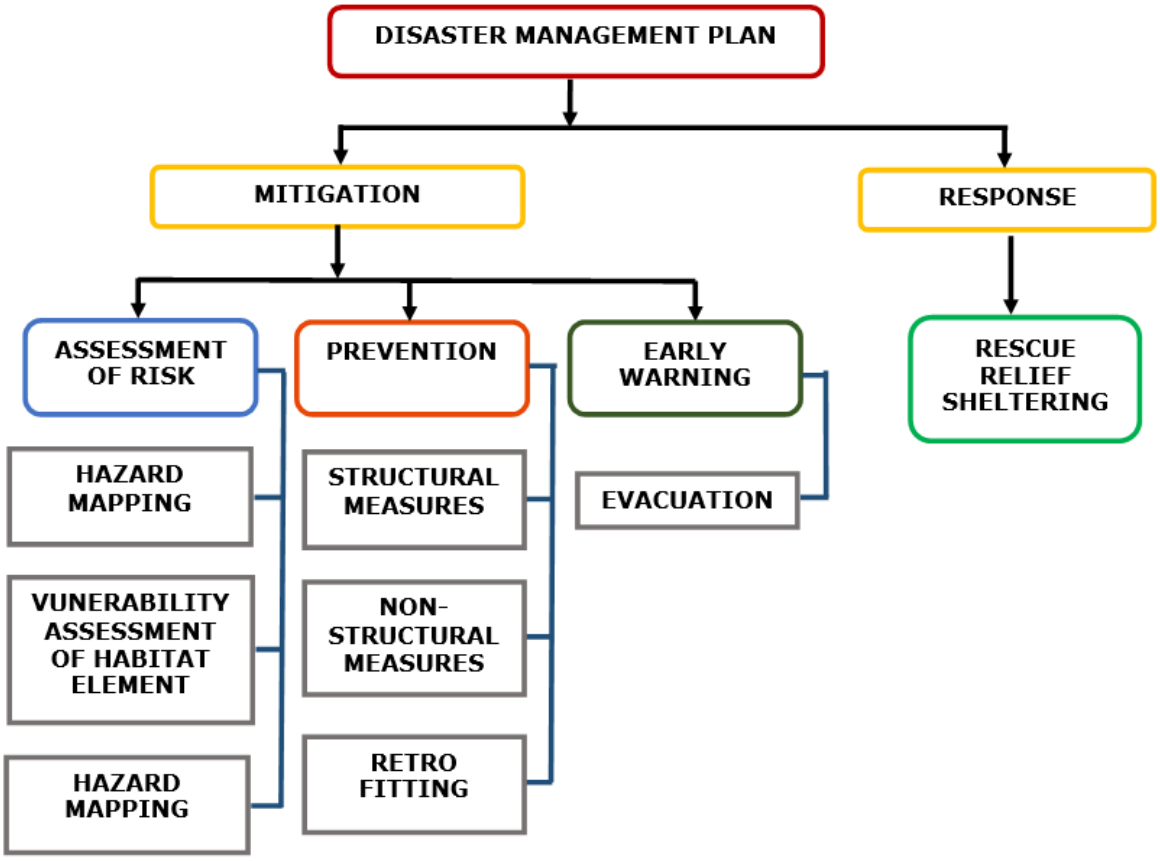


Figure 3-3: DMP PROCESS FOW DIAGRAM

Period of Impact Phase

This is the period when the disaster actually strikes and very little can be done to lessen the effects of disaster. The period of impact may last for a few seconds (like fire, explosion, and gas leak) or may prolong for days (fire, gas leak, etc.). This is the time to bring the action plan in force.

The coordinators in organization structure will perform the responsibilities assigned to them. Needless to emphasize that prompt and well organized rescue operations can save valuable lives.

Rescue Phase

The rescue phase starts immediately after the impact and continues until necessary measures are taken to rush help and combat with the situation.

Relief Phase

In this phase, apart from organization and relief measures internally, depending on severity of the disaster, external help should also be summoned to provide relief measures (like evacuations to a safe place and providing medical help, food clothing etc.). This phase will continue till normalcy is restored.

Rehabilitation Phase

This is the final and longest phase. It includes rebuilding damaged property, estimating the damages, payment of compensation, etc. Help from revenue/insurance authorities need to be obtained to assess the damage, quantum of compensation to be paid etc.

3.2.3 Key Elements of DMP

Following are the key elements of Disaster Management Plan:

- Basis of the plan
- Accident/emergency Management Plan
- On-site Disaster Management Plan
- Off-site Disaster Management Plan

Basis of the Plan

Identification and assessment of hazards is crucial for onsite emergency planning and it is therefore necessary to identify what emergencies could arise in production of various products and their storage.

Hazard analysis or consequence analysis gives the following results:

- Hazards from spread of fire or release of flammable and toxic chemicals from storage and production units; and
- Hazards due to formation of pressure waves due to vapor cloud explosion of flammable gases and oil spill hazards.

On-site Disaster Management Plan Purpose

The on-site DMP that deal with handling of the emergency within boundary of the proposed project well site mainly with the help of industry's own resources. The organizational setup for the on-site DMP is shown in Figure-7.5.

- To protect persons and property of processing equipments in case of all kinds of accidents, emergencies and disasters.
- To inform people and surroundings about emergency if it is likely to adversely affect them.
- To inform authorities including helping agencies (doctors, hospitals, fire, police transport etc.) 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. Review, revise, redesign, replace or reconstruct the process, plant, vessels and control measures if so assessed.

Off-site Disaster Management Plan Purpose

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. In Offsite disaster management plan, many agencies like government, revenue, public health, fire services, police, civil defence, home guards, medical services and other voluntary organization are involved. Thus, handling of such emergencies requires an organized multidisciplinary approach.

Evacuation of people, if required, can be done in orderly way. The different agencies involved in evacuation of people are civil administration (both state and central), non Govt. organizations, factory Inspectorate and Police authorities. The organizational setup for the off-site DMP is shown in Figure 3-5.

The District administration of Sivasagar has identified 16 expected task forces for key response operation functions that are described below. Additional taskforces can be added under the operations section as needed by the circumstances of a disaster. Each Taskforce is led by one organization and supporter by other organizations. Emergency operation taskforce functions is given in Table 7.10.

Table 3-10: Emergency Operation taskforce functions

Sr. No.	Emergency Operation Taskforce	Functions
1	Coordination and Planning	Coordinate early warning, Response & Recovery Operations

Sr. No.	Emergency Operation Taskforce	Functions
2	Administration and Protocol	Support Disaster Operations by efficiently completing the paper work and other Administrative tasks needed to ensure effective and timely relief assistance
3	Warning	Collection and dissemination of warnings of potential disasters
4	Law and Order	Assure the execution of all laws and maintenance of order in the area affected by the incident
5	Search and Rescue (including Evacuation)	Provide human and material resources needed to support local evacuation, search and rescue efforts
6	Public Works	Provide the personnel and resources needed to support local efforts to reestablish normally operating infrastructure
7	Water	Assure the provision of sufficient potable water for human and animal consumption (priority), and water for industrial and agricultural uses as appropriate
8	Food and Relief Supplies	Assure the provision of basic food and other relief needs in the affected communities
9	Power	Provide the resources to reestablish normal power supplies and systems in affected communities
10	Public Health and sanitation (including First aid and all medical care)	Provide personnel and resources to address pressing public health problems and re-establish normal health care systems
11	Animal Health and Welfare	Provision of health and other care to animals affected by a disaster.
12	Shelter	Provide materials and supplies to ensure temporary shelter for disaster-affected populations
13	Logistics	Provide Air, water and Land transport for evacuation and for the storage and delivery of relief supplies in coordination with other task forces and competent authorities
14	Survey (Damage Assessment)	Collect and analysis data on the impact of disaster, develop estimates of resource needs and relief plans, and compile reports on the disaster as required for District and State authorities and other parties as appropriate
15	Telecommunications	Coordinate and assure operation of all communication systems (e.g; Radio, TV, Telephones, Wireless) required to support early warning or post disaster operations
16	Media (Public Information)	Provide liaison with and assistance to print and electronic media on early warning and post-disaster reporting concerning the disaster

3.2.4 Levels of Emergencies

A generally accepted definition endorsed by ONGC is a critical condition that may endanger life, the environment, or company assets. This Emergency Management Plan (DMP) addresses two levels of Emergencies:

- Minor (Tier I); and
- Major (Tier II & III).

Minor Emergency

An Emergency requiring local support that can be handled by members of Incident Response Team (IRT) such as:

- Light bodily injury requiring the assistance of the doctor or a local nurse; and
- Minor environmental or property damage

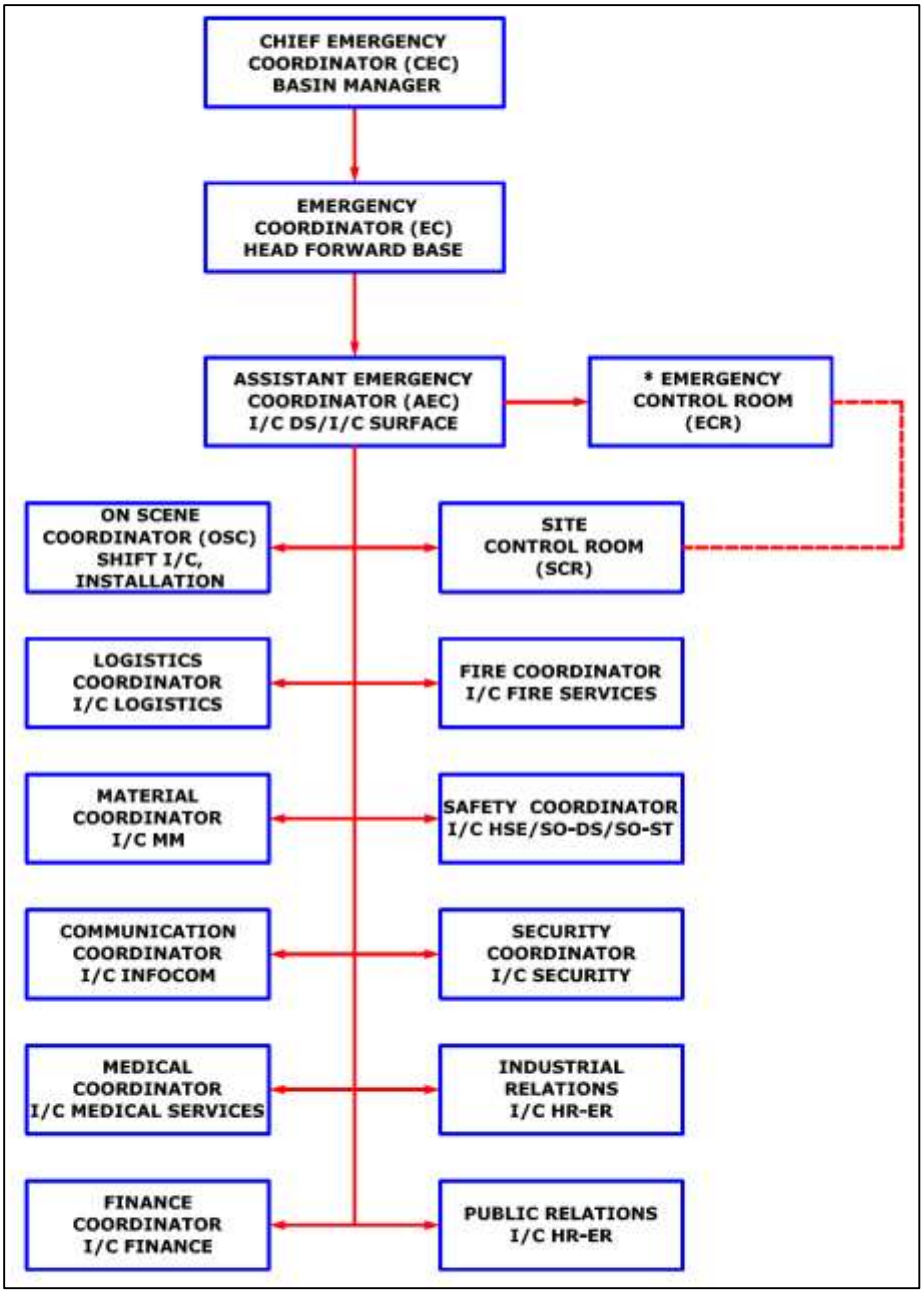


Figure 3-4: Organization Set up for Onsite DMP

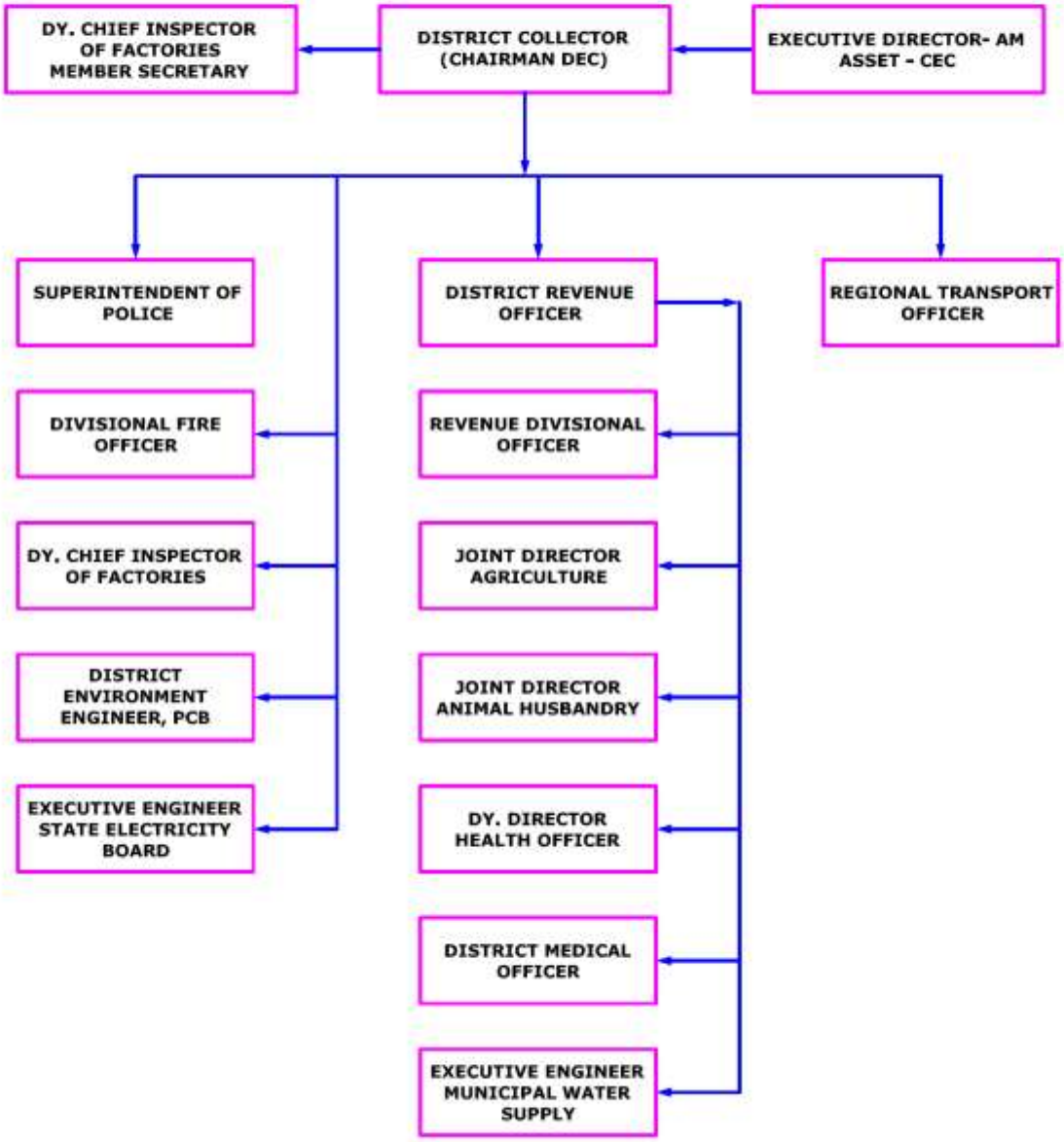


Figure 3-5: Organization Set up for off site DMP

Major Emergency

An Emergency that may require the assistance and support of the Emergency Response Group (ERG) at Regional Office in case of Tire-II emergencies and Crises Response Team (CRT) at Head Office for the Tire-III emergencies and external agencies. e.g.:

- Serious incidents of spills, blow outs, release of hazardous / toxic substances, structural failure / collapse;
- Medical evacuation in the event of life threatening bodily injury or severe electric shock, life threatening illness;
- Major environmental or property damage;
- Man lost situation;
- Major fire, explosion, radiation; and
- Unplanned evacuations such as natural calamity, war crisis, security breach.

3.2.5 Overall Philosophy of Emergency Response

Initial response to any incident will be managed at the incident location; in this case, it would be the site of infill well drilling. The overall level of response will depend on the nature and scale of the emergency.

The overall philosophy of emergency response is 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 and minimize the impact of the event on the installation and the environment by:
- Minimizing the hazard as far as possible;
- Minimizing the potential for escalation; and
- Containing any release.

3.2.6 Auditing

Audits should be carried out on a regular basis to verify and update the Emergency Response Plan and the corresponding procedures. The audit will review:

- The roles and responsibilities of the ERG and support organization;
- The requirements of legislation and regulatory bodies; and
- Resource requirements and availability.

3.2.7 Emergency Priorities

In the event of an Emergency occurring, the ONGC Policy lists, in order, the following priorities:

- Safeguard Life;
- Protect the Environment;
- Protect the Company / Third Party assets;
- Maintain the Company image and reputation; and
- Resume normal operations as soon as possible.

3.2.8 Emergency Response Management Group Interfaces

The relationship between the Remote Location "Incident Response Team" (IRT), "Emergency Response Group" (ERG), "Crisis Response Team" (CRT) and classification of emergencies is illustrated in the Figure-7.7.

3.2.9 Emergency Response Procedures

Minor 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 (Minor Emergency) – an event with no escalation potential, which can be controlled and contained by the action of personnel of Incident Response Team (IRT) at the incident site. In such cases of local alert, the 'ERG leader' will be notified but the ERG is not called out.

Some typical incidents are:

- Minor accident;
- Equipment damage;
- Medical evacuation (not very serious cases); and

- Minor fires.

Major Emergency

Tier-II Emergency

Events with escalation potential, depending on the effectiveness of the local response. These incidents may impact the entire site. For such type of incidents the installation manager assumes the charge of Incident Response Controller (IRC) and activates ERG who aide/guide the IRC in controlling the emergency situation. The country manager is notified on the same.

Some typical incidents are:

- Substantial security incident;
- Multiple casualties;
- Cyclone flooding;
- Serious damage to man/machinery;
- Substantial fire;
- Cultural conflict, and
- Serious incident.

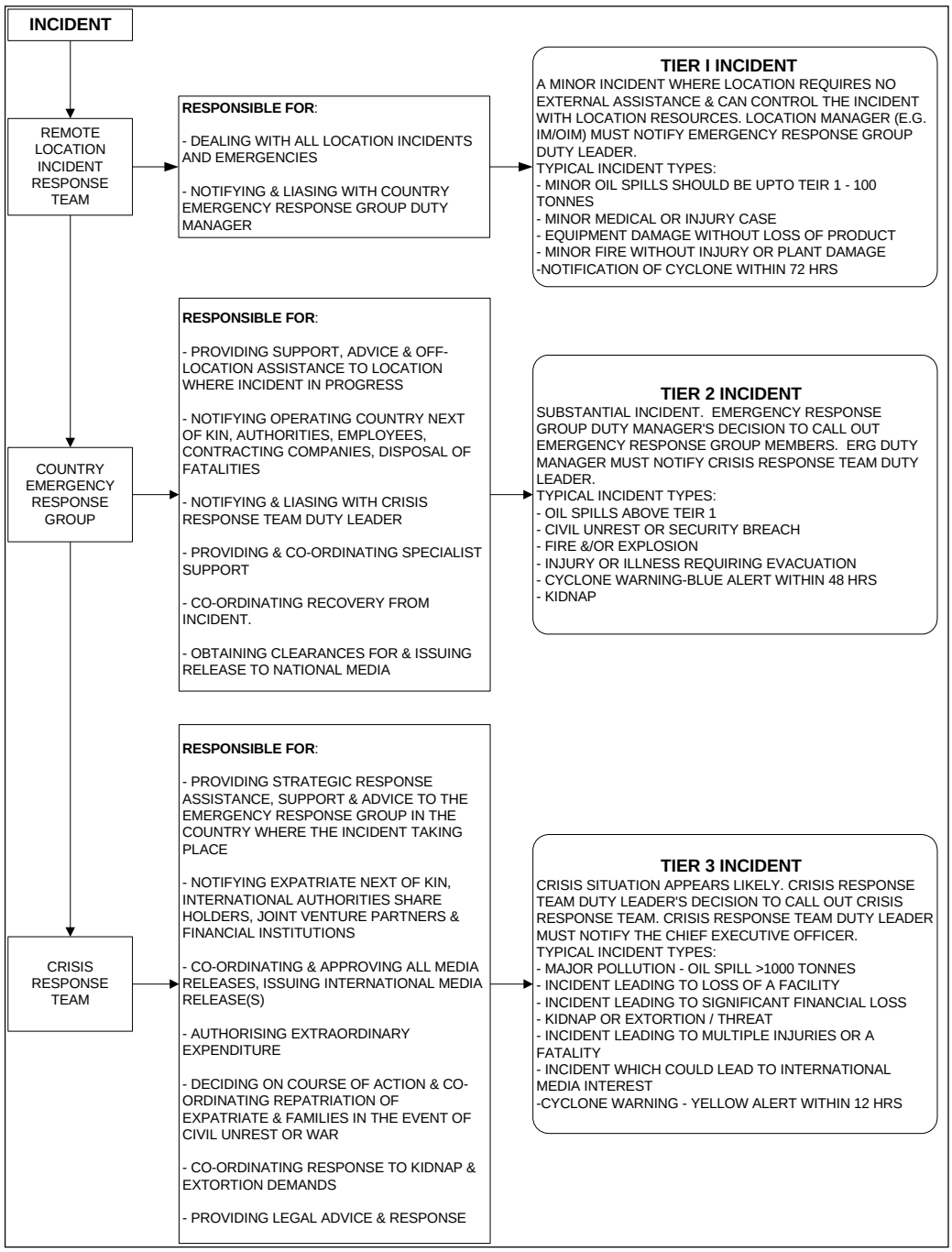


Figure 3-6: Emergency Classifiction

Tier- III Emergency

A crisis that requires assistance from external resources in order to save lives, minimize damage and to bring the abnormal situation back under control. These incidents have the potential to impact beyond ONGC site limit. In such cases, IRC activates the ERG who notify the country manager and

Crises Response Team (CRT) in Head Office will be activated. The CRT would guide / aide the ERG in controlling the emergency situation.

Some typical Tier-3 incidents are:

- Major fire/explosion;
- Evacuation of the rig/platform;

- Loss of the rig/platform;
- Fatality; and
- Terrorist attacks.

For a major emergency, the ERG team will use the Emergency Control Centers (ECCs) to enable constant guidance / aide during emergency situation between the incident site, ERG and CRT.

Emergency Response Strategies

Whenever there is an emergency, the response team is required to swing into action without losing time. Time is the essence of the immediate relief and rescue operations to save human life, to mitigate the impact on the environment and to safeguard commercial consideration. This DMP has been prepared keeping in mind the above fact and it is conceptually 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; and
- Alternate Plans & Contingency measures.

3.2.10 Alert Phase

It will be the duty of all site personnel at the site to remain alert at all times for hazardous situations that have the potential to escalate into an emergency incident. The ERG members would be activated as required.

Emergencies on site can be initiated in a number of ways depending upon the severity of the incident i.e., by the site fire alarm siren, which any personnel on the incident site can activate. The site siren will sound in an intermittent mode. Also, the individual fire alarms will sound in the area of the incident.

This procedure initiates the site fire and Rescue Department and Site Security into their standard procedures to attend the incident. This has the advantage of permitting the earliest possible action to be taken to control the immediate situation, which may avoid the development of a major emergency.

The 'Incident Controller' will attend the scene of the incident and the 'ERG Leader' will be notified. Depending upon the severity of the emergency (Tier-2) the ERG Leader will activate the ERG and notify the 'Country Manager' as appropriate. The incident controller will assess the situation from the edge of the incident scene to reduce the probability of personal injury. The ERG members will be on standby to go to the Emergency Control Centre (ECC).

Evacuation of employees to the nearest assembly point or refuge may be required, if not hindered by fire or toxic cloud (all personnel present on the incident site would make it a point to always move upwind in case of fire).

3.2.11 Preparedness for Emergencies

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.

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 staff trained and competent to fulfil the roles of other members of staff if they are not available.

List of Persons for Emergency Duties

A list of those staff that has emergency duties is displayed in the Control room. It is the responsibility of the ONGC Radio Officer would ensure that these lists are kept up to date.

3.2.12 Control of Emergencies

The major systems for controlling emergencies and preventing escalation are detailed in subsequent sections of the DMP, which gives the emergency procedures to be followed in case of an impending/occurring disaster.

It is absolutely necessary for the ERG leader to review the incident response and provide his inputs for improvements / modifications to the DMP and update accordingly. ERG leader would debrief all personnel involved in the emergency response action. It will be the responsibility of the ERG leader to develop a Post Emergency Action Plan with the assistance of Incident Controller. It will be the responsibility of the designated HSE personnel to prepare a complete incident report collating incident reports/ logs from the respondents and forward the same to higher authorities as appropriate.

3.2.13 Emergency Response Action

Incident Control Centres (ICC)

The Incident Controller will be responsible for co-ordinating the site response to any emergency and direct emergency response personnel as appropriate to the emergency. The installation manager's office shall be the designed ICC:

At the drilling rig, it is suggested that the best location for control centre will be main control room and alternately it may be shifted to Temporary Refuge (TR) in case of major emergency. There will be radio, telephone or messenger contact with the ICC.

The incident area will be tapped off and warning notices posted. The in-house Fire Team cordon off the incident area (Inner Cordon). Route markings from ICC to the incident to aid the emergency services will be arranged;

Various personnel will wear fluorescent jackets with a description of their role. This will include the Incident Controller and medics.

Emergency Control Centres (ECC)

The Emergency Control Centre is to be set up by a person designated by the ERG office. The ONGC's Guesthouse (if available) could be the alternate ECC. It is place from where the operations to handle the emergencies are directed and co-ordinated. The centre is equipped to receive and transmit information and direction from and to the Incident Controller as well as from outside. ECC shall contain equipment for logging the development of the incident to assist the controllers determine any necessary action:

The ICC and ECC should contain:

- An 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;
- An adequate number of internal telephones; and
- Radio equipment;
- A plan or plans of the works to show;

- Areas where there are large inventories of materials, including oil storage, drilling materials;
- Sources of safety equipment;
- The fire water system and additional sources of water;
- Stocks of other fire extinguishing materials;
- Assembly points, casually treatment centres;
- Location of the works in relation to the surrounding community; and
- Lorry/truck 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
- HAZCHEM sheets for the various hazardous materials used on-site;
- Note pads, pens, pencils to record all messages received and sent by whatever means;
- Nominal roll of employees or access to this information;
- List of key personnel, addresses and telephone numbers.

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

3.2.14 Emergency Response Procedures

Blowout

During a blowout, the Rig (specific) emergency Response Plan would be referred. The contingency plan for onshore blowout (drilling rig) is given in Figure-7.8. Common steps required during blowout are discussed as below:

Driller/person on the spot

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); and
- Prepare kill sheet and make calculations for standard well killing procedures;

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;
- Make up Kelly;
- Record shut in SIDP and SICP; and
- 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 steps as mentioned in case of while making trip; and
- If the trip in is not possible then use volumetric method off well control.

In case of sudden kick:

- Close the BOP;
- Record SIDC & SICP; and
- Prepare kill sheet and make calculations for standard well killing procedure.

On detection of a kick the Senior Tool pusher/Drilling supervisor is to be informed immediately; and

Person discovering the blowout should notify radio room of the incident.

Radio Room

Alert to the fire team;

Notify Incident Controller of the incident to clear non-essential traffic; and Send radio and other communications on instructions from Incident Controller

Drilling Supervisor/PIC

Minimize ignition sources;

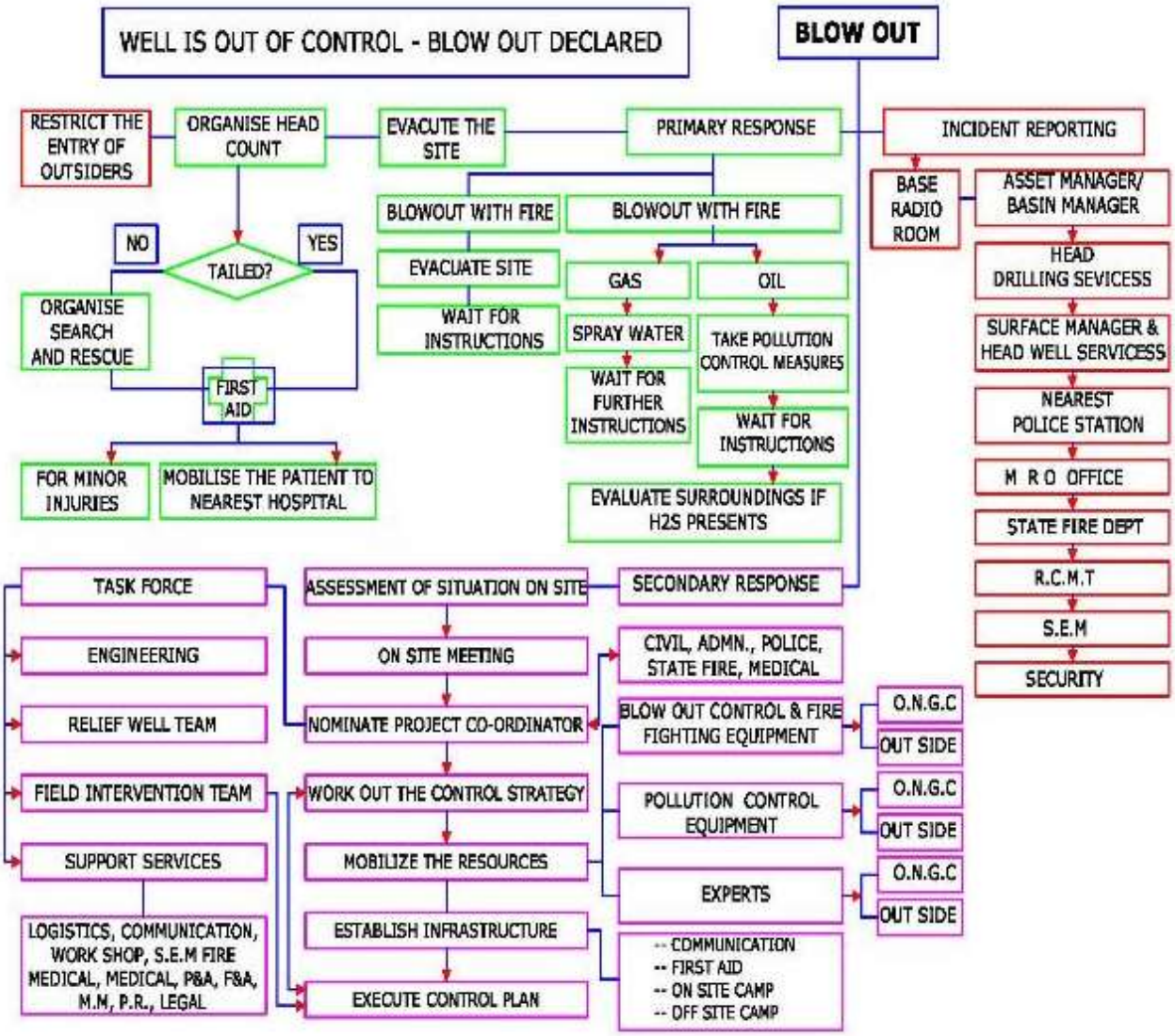


Figure 3-7: Contigency Plan fo onshore Blow out (Drilling Rig)

- Assess the situation along with Senior Tool pusher and declare the incident to be:
- Minor event, which can be brought under control using in situ equipment
- Serious event, which may not be brought under control; and
- Major event, in which the well is unlikely to be brought under control
- Incident controller to be informed immediately if the event is classified as serious or major event; and
- Instruct control room to suspend drilling operations

Incident Controller

Inform to the ERG Leader, provide full details and likely requirements and maintain contact;

Activate site response personnel as appropriate, provide full incident briefing and likely requirements and maintain liaison;

Ensure that Fire team is on standby;

Instruct to all non-essential personnel to prepare for evacuation. In a major emergency, an order for total evacuation must be given;

After situation has returned to normal, inspect incident site to determine whether further corrective action is required to make situation safe.

ERG Leader

Obtain full incident briefing and likely requirements from Incident Controller and maintain liaison;

Active ERG appropriate contact Directory;

Notify EMT Leader and provide full incident briefing and likely requirements;

Co-ordinate support activities as required; and

Determine need for external assistance for safety of personnel, well control and pollution prevention;

3.2.15 Well Control

The following preventers are stacked in a sequence and this assembly of preventers is termed as "BOP Stack" as shown in the Figure 3-8.

Blowout Preventers: Blow out Preventer consists of Annular Preventer, which can generally close on any size or shape of tubular in the well bore which closes the annular space between drill string and casing.

Ram Preventer: Ram preventers are of two types i.e. Pipe Rams and Shear Rams. Pipe rams also close the annulus between drill string and casing, but they have a fixed size. As such a specific pipe rams can be closed on a specific size of pipe. Shear rams are generally the last choice of preventer to be operated as they shear drill string and shut off the well bore. Blowout prevention equipment shall be installed, tested and operated according to the Well Control Manual for Drilling Operations. Certain key personnel on the drilling unit shall hold a valid certificate of examination from a recognized pressure control course.

The BOP stack in use shall be pressure tested initially before drilling out of the casing shoe and thereafter weekly. A sequence of successful tests indicate that greater confidence could be placed in the stack and control equipment, then the testing interval can be extended up to a maximum of two weeks.

All pipe fittings, valves and unions placed on or connected to blow-out prevention equipment, well casings, casing head housing, drill pipe or tubing shall have a working pressure rating at least equivalent to that of the component to which it is fitted.

Drilling operations shall not proceed until blowout prevention equipment is found to be serviceable by visual inspection and appropriate pressure testing.

BOP control systems are installed, tested and operated according to the Well Control Manual for Drilling Operations. In addition to the instrumentation to indicate the availability of air pressure and fluid pressure, the following safety features will be considered for the control systems:

A relief valve installed; accumulator low-pressure alarm; air-driven hydraulic fluid charge pumps; electric-driven hydraulic pump to be connected to the emergency generator; fail safe regulators; manifold pressure is consistent with ram closing force requirements at anticipated maximum surface pressure (high pressure wells); accumulator capacity at elevated manifold pressures still meets requirements; fire resistant hydraulic control hoses and control fluid; appropriate location of remote operating panels; redundant functions plugged off; hydraulic control hose are tested to the rated pressure of the unit.

Hydrogen Sulphide (H2S)

Natural gas leaks are expected regardless of the location. Natural gas is an extraneous material. As such all natural gas leak carry the risk of fire and explosion until the leak is contained. Hydrogen sulfide is a toxic chemical gas frequently found in natural gas deposits.

During drilling operations, the consequences of leaks or kicks with sour gas or crude can be very serious. Personnel can be incapacitated by relatively low concentrations of H2S in a very short time and equipment can suffer catastrophic failure due to H2S embrittlement.

A contingency plan will be drawn up when H2S may be expected during well operations. A study will be made of the geological and geographical features of the area, in order to predict the expected areas where H2S may be encountered or may accumulate. Information about the area and known field conditions, including temperatures, pressures, proposed well depth and H2S concentrations will be obtained and taken into consideration. The drilling program will highlight this hazard and give details of controls and recovery measures in place.

Once the cellar has been excavated, the drill pad constructed and equipment set in place, drilling can commence. Typically, at the time of site construction, a false conductor of large diameter will be grouted up to 3.5 m from surface. Initially, the drilling fluid used is quite often water alone. Drilling will then continue for several hundreds of meters. At this depth smaller diameter casing is usually cemented into the hole. This intermediate casing protects the well by sealing potentially weak zones. At this stage low density drilling muds will be used and although it is unlikely that gases or fluids under pressure might be encountered, a blowout preventer is typically installed to prevent fluid from the formation gushing to the surface. Drilling continues using progressively smaller bits and incrementally decreasing casing diameters. Changes in mud composition, and drill bit, are likely to occur according to the different strata encountered.

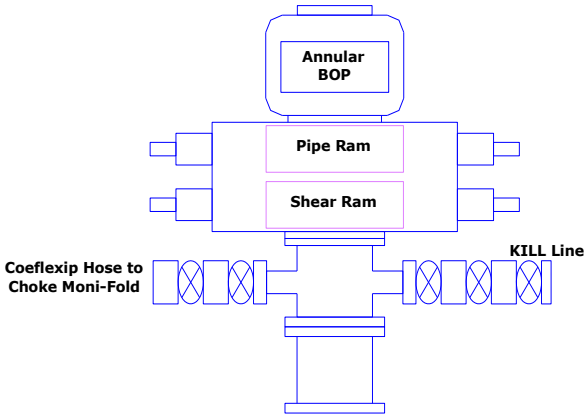


Figure 3-8: Typical Schematic of BOP Stack

3.2.16 Abandonment of Rig/Well

In case of major incident, which necessitates the abandonment of the rig/well, the following actions will be taken;

Table 3-11: Emergency Siren Modes

Emergency Siren Modes		
Fire	High/Low tone	Proceed to muster point(s)
Evacuation	On/off monotone	Evacuate as directed
All clear	Continuous monotone	Emergency ended
Control room will activate Emergency Siren upon fire Call Point or ESD being activated. Personnel can also alert Control Room by radio or phone		

Rig/well PIC

- Notify Radio Room of intention to abandon the rig
- Ensure that rig facilities are cleared for evacuation (e.g. clear equipment from heli-deck etc);
- Determine appropriate safe method of abandonment and notify all personnel to assemble at appropriate Muster Point;
- Contact Incident Controller to provide full incident briefing and likely requirements and maintain liaison; and
- Instruct all personnel to evacuate the rig.

All Other Personnel of Rig

On hearing alarm, put on life jacket and proceed to Muster Point nominated by Rig–PIC, remain calm and await instructions; and

If evacuating by jumping into "buddy up" and tie off if possible any try to stay together with as many people as possible.

Radio Room

On receiving emergency call, nominate a dedicated frequency for the emergency calls;

Notify Incident Controller and advise of emergency frequency and update frequently;

Inform all ONGC radio stations of incident and ask to clear non-essential traffic; and

Send radio and other communications on instructions of Incident Controller.

HSE Support

Conduct headcount of personnel assembled at Muster Point;

Notify Incident Controller of headcount/token results and emphasize on any discrepancy;

Ensure that headcount is updated if people are allocated tasks that remove them from Muster Point (e.g. fire team etc); and

For any discrepancy in headcount, reconcile daily record of persons on site with lists of persons assembled at Muster Points and notify Incident Controller of identify of missing person(s).

Incident Controller

Obtain full incident briefing and likely requirements from RIG PIC and maintain liaison;

Ensure that all production is shut in and that all machinery is rendered safe;

Ensure that all personnel are accounted for via headcount as SAR is conduct for any missing persons;

Obtain a personnel list on the affected rig; and

Notify ERG Leader of rig evacuation and any likely requirements

ERG Leader

Obtain full incident briefing and likely requirements from Incident Controller an maintain liaison;

Activate ERG with appropriate Contact Directory

Notify EMT Leader and provide full incident briefing and likely requirements; and

Co-ordinate support activities as required.

3.2.17 Structural Damage/Failure of the Rig

The actions to be taken during a structural damage/failure of the rig/well are as follows:

Drilling Supervisor/PIC

Notify Radio Room of incident;

Instruct Site Control Room to shut the drilling operation if required;

Inspect any damage/failure sustained by rig, if safe to do so, assess actions required to make rig safe;

Ensure that all personnel are accounted for and consider need for evacuation; and

Contact Incident Controller to provide full incident briefing and likely requirements and maintain liaison.

Radio Room

Call support vessel to affected rig if required;

Notify Incident Controller of incident and update as further communications received;

Inform all ONGC radio stations of incident and ask to clear non-essential traffic; and

Send radio and other communications on instructions from Incident Controller.

Incident Controller

Obtain full incident briefing, and likely requirements from Drilling Supervisor/PIC and maintain liaison;

Ensure that all personnel have been accounted for;

Ensure that drilling activity has been stopped if appropriate;

Notify ERG Leader, provide full incident briefing and likely requirements;

Proceed to affected part of the rig for damage assessment and depending on severity of damage, suspend drilling operations, make all equipment secure and restrict access until repairs can be undertaken;

To assess and declare the incident to be a minor, serious or major event; and

To consider evacuation of non-essential personnel and depending on the severity of the incident, the evacuation of all personnel.

ERG Leader

Obtain full incident briefing and likely requirements from Incident Controller and maintain liaison;

Activate ERG with appropriate Contact Directory;

Notify EMT Leader and provide full incident briefing and likely requirements; and

Activate technical support as appropriate for evaluation and control of situation.

All response Members Maintain log of events for collection at end of incident

3.2.18 Well Control Emergencies

Person first on scene

- Notify radio Room of incident;
- Follow appropriate well control procedure;
- Instruct all non-essential personnel if any to proceed to Muster Point(s); conduct headcount(s) as required;
- Ensure that all possible ignition sources on affected platform are turned off;

- Determine source of the problem and safest & most effective way to prevent incident from escalating;
- Ensure that wire line crew are advised/aware of any incident and likely requirements;
- Contract Incident Controller to provide full incident briefing and likely requirements, Maintain liaison.

Radio Room

Notify Incident Controller, Production Supervisor and Petroleum engineer of incident; update as further communications received;

Inform all ONGC radio stations of incident and ask to clear non essential traffic;

Send radio and other communications on instructions from Incident Controller.

Incident Controller

Obtain full incident briefing and likely requirements from Wire line and/or site Supervisor, Maintain liaison;

For wire line incident, ensure that drilling supervisor and petroleum engineer is notified;

Consider need to evacuate platform, if any, request results of any headcount and ensure that all personnel are accounted for conduct SAR for any missing personnel; and

ERG Leader

Obtain full incident briefing and likely requirements from Incident Controller. Maintain liaison

Activate ERG with Contact Directory as required;

Notify wire line contactor management and maintain liaison;

Determine need for external assistance for safety of personnel, well control and pollution prevention;

Activate pollution control procedures as required;

Liaise with support co-ordinator to activate well control specialties and equipment to incident site as required;

Consult with Incident Controller and Wire line Supervisor regarding safest, most effective way to resolve incident.

All Response Member

As time permits, maintain log of events for collection at end of incident

3.2.19 Fire On Rig

Person first on scene

Shut down production by activating ESD;

Close down any manual feed valve that may be feeding the fire, if safe to do so,

Notify Radio Room on incident;

Attempt to extinguish the fire with portable equipment, if safe to do so; and

Contact Incident Controller to provide incident briefing and any likely requirements.

Radio Room

Alert Fire Team of incident,

Notify Incident Controller of incident and update as further communications received;

Inform all radio stations of incident and ask to clear non-essential traffic; and

Send radio and other communications on instructions from Incident Controller.

Rig PIC (if any maintenance/survey team is on the platform)

Instruct Control room to shutdown activities from affected rig;

Instruct all non-essential personnel, if any to proceed to Muster Point and conduct headcount as required; and

If fire cannot be extinguished safely, consider need for evacuation (if any) of rig.

Incident Controller

Activate site response personnel as appropriate and provide full incident briefing and likely requirements. Maintain liaison;

If fire extinguished, ensure that there is no gas leak. If gas leak detected, and if safe to do so, shut off all ignition sources, close all relevant shut-off valves and evacuate rig;

Notify ERG Leader, provide full incident briefing and likely requirements;

After situation has returned to normal, inspect incident site to determine whether further corrective action is required to make situation safe.

ERG Leader

Obtain full incident briefing and likely requirements from Incident Controller. Maintain liaison;

Activate ERG with appropriate Contact Directory;

Notify EMT Leader and provide full incident briefing and likely requirements; and

Co-ordinate support activities as required.

All Response Members

As time permits, maintain log of events for collection at end of incident.

3.2.20 Rig Evacuation

Person on Rig

Notify Radio Room of intention to abandon the rig

Ensure that platform/rig facilities are cleared for evacuation;

Determine appropriate safe method of abandonment and notify all personnel to assemble at appropriate Muster Point'

Contact Incident Controller to provide full incident briefing and likely requirements. Maintain liaison;

Instruct all personnel to evacuate the platform / rig;

Put on a lifejacket and proceed to Muster Point nominated by rig PIC. Remain calm and await instructions; and

If evacuating by jumping into the water, "buddy up" and tie off, if possible, try to stay together with as many people as possible.

Radio Room

On receiving emergency call, nominate a dedicated frequency for the emergency calls;

Notify Incident Controller and advise of emergency frequency and update frequently;

Inform all radio stations of incident and ask to clear non-essential traffic; and

Send radio and other communications on instructions from Incident Controller.

Incident Controller

Obtain full incident briefing and likely requirements from rig PIC and maintain liaison;

Ensure that all activity is shut in and that all machinery is rendered safe;

Ensure that all personnel are accounted for via headcount and SAR is conducted for any missing persons;

Obtain a personnel list for the affected rig; and

Notify ERG Leader of platform evacuation and any likely requirements.

ERG Leader

Obtain full incident briefing and likely requirements from ERG Leader and maintain liaison;

Activate ERG with appropriate contact directory;

Notify EMT Leader and provide full incident briefing and likely requirements; and

Co-ordinate support activities as required;

All Response Members

As time permits, maintain log off events for collection at end of incident

3.2.21 Gas Release on Rig

Person Discovering Release

Avoid creating any source of ignition;

Shutdown platform/rig by activating ESD;

If the location of the leak is known, and if safe to do so, shut any relevant manual valves;

Notify Radio Room of incident; and

Inform radio room of incident

Rig PIC

Stop all hot work and shutdown all other sources of ignition;

If safe to do so, attempt to locate and shut off the source of the leak; and

Contact Radio Room/Incident Controller to provide full incident briefing and likely requirements. Maintain liaison.

Radio Room

Notify Incident Controller of incident and update as further communications received;

Notify Drilling Supervisor, if appropriate;

Inform all radio stations of incident and ask to clear non-essential traffic; and

Send radio and other communications on instructions from Incident Controller;

Incident Controller

Obtain full incident briefing and likely requirements from radio room and maintain liaison;

Instruct Site Control Room to shut in production, if required;

Ensure that all personnel are accounted for and consider need to evacuate that all personnel are accounted for and consider need to evacuate non-essential personnel (in case team is present on the platform). Evacuate all personnel if gas concentration reaches danger level;

Notify ERG Leader and provide full incident briefing and likely requirements.

ERG Leader

Obtain full incident briefing and likely requirements from Incident Controller and maintain liaison;

Activate ERG with appropriate Contact Directory;

Notify EMT Leader and provide full incident briefing and likely requirements; and

Co-ordinate support activities as required.

All Response Members

As time permits, maintain log of events for collection at end of incident

3.2.22 Structural Damage

Rig PIC

In case of any maintenance/survey team is present on the rig.

Notify Site Radio Room of Incident;

Instruct site controller room to shut in production if required;

Inspect any damage sustained by rig, if safe to do so and assess actions required to make rig/platform safe;

Ensure that all personnel are accounted for and consider need for evacuation, if any, and

Contact Incident Controller to provide full incident briefing and likely requirements, Maintain liaison.

Site Radio Room

Notify Incident Controller of incident and update as further communications received;

Inform all radio stations of incident and ask to clear non-essential traffic; and

Send radio and other communications on instructions from Incident Controller.

Incident Controller

Obtain full incident briefing including status of any instrument, which may have collided with the rig/platform, and likely requirements from site radio room. Maintain liaison;

Ensure that support vessel proceeds to affected platform if required;

Ensure that production on the affected rig/platform has been shut in;

Notify ERG Leader and provide full incident briefing and likely requirements; and

Proceed to affected platform for damage assessment and depending on severity of damage, keep production shut in, make all equipment secure and restrict access until repairs can be undertaken.

ERG Leader

Obtain full incident briefing and likely requirements from Incident Controller and maintain liaison;

Activate ERG with appropriate Contact directory.

Notify EMT Leader and provide full incident briefing and likely requirements; and

Activate technical support as appropriate for evaluation and control of situation;

All response Members

As time permits, maintain log of events for collection at end of incident

3.2.23 Ground Movement

Any Person

Establish the severity of the movement;

Drilling/production Supervisor/PIC is to be alerted as the movement is detected; and

Contact Site Radio Room and notify the incident

Site Radio Room

Inform the Incident Controller

Inform all radio stations of incident to clear non-essential traffic; and

Send radio and other communications on instructions from Incident Controller;

Drilling/Production

Assess the situation;

Drilling/production to be suspended; and

Inform the Incident Controller and to be informed immediately if the event is classified as serious or major.

Incident Controller

Obtain full status briefing from the Drilling/production supervisor/PIC and maintain continuous contact;

Ensure that support are proceeded to the rig/platform if required;

Ensure the safety of all personnel;

Consider evacuation if it is required depending upon the severity of the situation;

Contact ERG leader and provide details of the situation; and

Proceed to carry out damage (if any) assessment and take control measures as required;

ERG Leader

Obtain full incident briefing and likely requirements from Incident Controller and maintain liaison;

Activate ERG with appropriate Contact directory;

Notify EMT Leader if required and provide full incident briefing and likely requirements

All Response Members

Maintain log of events for collection at end of incident

3.2.24 Un-ignited Gas Release

Person discovering Fires

Avoid creating any source of ignition;

Shutdown drilling by activating ESD;

If location of the leak is known, and if safe to do so, shut any relevant manual valves;

Notify Site Radio Room of incident; and

Contact Incident Controller to provide incident briefing and any likely requirements.

Site Radio Room

Alert Fire Team of incident;

Notify Incident Controller of incident and update as further communications received;

Inform all radio stations of incident and ask to clear non-essential traffic;

Send radio and other communications on instruction from Incident Controller.

Incident Controller

Stop all hot work and shutdown all other sources of ignition;

Instruct Site Control Room to shut in production, if appropriate;

Evacuate all non-essential personnel and ensure that alternate Muster Point advice is given if a gas release threatens Primary Muster Point;

Evacuate all personnel, if gas concentration reaches danger level;

If safe to do so, organize for location and shut off of leak source;

Ensure that system is depressurized to flare/atmosphere as appropriate;

Notify ERG Leader, provide full incident briefing and likely requirements and maintain liaison;

Ensure that all personnel have been accounted for and ensure that non-essential personnel stay clear of incident site and initiate SAR for any missing persons;

Notify ERT Leader provide full incident briefing and likely requirements

ERG Leader

Obtain full incident briefing and likely requirements from Incident Controller and maintain liaison

Activate part or all of ERG as appropriate;

Notify EMT Leader and provide full incident briefing and likely requirements; and

Co-ordinate support activities as required;

All Response Member

As time permits, maintain log of events for collection at end of incident

3.2.25 Hydrocarbon Spill

Equipment and Training

Assure emergency dispersant and spray equipment for dealing with spills is readily available; and

Assure personnel are trained in use of emergency dispersant and spray equipment, and with the provision of this procedure.

Oil Spill Detection

Be alert during operations such as fuel oil transfer and critical drilling operations that could result in oil spills;

Keep watch on the transfer pump, manifolds, transfer hoses, and all other connections;

During critical drilling operations, keep watch on the drilling equipment instrumentation and stop drilling when unsafe conditions arise; and

Shut Down the Source

Review site for safety hazards;

Stop the spill at the source as quickly as possible;

Assure that transfer pumps are immediately stopped if spill occurs during fuel oil transfer; and

If the spill occurs from any equipment on either vessel, shut down the operating equipment and close any valves between the leak source and the equipment.

Oil Spill Reporting

Spills should be reported using the Pollution Report Form.

Oil Spill Contingency Plan

Detailed oil spill response actions are included in Oil Spill Contingency Plan (OSCP).

3.2.26 Medical Evacuation

The incidents that may require medical evacuation are mainly severe casualties. The actions to be taken during medical evacuation are as following:

Incident Controller

Determine need for Medevac and type and special conditions of transport required. Consult with Site doctor regarding appropriate action and maintain liaison;

Consult with Site doctor on appropriate destination for serious Medevac;

If patient is a contractor, contact contractor manager and provide full Medevac details; and

Notify ERG Leader and provide full incident briefing and likely requirements.

Name of ill/injured person(s) to be communicated secure communications.

ERG Leader

Obtain full incident briefing and likely requirement from Incident Controller and maintain liaison;

Activate ERG as appropriate;

Liaise with aircraft operator and airport authorities to facilitate medevac and ensure that site representative is at airport to accompany patient to hospital;

If required, obtain permission for hospital ambulance to access airport security zone. If access denied, ensure that airport ambulance should be available for transfer to hospital ambulance;

Notify next of kin;

If patient is a contractor, ensure that contractor manager is informed with full Medevac details; and

Maintain liaison with patient and patient's family until discharged and consider arranging for relatives of injured person to be brought to hospital.

All Response Members

Maintain log of events for collection at end of incident

3.2.27 Criminal Acts

Incident Controller

Take actions to detain offender(s) if, appropriate;

Notify ERG Leader and provide full incident briefing for the following:

Nature of crime;

Identify of person(s) involved;

Extent of any injury to personnel and if Medevac required

Any assistance required; and

Action taken to date

If person(s) have been taken into custody, determine with ERG Leader the need to involve Police and contact Police as appropriate:

Secure evidence, close off incident site, prepare sketches and photographs, identify witnesses and take statements;

Consider need for suspension of any impending crew change;

Consider restriction of information to "need-to-know" basis; and

Assist Police with their inquiries.

ERG Leader

Obtain full incident briefing and likely requirements from Incident Controller and maintain liaison;

Activate ERG as appropriate;

Notify EMT Leader and provide full incident briefing and likely requirements; and

Submit reports to relevant authorities

All Response Members

Maintain log of events for collection at end of incident.

3.2.28 Bomb Threat/Extortion

If there is a contingency like bomb threat/extortion attempt then the following procedures would be followed:

Person Receiving Threat

For written threat, keep all paper, envelopes etc. to preserve as evidence;

For verbal threat, use bomb threat checklist while talking to the person making threat and write details notes checklist not available;

Do not use radio to raise alarm–radio signals may trigger an explosive device

For verbal contact, be calm and respectful and DON'T PANIC;

Take threat seriously;

Signal for assistance if in a position to do so;

Pay attention to what is being said and to any background noise;

Accurately write all that is being demanded and ask calmly for confirmation if unclear;

Do not agree or concede to any demands without prior approval;

Try to keep caller talking as long as possible and DON'T HANG UP;

If caller "hangs up, do not hang up your phone (it may be possible to trace call); and

At the conclusion of the call, check all notes taken to ensure accuracy.

Incident Controller

Immediately shut in all drilling/production activities if appropriate;

Notify ERG Leader and provide full incident briefing and likely requirements;

Evacuate all non-essential personnel to a safe area and consider total evacuation as required;

Ensure that all relevant authorities (e.g. Police etc) are notified immediately;

Ensure that bomb threat checklist is completed by person receiving a verbal threat;

Make every effort to calm all involved and don't aggravate situation by personal attempts to resolve situation hastily;

Ensure that someone is continually standing by a phone to receive next communication from extortionist or ensure that alternative number is provided to caller; and

Await assistance from appropriate authorities.

ERG Leader

Obtain full incident briefing and likely requirement from Incident Controller and maintain liaison;

Activate ERG as appropriate;

Ensure that all relevant authorities (e.g. Police etc.) are notified immediately;

Liaise with relevant Government agencies to obtain assistance (e.g. Indian Armed forces etc) as required; and

Notify EMT Leader and provide full incident briefing and likely requirement.

All Response Members

Maintain log of events for collection at end of incident

3.2.29 End of Emergency

- Prior to termination of an emergency, the following issues would be considered and necessary action taken:
- Confirm that the emergency is concluded;
- List of resources that are required for ongoing incident control (if appropriate);
- Final information release and/or notification to
  - Site incident response personnel, ERG, EMT and Chairman;
  - Consultants;
  - Contractors;
  - Customers;
  - Emergency services;
  - Employees
  - State Regulatory Authorities;
  - National Regulatory Authorities
  - Environmental Agencies
  - Joint Ventures;
  - Local Communities;
  - Neighbour / third parties
  - Pressure groups
  - Suppliers
  - Trade unions; and
  - Media
- De-briefing of all personnel (including people currently relieved or stood down);
- Close down additional security arrangements;
- Finalize additional catering and other services;
- Continuing counselling for those involved in the incident;
- Compile and file all documents relating to the response;
- Arrange for full incident investigation and analysis;
- Carry out follow up review to ascertain effectiveness of
- Callout;
- Site incident Response, ERG and EMT Functions;
- Operational emergency response;
- Approve / comment on incident debriefing reports and recommended actions; and
- Recommended revision of Emergency Plans as required

3.2.30 Communications

All nominated and dedicated emergency response stall will carry VHF radios programmed with the relevant Watch Keeping / Emergency Frequency.

3.2.31 Communication Network

It is essential that all emergency communications will be relayed to the Incident Controller (or Alternate) and/or the ERG leader (or alternate as soon as possible in case of an emergency situation. As far as possible all Emergency Calls from site, helicopter and base station would be passed on through the site Radio Room. The Radio Operator will allocate a dedicated emergency frequency and will advise the Incident Controller of the emergency situation and frequency.

Upon the commencement of an emergency, the Radio Operator will inform radio stations that there is an emergency and ask to clear all non-essential radio traffic on the designated emergency radio channel/frequency for communications.

If an incident occurs after normal business hours, the Site Radio Room will make contact with all Radio rooms, which will in turn activate the ERG Leader and other personnel as advised.

3.2.32 Occupational Health & Safety Management Plan

The Occupation Health & Safety Management Plan (OHSMP) is applicable for all project operations which have the potential to adversely affect the health and safety of contractors' workers and onsite ONGC personnel. The Occupation Health & Safety Management Plan (OHSMP) has been formulated to address the occupational health and safety related impacts that may arise from proposed project activities viz. development and testing operation of construction machinery/equipment's, storage and handling of fuel and chemicals, operation of drilling rig and associated equipment, during drilling and decommissioning/site closure.

Mitigation Measures:

Contractor workers involved in the handling of construction materials viz. borrow material, cement etc. will be provided with proper PPEs viz. safety boots, nose masks etc.

No employee will be exposed to a noise level greater than 85 dB(A) for a duration of more than 8 hours per day. Provision of ear plugs, ear muffs etc. and rotation of workers operating near high noise generating areas.

Hazardous and risky areas, installations, materials, safety measures, emergency exits, etc. shall be appropriately marked.

All chemicals and hazardous materials storage container will be properly labeled and marked according to national and internationally recognized requirements and standards. Materials Safety Data Sheets (MSDS) or equivalent data/information in an easily understood language must be readily available to exposed workers and first –aid personnel.

The workplace must be equipped with fire detectors, alarm systems and fire-fighting equipments. Equipments shall be periodically inspected and maintained to keep good working condition.

The sewage system for the camp must be properly designed, built and operated so that no health hazard occurs.

Adequate sanitation facilities will be provided onsite for the operational workforce both during construction and operational phase of the project.

Garbage bins will be provided in the camp and regularly emptied and the garbage disposed off in a hygienic manner.

Training programs will be organized for the operational workforce regarding proper usage of PPEs, handling and storage of fuels and chemicals etc.

ANNEXURES

Annexure 1: Calculation of Pool fire

A. Radiation Intensity (kW/m²) **RI** - 37.5, 12.5, 4.5, 1.6

B. Rate of burning (m/s)

*y= (92.6e^(-0.0043TB)*Mol.wt/p)*(10^-7/6)*

where y = Burning velocity (m/s)
Mol.wt = Molecular weight (kg/kgmol)
p = liquid specific gravity
TB = Normal boiling point, deg.F

C. Pool Size (m)

1. Maximum diameter of pool (m)

D_{max} *=1.7892((V^2/y)*((g/Cd)^0.5)^(2/11)*

Where D_{max} = Maximum diameter of pool of a instantaneous release (m)
V = Volume of liquid (m^3)
y =Burning velocity (m/s)
g = Accelaration due to gravity (9.81 m/s^2)
Cd = Ground friction Co-efficient (0.5 for general use)

2. Pool Radius (m)

Rp $=D_{max}/2$

3. Time to reach maximum pool diameter for instantaneous release (Seconds)

t_{max} *= 0.5249*((V^3*Cd^2)/(g^2*y^7))^(1/11)*

D. Emissive Power of A flame (kW/m²)

*Ep = '-0.313*TB+117*

Where
Ep = Effective emissive power (kW/m^2)
TB = Normal boiling point, deg.F

E. Heat received at a particular distance (m)

X = 1.079(Ep/Qi)^0.57*Rp*

Where
X = Distance (m)
Ep = Effective emissive power (kW/m^2)
Qi = Radiation intensity (kW/m^2)
Rp = Pool radius (m)

F. Radiation Intensities (kW/m²)

Distance from the centre of the Pool (m) = =1.079(Ep/RI)^0.57*Rp*

Annexure 2: Secondary Data of Failure rate frequency

ANNEXURE X

1.0 Secondary Data Collected on Blowout Frequency and Failure Rate Analysis

1.1 Blowout Frequency

The analysis of the database for the US GoM OCS/North Sea for the period 1980-92 by Scandpower (1995) for the blowout frequency is given in **Table-1**. These are also presented by E&P Forum (1996).

TABLE-1
BLOWOUT FREQUENCIES BY PHASE OF OPERATION

Phase	Blowouts 1980-92	Exposure 1980-92	Blowout Frequency
Exploration drilling	43	5781 wells	7.5×10^{-3} per well drilled

Source: SCANDPOWER 1995

1.2 Blowout Frequencies Based on Fluid Released

Table-2 gives deep and shallow gas blowout frequencies from the analysis by Scandpower (1995) of the database. These are also presented by E&P Forum (1996).

TABLE-2
DRILLING BLOWOUT FREQUENCIES BY FLUID RELEASED

Phase	Fluid Type	Blowout Frequency (per well drilled)
Exploration drilling	Shallow gas	4.7×10^{-3}
	Deep	2.8×10^{-3}
	Total	7.5×10^{-3}

Source: SCANDPOWER 1995

1.3 Blowouts in Individual Drilling Operations

The contributions of the individual operations to the total blowout frequency for exploration and development drilling are given in **Table-3**.

TABLE-3
CONTRIBUTION OF INDIVIDUAL OPERATIONS TO BLOWOUT FREQUENCIES (SCANDPOWER 1995)

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	100