

RISK ASSESSMENT

1.0 GENERAL

Risk Analysis is a means of objectively measuring the risks from hazardous activities of a facility or operation. The risks are quantified in terms of their probability and consequences. By comparison with suitable risk criteria, the results can be used to help decide whether the facility is unacceptable, or whether improvements are necessary. The risk criteria may be imposed by legislation, or they may be internal targets generated by a company or organization to help it assess its operations. Risk assessment tries to answer five simple questions. Beside each question, the technical term for that activity in the risk assessment process is introduced:

- What can go wrong? → Hazard Identification
- How bad? → Consequence Analysis
- How often? → Frequency Estimation
- So what? → Risk Assessment
- What do I do? → Risk Management

Facilities / activities which produce, treat, store and handle hazardous substances have a high hazard potential endangering the safety of man and environment at work place and outside. Recognizing the need to control and minimize the risks posed by such activities, the Ministry of Environment, Forests and Climate control have notified the "Manufacture Storage & Import of Hazardous Chemicals Rules" (MSIHC) in the year 1989 and subsequently modified, inserted and added different clauses in the said rule in the year 2000 to make it more stringent. For effective implementation of the rule, Ministry of Environment, Forests and Climate Control (MoEFCC) has provided a set of guidelines. The guidelines, in addition to other aspects, set out the duties required to be performed by the occupier along with the procedure. The rule also lists out the industrial activities and chemicals, which are required to be considered as hazardous.

Deendayal Port, Kandla is an integrated port facility with 14 cargo berths, 6 Oil jetties, 4 moorings for mid-stream handling of cargo, 02 Cargo Moorings in the inner harbour area for stream handling and a total storage capacity of approx. 31.52 Lakh KL. Due to changes in priorities of the user agencies some of the pipelines have become redundant. At the same time, it has become necessary to handle larger volumes of liquid cargo to meet the requirements of the port users. Moreover, some of the steel structural supports of the pipelines have become weak due to corrosion and need to be replaced. Deendayal Port Trust has therefore, decided to scrap the existing redundant pipelines through the user agencies and replace some of the existing pipelines with new pipelines of higher capacity designed to handle more liquid cargo at Oil jetty area till Y-junction.

Deendayal Port Trust (DPT), Kandla already has an elaborate and updated Disaster Management Plan in place, including the hazards anticipated due to the proposed activities at the existing Oil Jetty 1 to Oil Jetty 5 area up till Y-Junction. TELOS Consultancy Services (P) Ltd. has carried out a detailed risk assessment and Disaster Management Plan based on original risk assessment study carried out by TATA AIG Risk Management and subsequently updated by DPT, to ensure safety of operations as well as identify major associated hazards for devising suitable preventive and mitigative safety measures for the port. The same has been used as reference and used to briefly analyze the associated environmental aspects and the impacts on to those aspects due to handling of identified hazardous substances for the proposed activities associated with the present proposal.



In view of this, DPT's present proposal of augmentation of liquid cargo handling capacity of existing Oil Jetties by replacement and revamping of existing pipelines along with laying of new pipelines of higher capacity, is being scrutinized in line of the above referred "Manufacture, storage and import of hazardous chemicals (MSIHC) Rules" 1989 subsequently amended in the year 2000 and the observations / findings are presented in this chapter. An elaborate and well-documented Disaster Management Plan covering all substances/gases handled by Deendayal Port at Kandla, as mentioned before, is already in place at Deendayal Port, Kandla and is briefly summarized hereunder.

The assessment has been made in a systematic manner covering the requirements of the above-mentioned rules. Accordingly subsequent sections have been divided as follows:

- Process description
- Applicability of the rule
- Description of hazardous substances
- Hazard Identification
- Hazard Assessment (& hazard scenarios)
- Consequence analysis
- Brief description of the measures taken and
- On site emergency plan

Accordingly, succeeding sections are elaborated.

2.0 PROCESS DESCRIPTION

Deendayal Port, Kandla is a major port located at the north-western apex of the Gulf of Kutch in Gandhidham Taluk of Kachchh District of Gujarat. The port is presently handling 100 Million Tonnes per Year (Mt/yr) of cargo which is the highest amongst all Indian Ports. The cargo handled at Deendayal Port comprises of a mix of liquid cargo (crude oil, POL Products, Chemicals, Edible Oil etc.) and dry cargo (coal, ores, fertilizers & fertilizer raw materials, steel goods, containerized cargo etc.). Deendayal Port Trust has six nos. oil jetties located on the western side of Kandla Creek, located ~130 m - ~220 m offshore. The pipelines from the six oil jetties converge at "Y Junction" on the shore from where pipes lead to various storage facilities. Additionally, in order to cater to the increasing needs of Liquid cargo handling, the port has also taken up construction of Oil Jetty No. 7 at Old Kandla, north of existing Oil Jetty 6.

The existing liquid cargo mix handled at the Oil jetties of Deendayal Port includes edible oil, POL (Petroleum, Oil & Lubricants) products and chemicals. The different grades of edible oils handled at Deendayal Port are as follows:

- Crude Palm oil
- RBDP Oil (Refined bleached deodorized palm oil)
- Crude degummed Soya bean oil
- Soya bean oil
- Crude degummed Rapeseed oil
- Rapeseed oil
- Sunflower oil
- Castor Oil (edible as well as non-edible)

Crude Palm oil and Crude Soya bean oil dominate in overall volumes amongst all aforementioned items at DPT.



Deendayal Port also handles nearly 170 chemicals which can be broadly classified as Polyols, Glycols, Monomers, solvents, Phenols, Acids, Castor and other petroleum based chemical products.

Presently, there are a total of 167 pipelines in the 5 oil jetties of Deendayal Port Trust. OJ-1 has 25 pipelines, OJ-2 has 40, OJ-3 has 45, OJ-4 has 36 and OJ-5 has 21 pipelines. These pipelines handle various products and are of various diameters.

The present proposal envisages revamping of existing pipelines and replacement with newer pipelines of higher capacity. The new lines will be handling edible oils as well as various chemicals. On implementation of the proposed revamping works, the existing liquid cargohandling capacity of DPT shall increase from 8 MTPA to 23.8 MTPA.

3.0 APPLICABILITY OF THE RULE

As per definition of a "pipeline" under clause 2(k) referred as an "industrial activity" under sub-clause (iii) of Clause 2(h) MSIHC Rules, 1989 amended in 2000, the transport of hazardous chemicals as mentioned in the said rules by means of a pipe or a system of pipes is classified as an "industrial activity" handling hazardous substances.

To assess whether the above mentioned industrial activities/substances are likely to come within the scope of the above mentioned "Manufacture Storage and Import of Hazardous Chemicals Rules, 1989 amended in 2000", the threshold quantities mentioned in the rules are used for comparison, as given in Table 1.

Table 1: Threshold Quantities & Identified Hazardous Substances to be Handled by new pipelines at Revamped Oil Jetties of Deendayal Port Trust as per MSIHC Rules, 1989 Amended in 2000.

Sn	Hazardous substance to be handled by new pipelines	Whether Included in The List of Hazardous & Toxic Chemicals	Type of vessel used for handling	Lower Threshold Qty. (In Tonne) <i>[For application of rules 5,7 to 9 and 13 to 15]</i>	Upper Threshold Qty. (In Tonne) <i>[For application of rules 10 to 12]</i>	Remarks
1.	Edible oil (Palm oil & Castor oil is the major type)	No	Stainless Steel Pipes (above ground)	-	-	Does not come under the purview of MSIHC Rules due to very low flammability accounted to high Flash point(>90°C)
2.	Polyol group of chemicals	No	Mild Steel Pipes (above ground)	-	-	Does not come under the purview of MSIHC Rules due to very low flammability accounted to high Flash point(>90°C)
3.	Glycol group of chemicals	Yes [Schedule 1, Part II]	Mild Steel Pipes (above ground)	2500	20,000	Flammable liquid based on flash point of the chemicals. Threshold defined as per Schedule 3, Part II.
4.	Alcohols such as methanol, propanol etc.	Yes [Schedule 1, Part II]	Mild Steel Pipes (above ground)	1500	10,000	Flammable liquid based on flash point of the chemicals. Threshold defined as per Schedule 3, Part II.
5.	Aromatic compounds as toluene, Phenol, benzene, xylene etc.	Yes [Schedule 1, Part II]	Mild Steel Pipes (above ground)	1500	10,000	Flammable liquid based on flash point of the chemicals. Threshold defined as per Schedule 3, Part II.
6.	Acrylates such as butyl	Yes	Mild Steel Pipes	1500	10,000	Flammable liquid based on flash



Sn	Hazardous substance to be handled by new pipelines	Whether Included in The List of Hazardous & Toxic Chemicals	Type of vessel used for handling	Lower Threshold Qty. (In Tonne) <i>[For application of rules 5,7 to 9 and 13 to 15]</i>	Upper Threshold Qty. (In Tonne) <i>[For application of rules 10 to 12]</i>	Remarks
	acrylate etc.	[Schedule 1, Part II]	(above ground)			point of the chemicals. Threshold defined as per Schedule 3, Part II.
7.	Solvents including ketone group of chemicals such as acetone etc.	Yes [Schedule 1, Part II]	Mild Steel Pipes (above ground)	1500	10,000	Flammable liquid based on flash point of the chemicals. Threshold defined as per Schedule 3, Part II.
8.	Corrosive liquids such as Sulphuric acid, Phosphoric acid & Ammonia	Yes [Schedule 1, Part II]	Mild Steel Pipes (above ground)	-	-	No threshold quantities defined for the purpose of identifying fire & explosion hazards in MSIHC Rules.
9.	Liquefied Petroleum Gas (LPG, primarily Butane & propane)	Yes [Schedule 1, Part II]	Mild Steel Pipes (above ground)	5000	50,000	Flammable liquid based on Flash point of a typical LPG composition. Threshold defined as per Schedule 3, Part II.

On comparison of the handled quantity of hazardous chemical with threshold quantities, it is observed that the chemicals under the chemical family of glycols, alcohols, aromatic compounds, acrylates and solvents are coming under the purview of MSIHC rules due to their hazardous nature and is also exceeding the corresponding lower and upper threshold quantities. Accordingly, rule nos. 7,8,9,10,11,12,13,14 and 15 & 17 of the MSIHC Rules, 1989 with subsequent amendments will be applicable. Rule-7 i.e. notification of site requires submission of a written report containing among other information the followings:

- Identification of major accident hazards
- The conditions or events which could be significant in bringing one about
- Quantified risk assessment of the process
- Brief descriptions of the measures taken
- Area likely to be affected by the major accident etc.

Hence, owing to the deliberation above, a quantitative risk assessment of the facility has been done based on MCAA (maximum credible accident analysis) approach.

4.0 DESCRIPTION OF HAZARDOUS SUBSTANCES

The hazardous chemicals which are expected to be handled are presented in aforementioned Table 1 above.

Polyol group of chemicals: Polyols are compounds with multiple hydroxyl functional groups available for organic reactions. Polymeric polyols are the second component for polyurethanes and are reacted with isocyanates. A variety of polyols such as Pentylol, Sabutol, Caradol and Voranol are expected to be handled at the revamped Oil jetties of existing Deendayal Port Trust, Kandla. These polyols have very high flash points, over 200°C, and have very low flammability.

Glycol group of chemicals: Glycols are synthetic organic compounds, chemically classified as a diol and is miscible with a broad range of solvents, including water, acetone, etc. The existing chemical cargo handled at Oil jetties of Deendayal Port Trust (DPT), Kandla consists of propylene glycol, ethylene glycol, Dowanol, etc. These are flammable liquids with flash points ranging from 42°C to 99°C, and pose mild fire hazards.



Alcohols group of chemicals: The common alcoholic group of chemicals handled at DPT, Kandla includes butanol, isobutyl alcohol, isopropyl alcohol, propanol, 2-ethyl hexanol, EXXAL iso-tridecanol, 2-ethyl hexanol (Octanol), iso-nonanol, denatured ethanol etc. These chemicals are generally highly flammable in nature. However, owing to very high flash points, EXXAL iso-tridecanol and iso-nonanol are not flammable in nature.

Aromatics and derivative compounds: Aromatic compounds, also known as arenes, are chemical compounds that contain conjugated planar ring systems with delocalized pi electron clouds instead of discrete alternating single and double bonds. Typical aromatic compounds are benzene, toluene etc. The liquid cargos handled at present under this chemical category include toluene, Phenol, benzene, xylene, etc. These chemicals are typically highly flammable liquids with the exception of higher alkyl benzenes (which have flash points $>130^{\circ}\text{C}$).

Acrylates: Acrylates are the salts, esters, and conjugate bases of acrylic acid and its derivatives. Acrylates and methacrylates (the salts and esters of methacrylic acid) are common monomers in polymer plastics, forming the acrylate polymers. The chemicals of this group handled at the existing oil jetties of DPT, Kandla are Methyl methacrylate, ethyl hexyl acrylate, butyl acrylate, ethyl acrylate etc. These chemicals are highly flammable in nature due to their low flash points.

Solvents: A number of organic solvents (ketones and ether group of chemicals) such as acetone etc. are also presently handled by oil jetties of DPT, Kandla. These are mostly having low flammability with the exception of acetone, which is highly flammable liquid.

Liquefied Petroleum Gas (LPG) : It is a mixture of flammable gases, primarily propane and butane which is handled in liquefied form under pressurised conditions. It is a flammable mixture of hydrocarbon gases used as fuel in heating appliances, cooking equipment, and vehicles. In liquefied form, it is a colourless and odourless liquid, so small quantity of ethyl mercaptan is added to it to give it a distinct, characteristic smell. The existing jetties at DPT Kandla presently handle LPG, which shall be provided with newer, dedicated pipelines for handling after implementation of the present proposal.

5.0 HAZARD IDENTIFICATION

Hazard is something with a potential to cause harm. The most obvious hazard on an installation is due to inventories of flammable/ toxic gases and liquids that are produced and processed under normal operations. These materials are safely contained but risk may be realized if a quantity of this material escapes containment, a source of ignition is present and a fire or explosion ensues. Should these hazardous substances be released or escape containment, then there is an additional risk presented to personnel in the facility and outside population. Therefore, identification and assessment of major hazards is of prime importance. Hazard identification is one of the most critical steps in any risk analysis study. A hazard omitted is a hazard not analyzed. Hazard identification is a qualitative process.

There are several techniques available for identification of the potential hazards. In this particular case "Methodical Equipment Leak / Rupture" technique has been used to identify the potential hazards and failure cases for risk estimation. The Methodical Equipment leak / rupture or generic failure approach is a means of failure identification that generates failure cases by conceptually breaking open every pipe and vessel over an identified range of hole sizes, which would lead to a loss of containment.

Such an approach can lead to a large numbers of failure cases and some screening of cases is usually undertaken to reduce the number. Each line or vessel, of course, may break or rupture in an infinite number of ways. For example, a pipe break may be of any size from a pin-hole leak to a full bore rupture and may be in any position between the pipe ends. It can involve various pressures and temperatures. The resulting leak may be oriented in virtually any direction. It may be ignited at numerous different locations and after various time intervals. Varying numbers of personnel may be in the areas, and may respond in varying ways. The weather conditions, the mode of operation, the success or otherwise of various mitigating measures may all affect the resulting scenario. This continuum of possible scenarios cannot be modelled in its entirety. For risk analysis it must be represented by a set of discrete "accident scenarios", each associated with a defined consequence.

In order to disentangle hazard identification from the complexities of consequence modelling, it is desirable to specify break points in each scenario. In this study, those break points are termed as "failure cases" which are represented in a risk analysis of the range of possible accidents that may occur in reality and they are basically the "initiating events" for an accident scenario. "Accident Scenarios" are complete sets of circumstances necessary to define the consequences of particular failure cases.

In this study, failure cases have been adopted based on "Methodical Equipment leak / rupture" technique, the approach elaborated in Guidelines for "Chemical Process Quantitative Risk Analysis (CPQRA)". The present proposal involves the revamping and replacement of the principal types of equipment which is anticipated to be subjected to leak and the principal types of leaks that may occur in this installation are listed as under:

Leak Source	Type of Leak
Process pipe work	Pipe splits (leaks), Full bore rupture

Hazards associated with the identified hazardous chemicals based on NFPA ratings as well as other parameters are presented in Table 2.

Table 2: Hazard Types Associated With Identified Hazardous Chemicals

Group of chemical	Major Chemicals	Type of Hazard*	**NFPA Hazard Rating			IDLH Value	Flash point (°C)	Flammability range	Remarks
			Health	Flammability	Reactivity				
ALCOHOLS	Methanol	1,7,9	1	3	0	6000 ppm	12°C	Lower: 6% Higher: 36.5%	Liquid transported through pipelines
	Butanol	1,7,9	1	3	0	1400 ppm	28.9°C	Lower: 1.4% Higher: 11.2%	
	Isopropyl alcohol	1,7,9	1	3	0	2000 ppm	11.7°C	Lower: 2% Higher: 12.7%	
AROMATIC COMPOUNDS	Toluene	1,7,9	2	3	0	500 ppm	4.44°C	Lower: 1.1% Higher: 7.1%	
	Phenol	1,4,9	3	2	0	250 ppm	79°C	Lower: 1.7% Higher: 8.6%	
	Benzene	1,8,9	2	3	0	500 ppm	-11°C	Lower: 1.2% Higher: 7.8%	
	Xylene	1,3,9	2	3	0	900 ppm	24°C	Lower: 1% Higher: 7%	
ACRYLATE	Methyl methacrylate	1,4,7	2	3	2	1000 ppm	13°C	Lower: 2.1% Higher: 12.5%	
	Ethyl hexyl acrylate	1,4,9	1	2	1	-	86°C	Lower: 0.9% Higher: 6%	

EIA/EMP Studies for Proposed Augmentation of Liquid Cargo Handling Capacity from 8 MMTPA to 23.8 MMTPA
Through Modernisation of Existing Pipeline Network at Oil Jetty Area, Deendayal Port Trust, Kandla

Group of chemical	Major Chemicals	Type of Hazard*	**NFPA Hazard Rating			IDLH Value	Flash point (°C)	Flammability range	Remarks
			Health	Flammability	Reactivity				
SOLVENTS	Butyl acrylate	1,4,7	3	2	2	-	29°C	Lower: 1.3% Higher: 9.9%	
	Ethyl acrylate	1,3,8	2	3	4	300 ppm	-2°C	Lower: 1.4% Higher: 13%	
	Acetone	1,4,9	1	3	0	2500 ppm	-20°C	Lower: 2.6% Higher: 12.8%	
	Butane Propane	1,2,9	1	4	0	2000 ppm	60°C to 104.4°C	Lower: 1.9% Higher: 9.5%	

Note: Type of Hazard

1 Flammable substance	6 Gas or vapour not dangerous other than displacing air
2 Oxidising substance, reacts with reducing agents	7 Causes skin irritation or burns
3 Emits a toxic gas or vapour	8 Toxic substance
4 Emits an irritating gas or vapour	9 Explosive material under certain conditions
5 Emits a narcotic gas or vapour	

NFPA Hazard Rating				
a) HEALTH				
1 - None	2 - Minor	3 - Moderate, could cause temporary incapacitation or injury	4 - Severe, short exposure may cause serious injury	5 - Extreme, short exposure may cause death
b) FLAMMABILITY				
1-None, Material does not burn	2- Minor, material must be preheated to ignite	3- Moderate, moderate heating is required for ignition and volatile vapours are released	4- Severe, material ignites at normal temperature	5- Extreme, very flammable substance that readily forms explosive mixtures
c) REACTIVITY				
1-None, stable when exposed to fire	2-Minor, unstable at high temp. or press and may react with water	3-Moderate, unstable but does not explode, may form explosive mixture with water	4-Severe, Explodes if heated or water added	5-Extreme, readily explosives under normal condition

From the aforementioned Table 2, the most hazardous substance from each group is selected for the purpose of modelling the consequences due to an accidental release, as indicated in Table 3:

Table 3: Identified Hazardous Substances For Consequence Modelling

Chemical group	Most hazardous chemical	Maximum Quantity handled ^{1,2} (in T)	Comparison with Threshold Qty. (In Tonne)		
			Lower	Upper	Remarks
ALCOHOLS	Methanol	119	1500	10,000	All chemicals are below lower threshold. However, consequence analysis carried out owing to their hazardous nature.
AROMATIC COMPOUNDS	Phenol	156	1500	10,000	
	Benzene	132	1500	10,000	
ACRYLATES	Butyl acrylate	133	1500	10,000	
SOLVENTS	Acetone	119	1500	10,000	
LPG	Butane & Propane	220	5,000	50,000	
Note: 1. Considering a credible scenario in which the jetty handling the highest quantity of a particular chemical will have the highest probability of causing severe consequences on failure. 2. Inventories estimated based on individual pipeline dimensions with 80% occupancy of the filled in the pipes at any point of time during operations					

The indicated chemicals are primarily flammable liquids, with some chemicals such as phenol, benzene etc. having toxic properties as well. LPG is the only flammable gas to be handled under liquefied condition.

6.0 HAZARD ASSESSMENT

In the earlier section, type of hazard associated with different type of substances and the event of release of these substances is being identified. It has also been identified the category of hazard associated with different chemicals.

In any plant, hazardous situation arises due to:



- Failure in the monitoring of crucial process parameters e.g. pressure, temperature, flow quantity etc.
- Failure in the utilities e.g. cooling water
- Failure control elements e.g. pressure, temperature level, flow controllers etc.
- Failure of components such as pumps, compressor etc.
- Failure of safety systems, safety valves / relief valves, sprinkler systems, alarm etc.
- Mechanical failure of vessels or pipe work due to excessive stress, over pressure, corrosion etc.
- Wrong operation, failing to adhere to the safety norms etc.

Such a situation is possible during handling of liquid chemicals too. It is unlikely that small leakage through pipes, gaskets, flanges or any other means (user points) will create a hazardous situation unless allowed to be released for a long time as will be established in the subsequent sections. It is expected that during such small leakage preventive steps will be taken within a specified time span. Therefore a Preliminary Hazard Analysis (PHA) is carried out first for assessment of hazard.

Effects of the above Hazards:

The effect of accidents in these areas will be confined to the facilities only and can be controlled within the areas by the operating personnel themselves. At the extreme, it may require the resources of the whole facility to control the effects but these are not at all expected to spill over to the community.

Table 4: Preliminary Hazard Analysis

Sn.	Project component	Incident type	Failure Scenario	Causes of failure	Proposed preventive measures
1.	Pipelines	Release of liquid chemicals into the environment in form of pools, Formation of vapour cloud, pool fires, fire, explosion	Failure of pipeline, bursting of pipeline due to - Corrosion - Vibration - External loading - Operation error - Over pressure - Maintenance failure - Communication failure - Sabotage	- Pressure increase - Rupture of pipe - Leak in pipe work - Instrumentation failure - Operator error - External fire - Corrosion	- Design of pipelines (i.e. wall thickness and stress relief), well sites, Central Processing Facility and related infrastructure to relevant standards and legislation. - Installation of leak detection systems. - Conduct regular inspections, maintenance and testing of equipment. - Site policies, management plans and procedures. - Operator induction and ongoing training. - Maintenance of fire breaks to slow the progress of bushfires. - Routine hazard reduction burns. - Fire-fighting equipment and spill kits located in on-site vehicles and infrastructure (where appropriate).
		Sabotage	Malicious act/sabotage resulting in off-site impacts.	- Inadequate protection of facilities. - Lapse in safety procedures due to Human error.	- Restriction of access to storage areas, including securing storage facilities. - Provision of adequate lighting around storage facilities. - Signage (i.e. unauthorized entry warning and information signs). - Police would be notified as soon as possible in case of a suspected breach.

7.0 MAXIMUM CREDIBLE ACCIDENT ANALYSIS (MCAA)

A Maximum Credible Accident (MCA) can be characterized, as an accident with a maximum damage potential, this is still believed to be probable. The selection of accident scenarios representative for a MCA-Analysis has been done on the basis of engineering judgement and expertise in the field of risk analysis studies, especially accident analysis.



In the revamped oil jetties of Deendayal port at Kandla, involving loading and unloading of chemicals through pipelines, which is also identified as an “Industrial activity” handling hazardous substances as per MSIHC Rules, hazardous substances may be released as a result of failures or catastrophes, causing possible damage to the surrounding area.

MCA Analysis assists in identifying the potential major accidents arising due to flammable and/or toxic storages or handling facilities and estimate the maximum consequent effects on the surrounding environment in terms of damage distances of heat, radiation, toxic release, vapour cloud explosion etc. depending upon the effective hazardous attributes and their impact on the event.

The visualization of MCA scenarios has been done considering the chemical inventory being handled at the proposed facility, various loss of containment scenarios and subsequent accident scenarios and analysis of incident history of similar nature to establish credibility of the identified accident scenarios. Based on the above, the identified credible accident scenarios having maximum damage effects (worst case) were as follows:

a. Release of chemical due to rupture of piping resulting in

- Jet fire/Fireball
- Pool fire
- Flash fire
- Vapour Cloud explosion
- Toxic cloud dispersion (for toxic compounds).

8.0 CONSEQUENCE ANALYSIS

Subsequent to the accidental release of hazardous chemicals, the consequence depends on various factors e.g. type and inventory of released hazardous materials, presence and location of an ignition source, meteorological conditions, etc. Consequence analysis for the selected accident scenarios has been carried to estimate the vulnerable zones.

8.1 Consequence Model/Software Used

DNV's PHAST (Version 6.4) software, which is a consequence and risk assessment software for calculation of physical effects (fire, explosion, atmospheric dispersion) of the escape of hazardous materials, has been used to perform the consequence calculations. The software allows detailed modelling and quantitative assessment of release of pure chemicals as well as mixtures from different scenarios.

8.2 Hazardous Scenarios Modelled

Consequence analysis quantifies vulnerable zone for a conceived incident and once the vulnerable zone is identified for an incident, measures can be proposed to eliminate damage to plant and potential injury to personnel. Consequence analysis for identified representative chemicals probable to be handled at the revamped oil jetties of Deendayal Port, Kandla has been carried out. The release scenarios selected and associated hazards based on MCA Analysis are listed below in Table 5:

Table 5: Probable Release & Accident Scenarios Identified As Per MCAA

Sn	Hazardous substance	Credible Release scenario	Credible identified accidents
1.	All chemical groups identified as hazardous	Full bore rupture of piping	Fireball, Pool fire, Flash fire, Vapour Cloud explosion, Toxic cloud dispersion (for toxic compounds)



8.3 Meteorological Conditions Considered

Minimum wind speed of 1.5 m/s and stable as well as neutral atmospheric stability conditions have been assumed to model fire effects in a worst case scenario having low chance of dilution of flammable substance concentration in the atmosphere and a higher damage effect. An average Wind speed of 3.0 m/s based on annual climatological trend of wind speeds at Kandla as collected from IMD Atlas at Kandla with neutral atmospheric stability conditions has been assumed to predict maximum extent of dispersion of toxic components of the identified hazardous substances during a release.

Wind speed (m/s)	Atmospheric Stability Class
1.5	F (Moderately Stable condition) D (Neutral condition)
3	D (Neutral condition)

8.4 Damage Criteria Considered In The Model

In order to apprehend the damage produced by various scenarios, it is appropriate to discuss the physiological/physical effects of thermal radiation intensities due to fire accidents and overpressure effects of explosions. The thermal radiation due to pool fire or jet fires usually results in burn on the human body. Furthermore, inanimate objects like equipment, piping, cable, etc. may also be affected and also need to be evaluated for damages. The effect of overpressure due to blast effect and the effect of thermal radiation due to fire on unprotected skin, as per Indian Standard IS 15656: 2006 HAZARD IDENTIFICATION AND RISK ANALYSIS — CODE OF PRACTICE is presented below in Tables 6 and 7, respectively.

Table 6: Effect Of Different Overpressures On Human Life & Property

Overpressure (bar)	Type of Damage on structure	Type of Damage on Human life
0.02	Typical window glass breakage	-
0.14	Partial collapse of buildings	Personnel knocked down
0.21	Steel framed buildings get distorted and uprooted from their foundations	Ear drum rupture (beginning of serious injury to human life)

Table 7: Relation Of Heat Radiation Intensity, Time And Effect On Man

Heat Radiation Level (Kw/m ²)	Duration (Secs)	Effect on Humans	Effect on property
4 -6	20	Sufficient to cause pain to personnel	Impairment of escape routes
12.5	5-20	Extreme pain within 20s	Provides minimum energy required for piloted ignition of wood and melting of plastic
37.5	10	Immediate fatality (100% lethality)	Sufficient to cause severe damage to process equipment

The results of consequence analysis are summarised in the succeeding section..

8.5 Results Of Consequence Analysis For Identified Hazardous Scenarios

A) Methanol

- **Scenario:** Catastrophic rupture of piping
- **Consequent outcome-I:** Pool spill followed by immediate ignition resulting in Pool fire.

The hazard extents for pool fire resulted due to spill of methanol are presented below:

POOL FIRE				
Unrestricted pool diameter: 68 m				
Sn.	Radiation Intensity (kW/m ²)	Effect distance (m from spilled pool) in weather conditions		
		1.5F	1.5D	3D
1	4.0	267	266	267
2	12.50	172	172	174
3	37.50	114	114	120

The radiations at various distances for pool fire are shown in figure below.

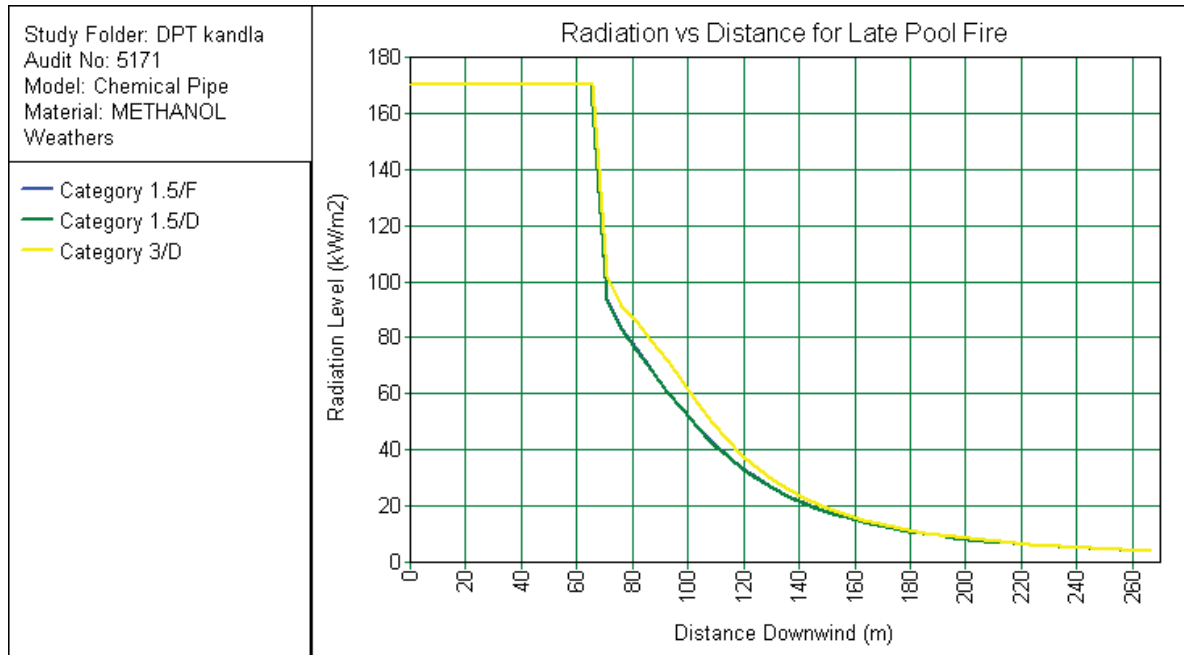


Figure 1: Radiation at Various Distances due to Pool Fire of Methanol

The thermal intensity radii for pool fire are shown in figure below.

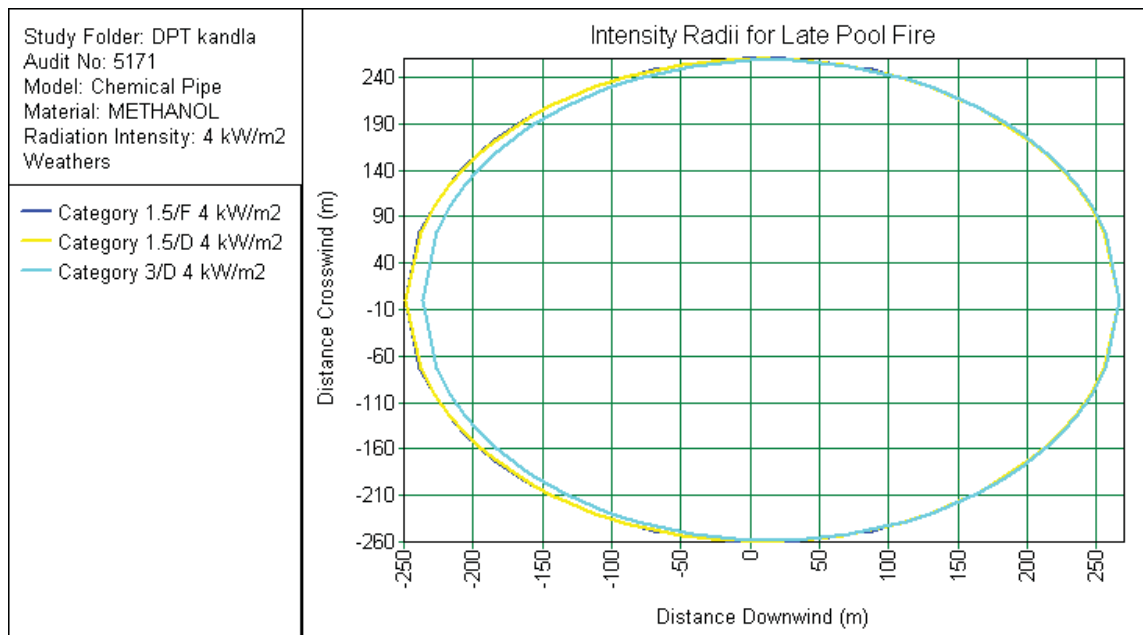


Figure 2: Thermal Intensity Radii due to Pool Fire of Methanol

The worst case vulnerable distance (hazard effect distance) for pool fire due to rupture of pipe having significant damage to human life is observed to be up to 120 m (@37.5 KW/m² having immediate death probability).

- Consequent outcome-II: Vapour Cloud explosion due to delayed remote ignition.

The hazard effect extents for Vapour Cloud explosion resulted due to methanol release and ignited at a distance of 10 m from the release is presented below:

VAPOUR CLOUD EXPLOSION				
Distance of ignition source = 10m				
Sn.	Blast overpressure	Effect distance (m) in weather conditions		
		1.5F	1.5D	3D
1	0.21 bar	25	24	23
2	0.14 bar	29	28	26
3	0.02 bar	84	79	72

The blast overpressures at various distances for vapour cloud explosion are shown in Figure.

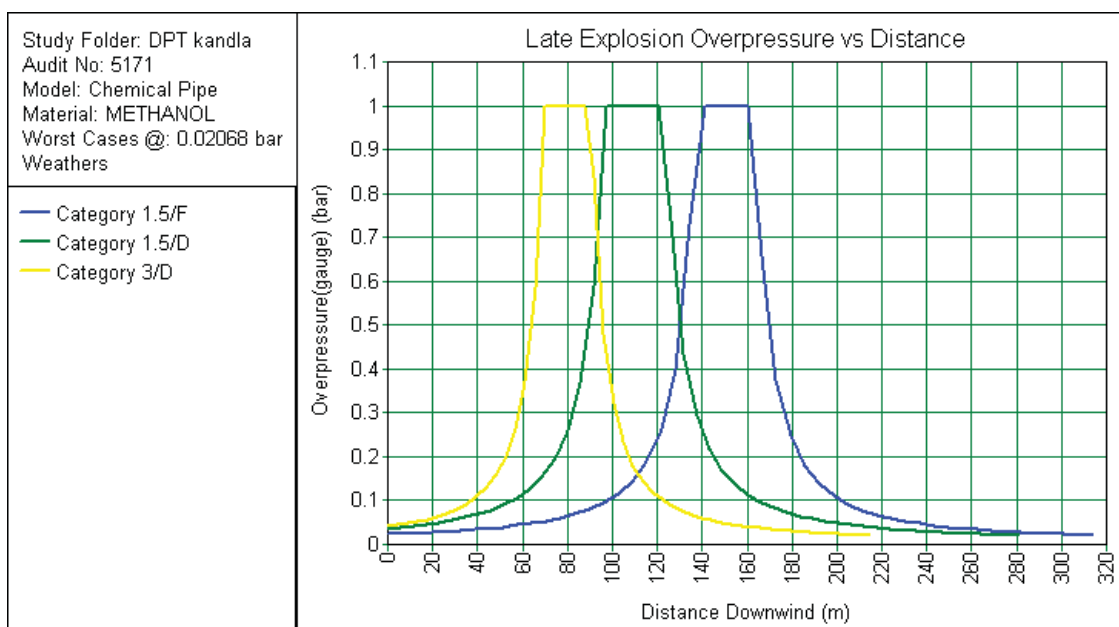


Figure 3: Blast Overpressure at Various Distances due to Vapour Cloud Explosion of Methanol

The worst case vulnerable distance (hazard effect distance) for explosion due to release of methanol having significant damage to human life is observed to be up to 25m (@0.21 bar having 100% probability of death).

- Consequent outcome-III: Release from ruptured pipe followed by delayed ignition resulting in Flash-fire.

The hazard effect extents for Flash fire resulted due to release of methanol are presented below:

FLASH FIRE				
½ LFL concentration = 36500 ppm				
Sn.	Concentration of Interest	Effect distance (m) in weather conditions		
		1.5F	1.5D	3D

1	LFL	135	109	94
2	½ LFL	316	151	153

The thermal intensity radii for flash fire are shown in Fig. 4 below:

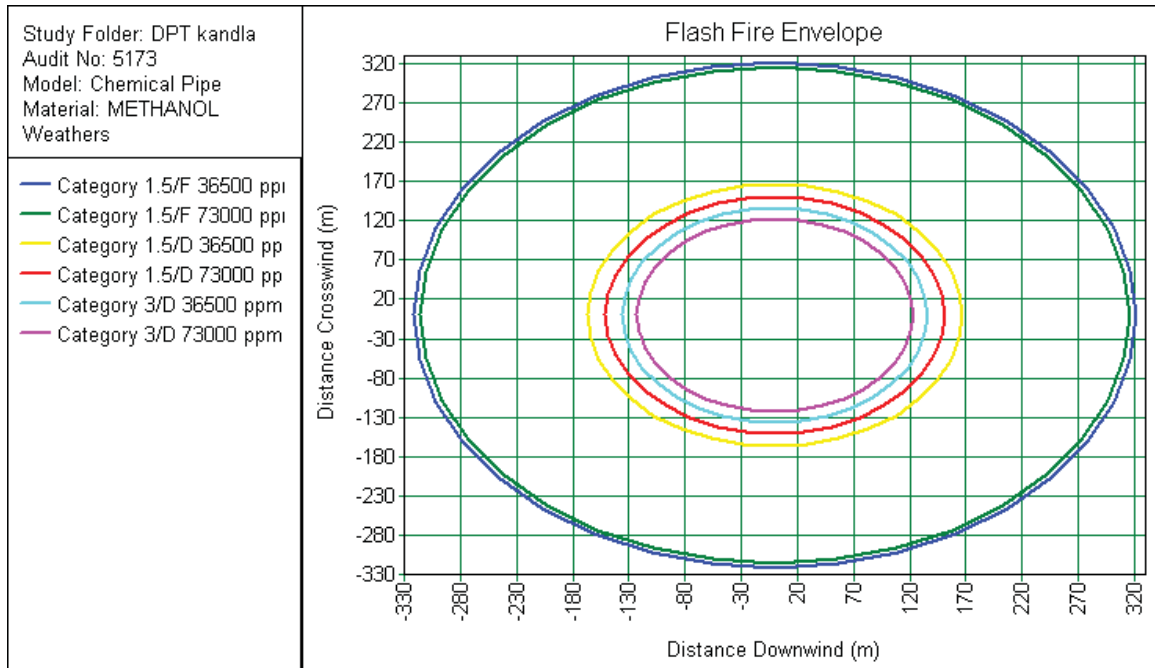


Figure 4: Thermal Intensity Radii due to Flash Fire of Methanol

The worst case vulnerable distance (hazard effect distance) for Flash-fire due to release of methanol having significant damage to human life is observed to be up to 135m (@LFL having 100% probability of death).

B) Phenol

- Scenario:** Catastrophic rupture of piping
- Consequent outcome-I:** Pool spill followed by immediate ignition resulting in Pool fire.

The hazard extents for pool fire resulted due to spill of phenol are presented below:

POOL FIRE				
Unrestricted pool diameter: 136m				
Sn.	Radiation Intensity (kW/m ²)	Effect distance (m from spilled pool) in weather conditions		
		1.5F	1.5D	3D
1	4.0	133	133	143
2	12.50	69	69	70
3	37.50	NR	NR	NR

The radiation at various distances for pool fire are shown in Fig.5

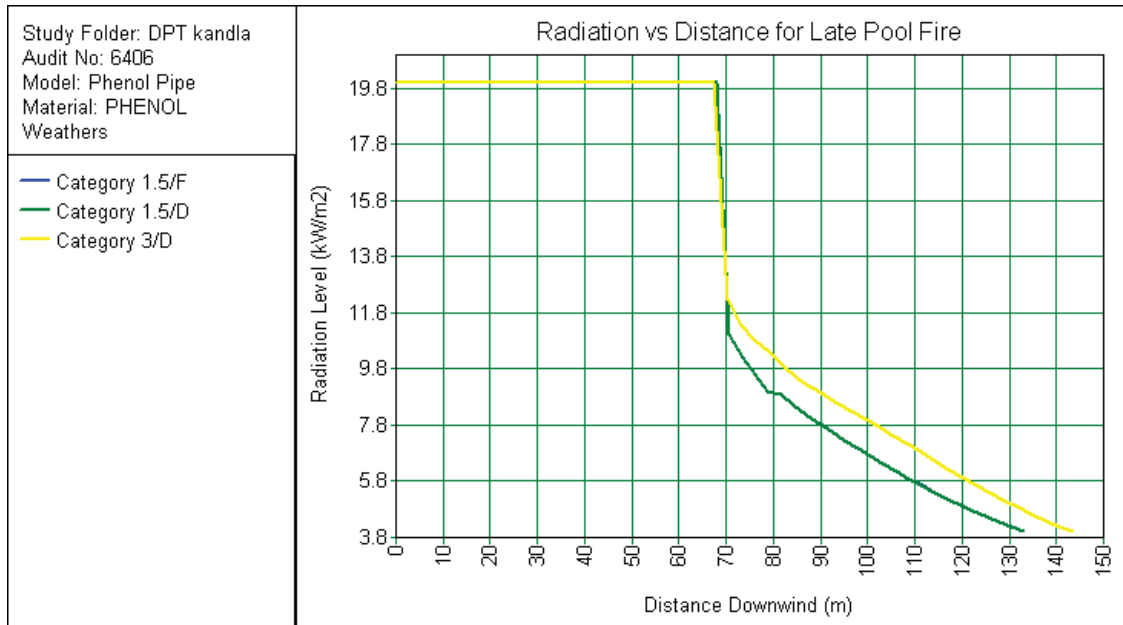


Figure 5: Radiation at Various Distances due to Pool Fire of Phenol

The thermal intensity radii for pool fire are shown in Figure.

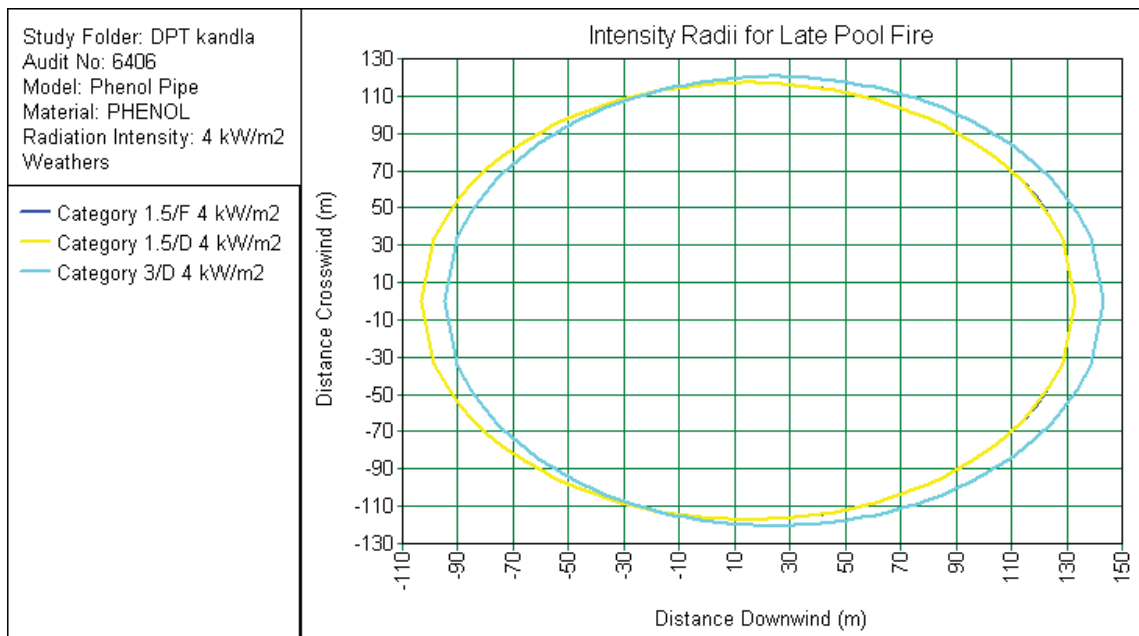


Figure 6: Thermal Intensity Radii due to Pool Fire of Phenol

The worst case vulnerable distance (hazard effect distance) for pool fire due to rupture of pipe having significant damage to human life is observed to be up to 70 m (@12.5 KW/m² having ~7% death probability).

- *Consequent outcome-II: Vapour Cloud explosion due to delayed remote ignition.*

The hazard effect extents for Vapour Cloud explosion resulted due to phenol release and ignited at a distance of 10 m from the release is presented below:

VAPOUR CLOUD EXPLOSION				
Distance of ignition source = 10m				
Sn.	Blast overpressure	Effect distance (m) in weather conditions		
		1.5F	1.5D	3D
1	0.21 bar	15	NR	NR
2	0.14 bar	16	NR	NR
3	0.02 bar	34	NR	NR

The blast overpressures at various distances for vapour cloud explosion are shown in Figure.

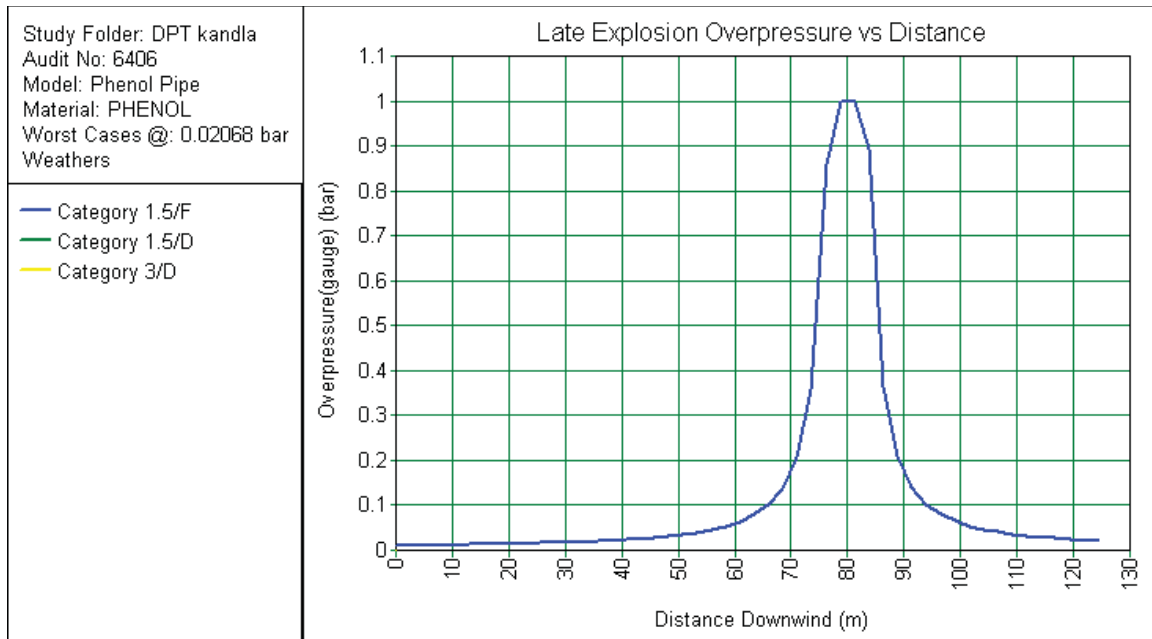


Figure 7: Blast Overpressure at Various Distances due to Vapour Cloud Explosion of Phenol

The worst case vulnerable distance (hazard effect distance) for explosion due to release of phenol having significant damage to human life is observed to be up to 15m (@0.21 bar having 100% probability of death).

- *Consequent outcome-III: Release from ruptured pipe followed by delayed ignition resulting in Flash-fire.*

The hazard effect extents for Flash fire resulted due to release of phenol are presented below:

FLASH FIRE				
$\frac{1}{2}$ LFL concentration = 7500 ppm				
Sn.	Concentration of Interest	Effect distance (m) in weather conditions		
		1.5F	1.5D	3D
1	LFL	139	69	66
2	$\frac{1}{2}$ LFL	138	69	66

The thermal intensity radii for flash fire are shown in Figure below:

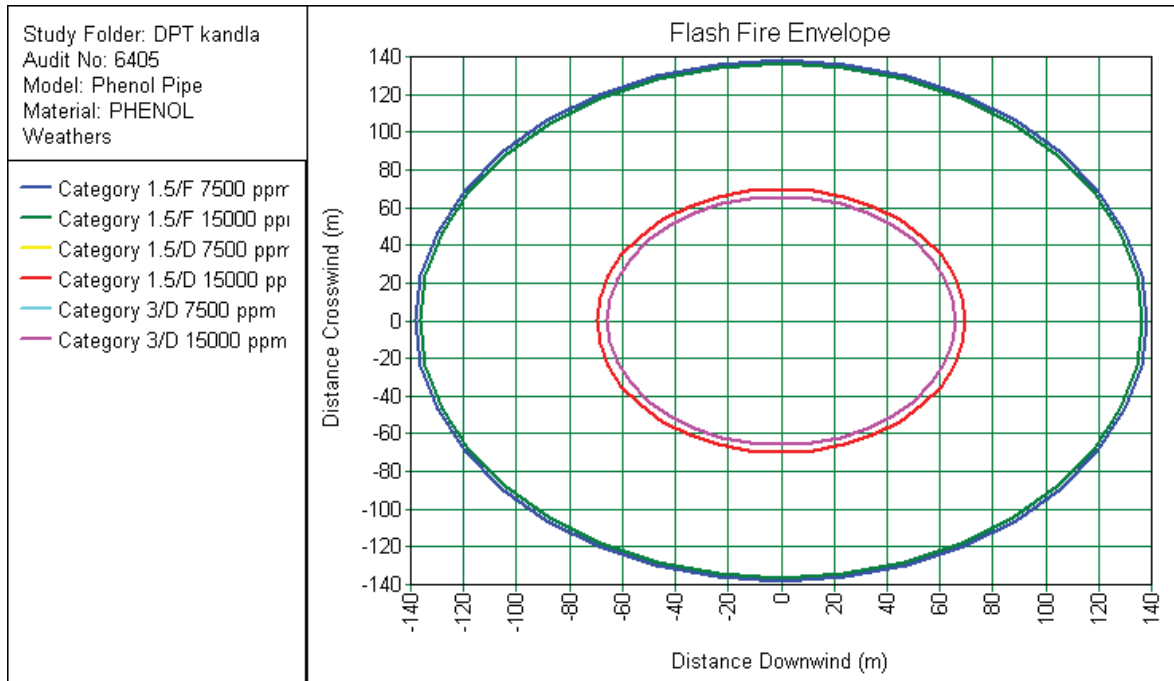


Figure 8: Thermal Intensity Radii due to Flash Fire of Phenol

The worst case vulnerable distance (hazard effect distance) for Flash-fire due to release of phenol having significant damage to human life is observed to be up to 139m (@LFL having 100% probability of death).

C) Benzene

- **Scenario:** Catastrophic rupture of piping
- **Consequent outcome-I:** Pool spill followed by immediate ignition resulting in Pool fire.

The hazard extents for pool fire resulted due to spill of benzene are presented below:

POOL FIRE				
Unrestricted pool diameter: 137m				
Sn.	Radiation Intensity (kW/m ²)	Effect distance (m from spilled pool) in weather conditions		
		1.5F	1.5D	3D
1	4.0	149	149	166
2	12.50	70	69	70
3	37.50	NR	NR	NR

The radiation at various distances for pool fire are shown in figure below.

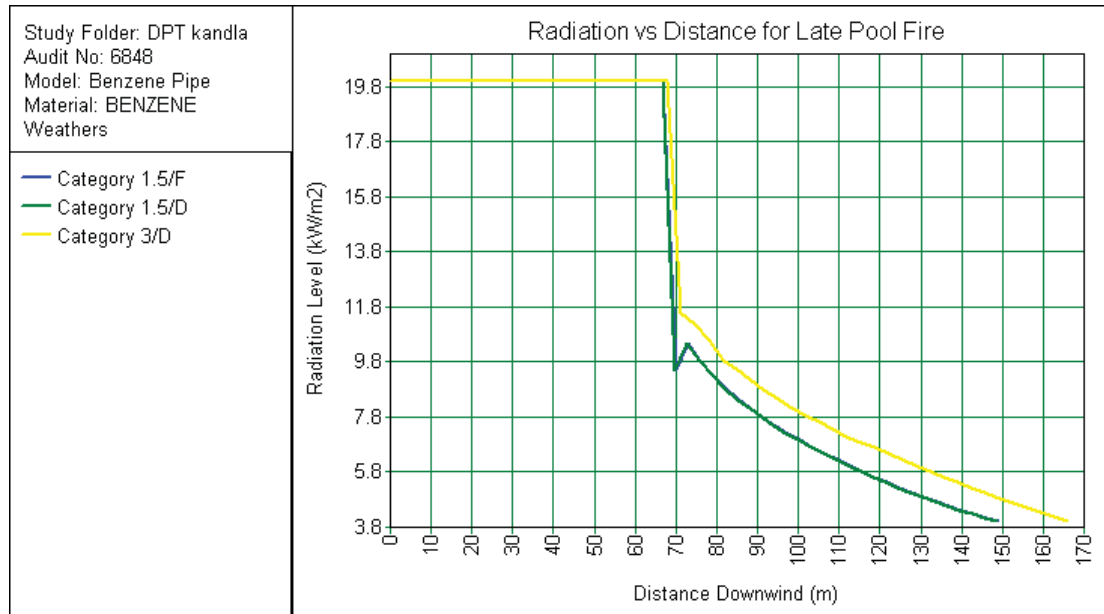


Figure 9: Radiation at Various Distances due to Pool Fire of Benzene

The thermal intensity radii for pool fire are shown in figure.

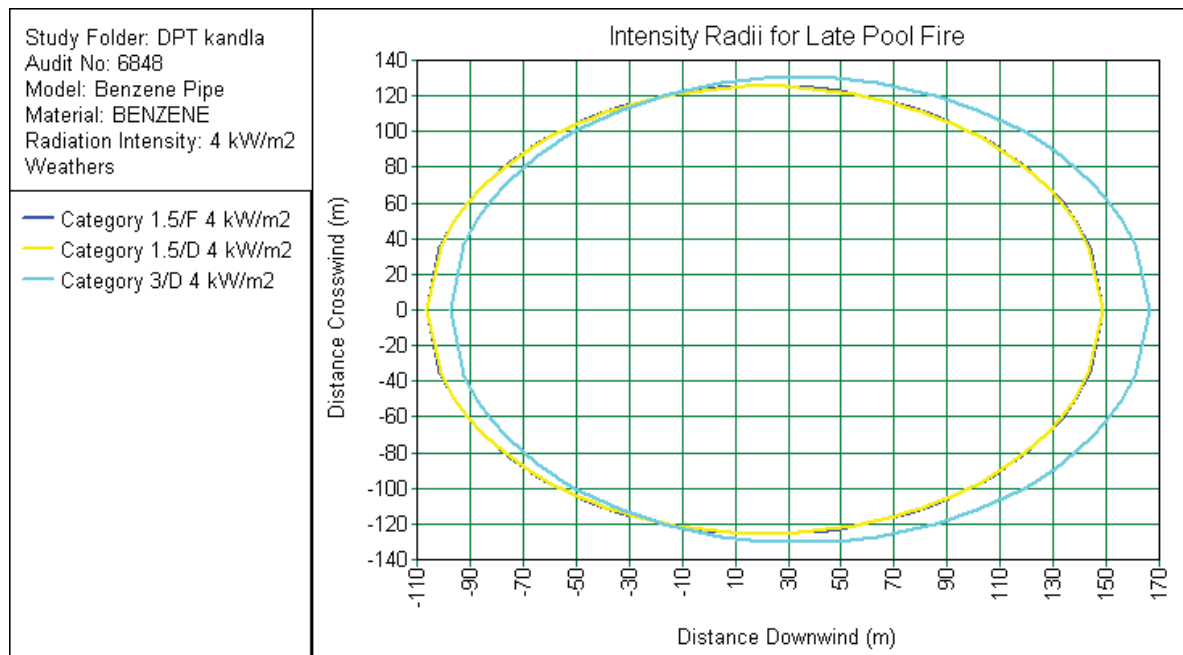


Figure 10: Thermal Intensity Radii due to Pool Fire of Benzene

The worst case vulnerable distance (hazard effect distance) for pool fire due to rupture of pipe having significant damage to human life is observed to be up to 70 m (@12.5 KW/m² having ~7% death probability).

- *Consequent outcome-II: Vapour Cloud explosion due to delayed remote ignition.*

The hazard effect extents for Vapour Cloud explosion resulted due to benzene release and ignited at a distance of 10 m from the release is presented below:

VAPOUR CLOUD EXPLOSION				
Distance of ignition source = 10m				
Sn.	Blast overpressure	Effect distance (m) in weather conditions		
		1.5F	1.5D	3D
1	0.21 bar	19	20	20
2	0.14 bar	21	23	23
3	0.02 bar	53	58	62

The blast overpressures at various distances for vapour cloud explosion are shown in figure.

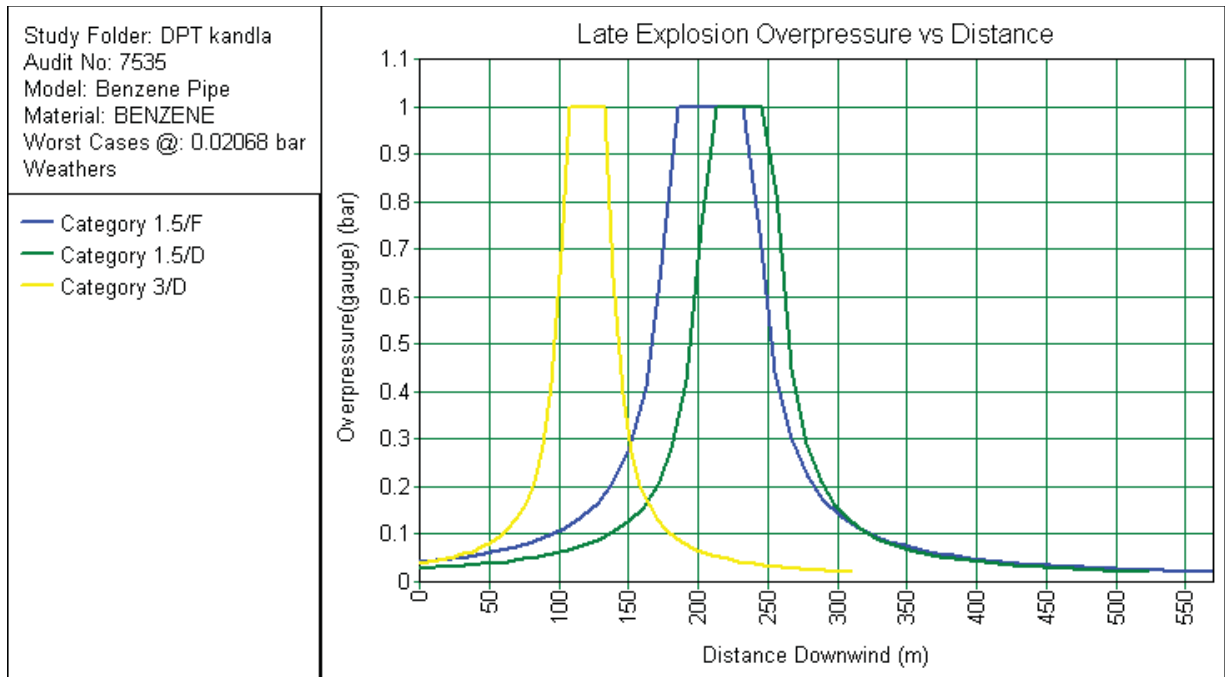


Figure 11: Blast Overpressure at Various Distances due to Vapour Cloud Explosion of Benzene

The worst case vulnerable distance (hazard effect distance) for explosion due to release of benzene having significant damage to human life is observed to be up to 20m (@0.21 bar having 100% probability of death).

- *Consequent outcome-III: Release from ruptured pipe followed by delayed ignition resulting in Flash-fire.*

The hazard effect extents for Flash fire resulted due to release of benzene are presented below:

FLASH FIRE				
$\frac{1}{2}$ LFL concentration = 6000 ppm				
Sn.	Concentration of Interest	Effect distance (m) in weather conditions		
		1.5F	1.5D	3D
1	LFL	300	230	140
2	$\frac{1}{2}$ LFL	360	260	184

The thermal intensity radii for flash fire are shown in figure below:

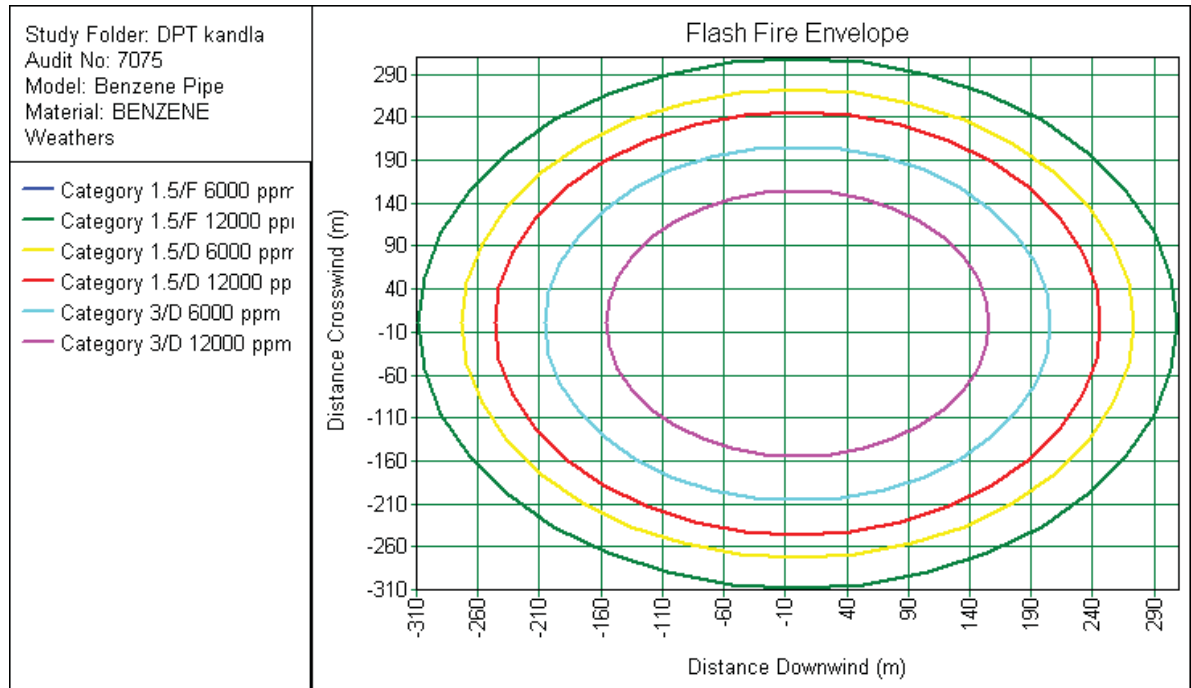


Figure 12: Thermal Intensity Radii due to Flash Fire of Benzene

The worst case vulnerable distance (hazard effect distance) for Flash-fire due to release of benzene having significant damage to human life is observed to be up to 300m (@LFL having 100% probability of death).

- Consequent outcome-IV: Release from ruptured pipe leading to a toxic release

The toxic hazard lethality extents for toxic releases leading to lethal consequences, resulted due to release of benzene are presented below:

TOXIC RELEASE				
Sn.	Distance from Release point (m)	Probability of fatality		
		1.5F	1.5D	3D
1	0	1	1	1
2	25	1	1	0.24
3	50	1	1	0
4	75	1	0.87	-
5	100	0.61	0.01	-
6	125	0	0	-

The probability of fatality due to a time-averaged toxic release (IDLH) of benzene is shown in figure below:

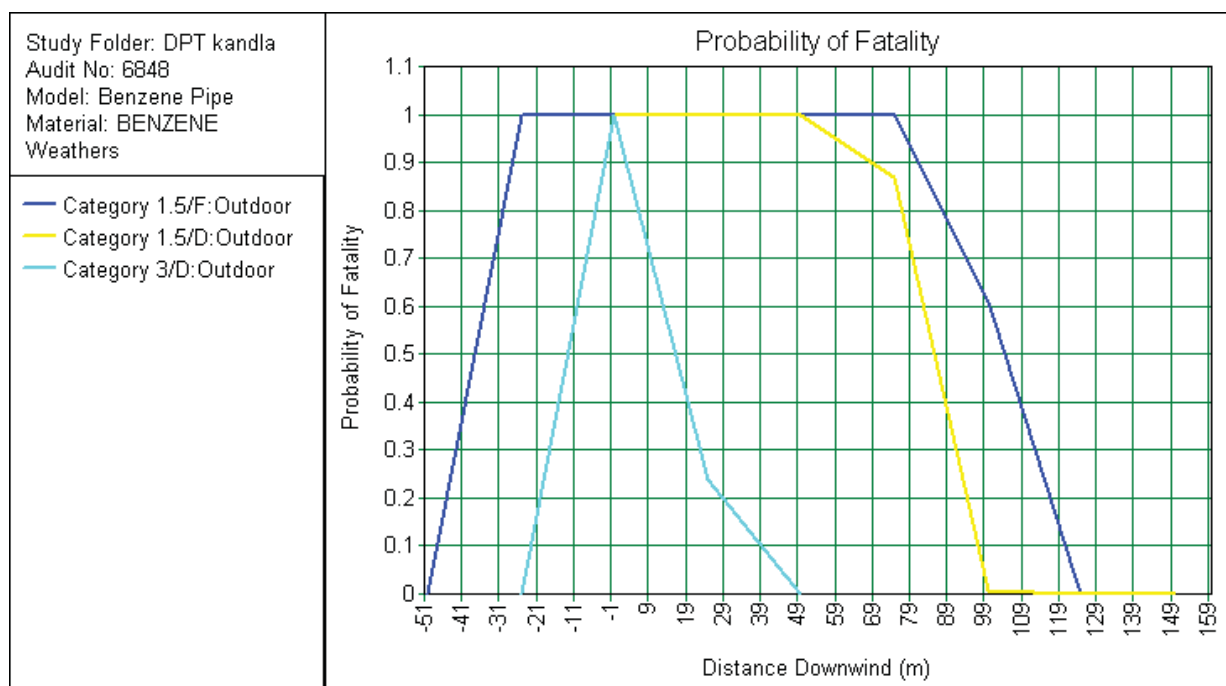


Figure 13: Probability of Fatality due to a Time-Averaged Toxic Release (IDLH) of Benzene

The worst case vulnerable distance (hazard effect distance) for a time-averaged IDLH (immediately dangerous to life or health) toxic release of benzene for an exposure time of 30 minutes, having significant damage to human life is observed to be up to 125m (beyond which is the safe zone).

D) Butyl Acrylate

- Scenario:** Catastrophic rupture of piping
- Consequent outcome-I:** Pool spill followed by immediate ignition resulting in Pool fire.

The hazard extents for pool fire resulted due to spill of Butyl Acrylate are presented below:

POOL FIRE				
Unrestricted pool diameter: 137m				
Sn.	Radiation Intensity (kW/m ²)	Effect distance (m from spilled pool) in weather conditions		
		1.5F	1.5D	3D
1	4.0	141	141	154
2	12.50	70	70	71
3	37.50	NR	NR	NR

The radiation at various distances for pool fire are shown in figure below

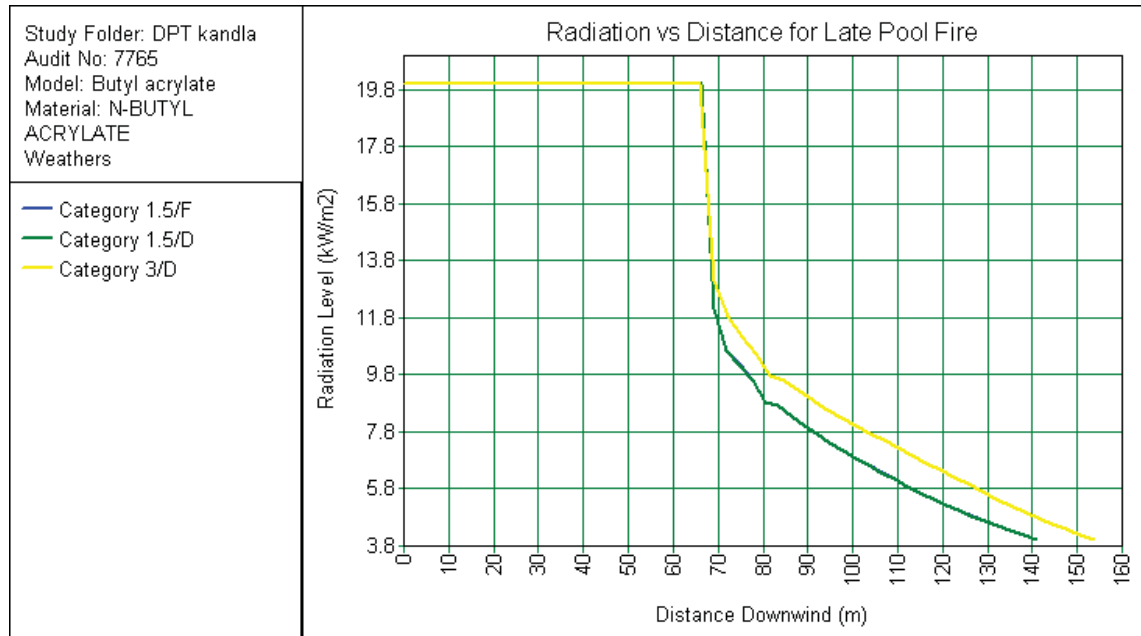


Figure 14: Radiation at Various Distances due to Pool Fire of Butyl Acrylate

The thermal intensity radii for pool fire are shown in figure.

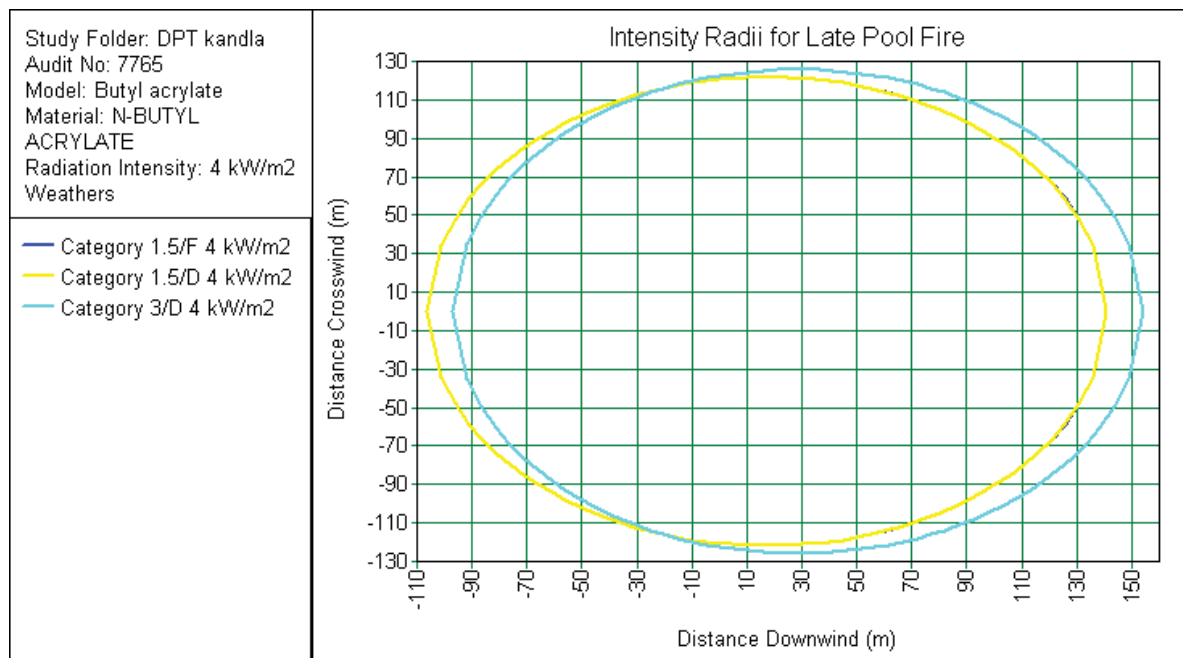


Figure 15: Thermal Intensity Radii due to Pool Fire of Butyl Acrylate

The worst case vulnerable distance (hazard effect distance) for pool fire due to rupture of pipe having significant damage to human life is observed to be up to 71 m (@12.5 KW/m² having ~7% death probability).

- *Consequent outcome-II: Vapour Cloud explosion due to delayed remote ignition.*

The hazard effect extents for Vapour Cloud explosion resulted due to butyl acrylate release and ignited at a distance of 10 m from the release is presented below:

VAPOUR CLOUD EXPLOSION				
Distance of ignition source = 10m				
Sn.	Blast overpressure	Effect distance (m) in weather conditions		
		1.5F	1.5D	3D
1	0.21 bar	19	19	18
2	0.14 bar	21	22	20
3	0.02 bar	52	56	49

The blast overpressures at various distances for vapour cloud explosion are shown in figure.

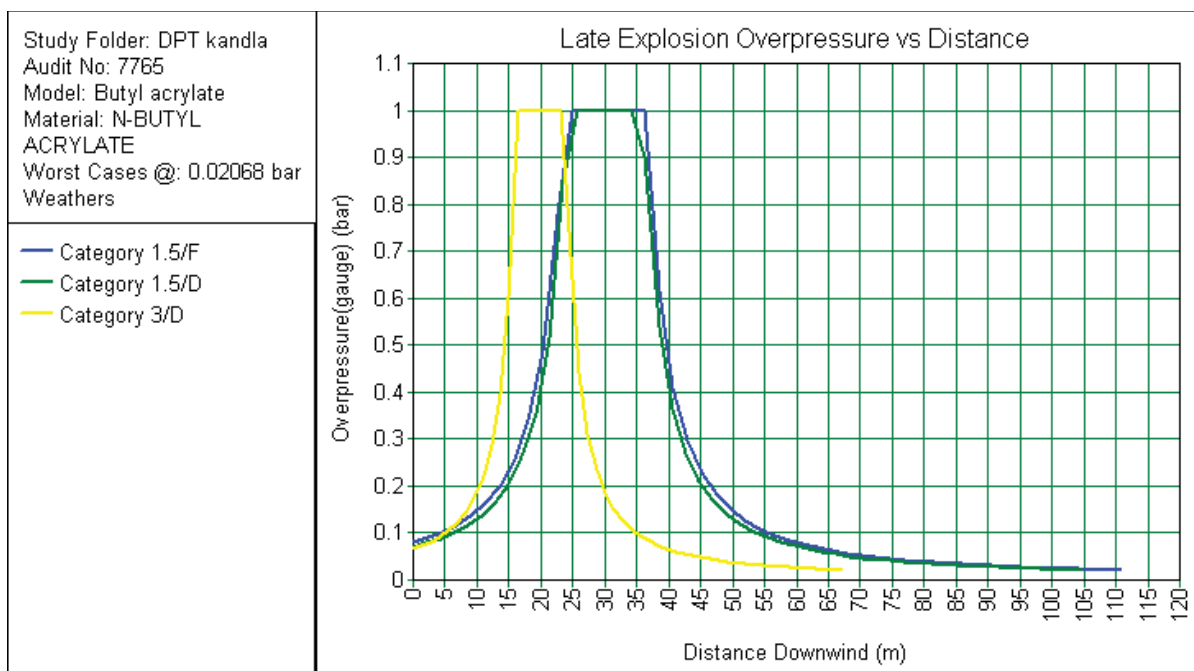


Figure 16: Blast Overpressure at Various Distances due to Vapour Cloud Explosion of Butyl Acrylate

The worst case vulnerable distance (hazard effect distance) for explosion due to release of butyl acrylate having significant damage to human life is observed to be up to 19m(@0.21 bar having 100% probability of death).

- *Consequent outcome-III: Release from ruptured pipe followed by delayed ignition resulting in Flash-fire.*

The hazard effect extents for Flash fire resulted due to release of butyl acrylate are presented below:

FLASH FIRE				
$\frac{1}{2}$ LFL concentration = 7500 ppm				
Sn.	Concentration of Interest	Effect distance (m) in weather conditions		
		1.5F	1.5D	3D
1	LFL	114	112	79
2	$\frac{1}{2}$ LFL	162	156	126

The thermal intensity radii for flash fire are shown in figure below:

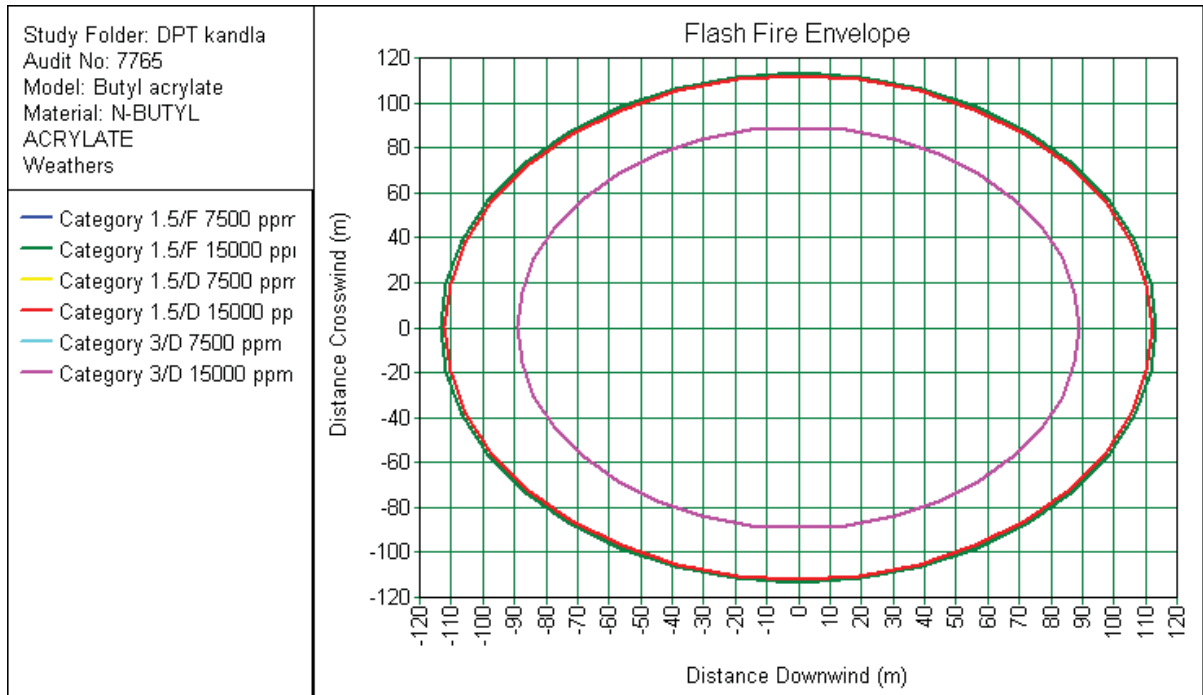


Figure 17: Thermal Intensity Radii due to Flash Fire of Butyl Acrylate

The worst case vulnerable distance (hazard effect distance) for Flash-fire due to release of butyl acrylate having significant damage to human life is observed to be up to 114m (@LFL having 100% probability of death).

E) Acetone

- **Scenario:** Catastrophic rupture of piping
- **Consequent outcome-I:** Pool spill followed by immediate ignition resulting in Pool fire.

The hazard extents for pool fire resulted due to spill of acetone are presented below:

POOL FIRE				
Unrestricted pool diameter: 135m				
Sn.	Radiation Intensity (kW/m ²)	Effect distance (m from spilled pool) in weather conditions		
		1.5F	1.5D	3D
1	4.0	350	349	352
2	12.50	218	217	224
3	37.50	131	131	144

The radiation at various distances for pool fire are shown in figure below.

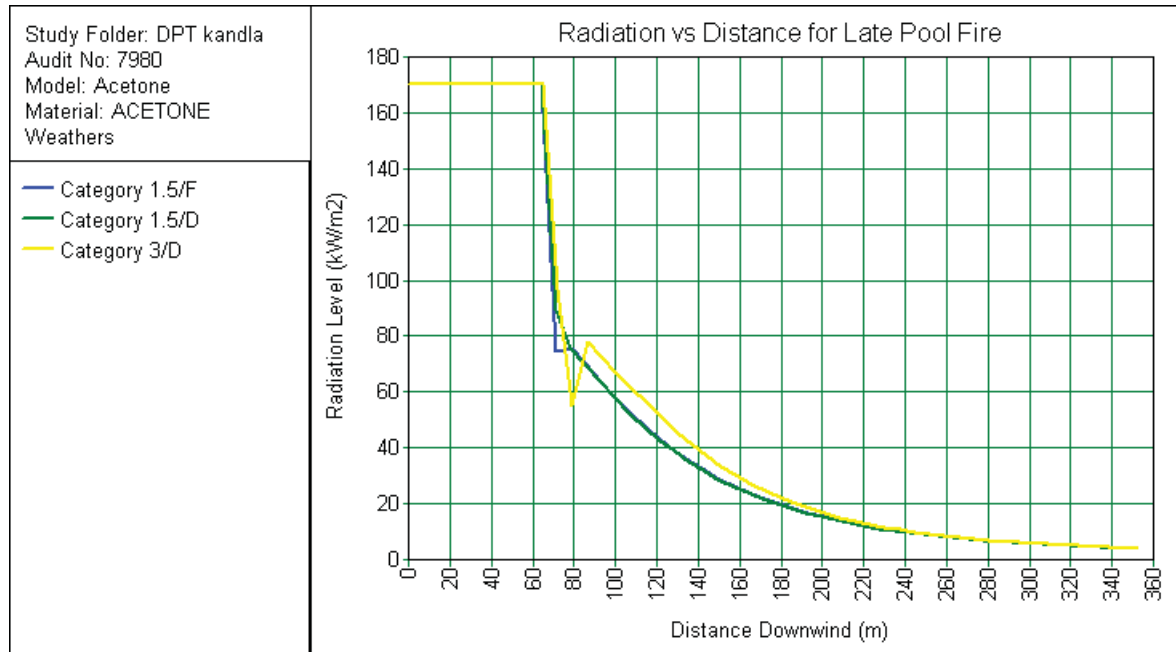


Figure 18: Radiation at Various Distances due to Pool Fire of Acetone

The thermal intensity radii for pool fire are shown in figure below.

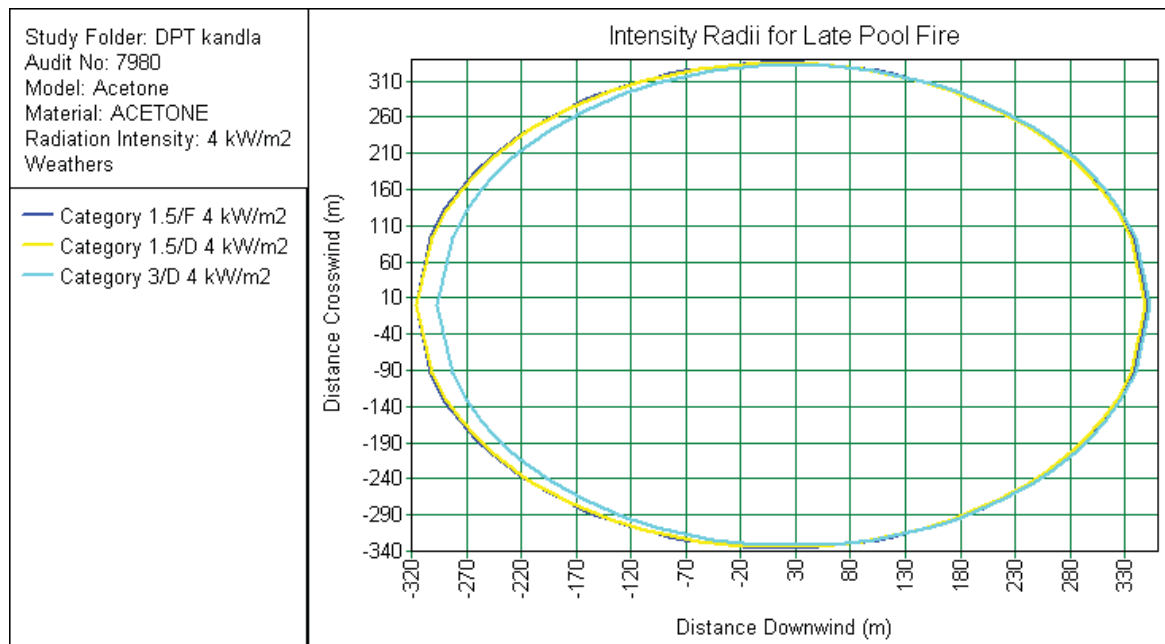


Figure 19: Thermal Intensity Radii due to Pool Fire of Acetone

The worst case vulnerable distance (hazard effect distance) for pool fire due to rupture of pipe having significant damage to human life is observed to be up to 144m (@37.5 KW/m² having immediate death probability).

- *Consequent outcome-II: Vapour Cloud explosion due to delayed remote ignition.*

The hazard effect extents for Vapour Cloud explosion resulted due to acetone release and ignited at a distance of 10 m from the release is presented below:

VAPOUR CLOUD EXPLOSION				
Distance of ignition source = 10m				
Sn.	Blast overpressure	Effect distance (m) in weather conditions		
		1.5F	1.5D	3D
1	0.21 bar	20	20	44
2	0.14 bar	22	23	54
3	0.02 bar	58	61	180

The blast overpressures at various distances for vapour cloud explosion are shown in figure.

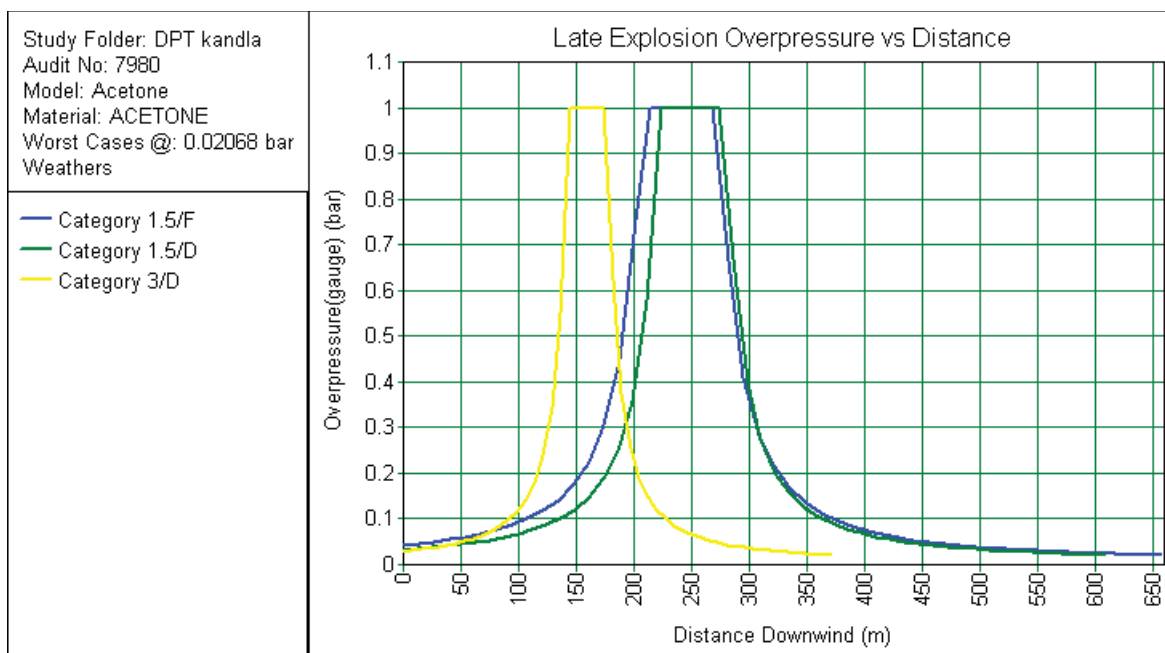


Figure 20: Blast Overpressure at Various Distances due to Vapour Cloud Explosion of Acetone

The worst case vulnerable distance (hazard effect distance) for explosion due to release of acetone having significant damage to human life is observed to be up to 44m (@0.21 bar having 100% probability of death).

- *Consequent outcome-III: Release from ruptured pipe followed by delayed ignition resulting in Flash-fire.*

The hazard effect extents for Flash fire resulted due to release of acetone are presented below:

FLASH FIRE				
$\frac{1}{2}$ LFL concentration = 13000 ppm				
Sn.	Concentration of Interest	Effect distance (m) in weather conditions		
		1.5F	1.5D	3D
1	LFL	370	315	175
2	$\frac{1}{2}$ LFL	506	415	225

The thermal intensity radii for flash fire are shown in figure:

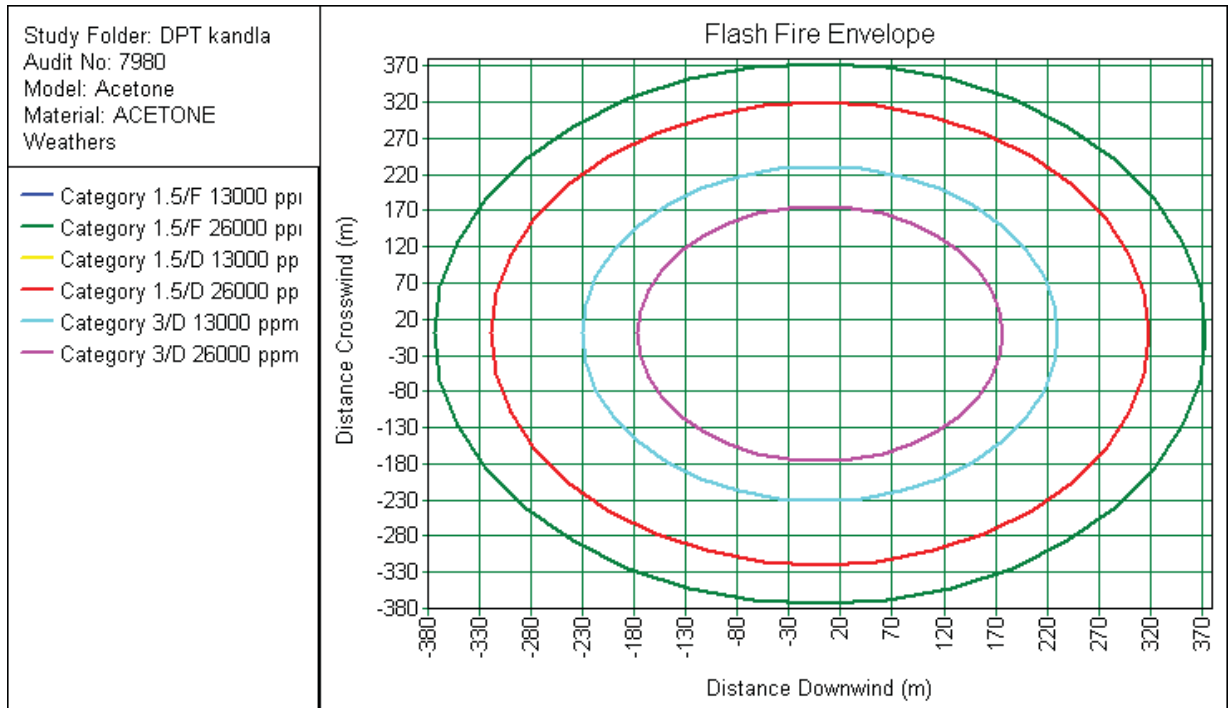


Figure 21: Thermal Intensity Radii due to Flash Fire of Acetone

The worst case vulnerable distance (hazard effect distance) for Flash-fire due to release of acetone having significant damage to human life is observed to be up to 370m (@LFL having 100% probability of death).

F) LPG

- **Scenario:** Catastrophic rupture of LPG piping
- **Consequent outcome-I:** Release from failure of LPG pipelines followed by immediate ignition resulting in Jet fire.

The hazard effect extents for jet fire resulted due to release of pressurized LPG from failure of pipelines is as follows:

JETFIRE				
Release rate of LPG = 456.32 kg/s				
Sn.	Radiation Intensity (kW/m ²)	Effect distance (m from spilled pool) in weather conditions		
		1.5F	1.5D	3D
1	4.0	222.21	222.21	202.70
2	12.50	-	-	61.59
3	37.50	-	-	-

The radiation vs. distance graph as well as thermal intensity radii for jet fire due to LPG release from pipeline are shown in Fig.22 and Fig.23 respectively.

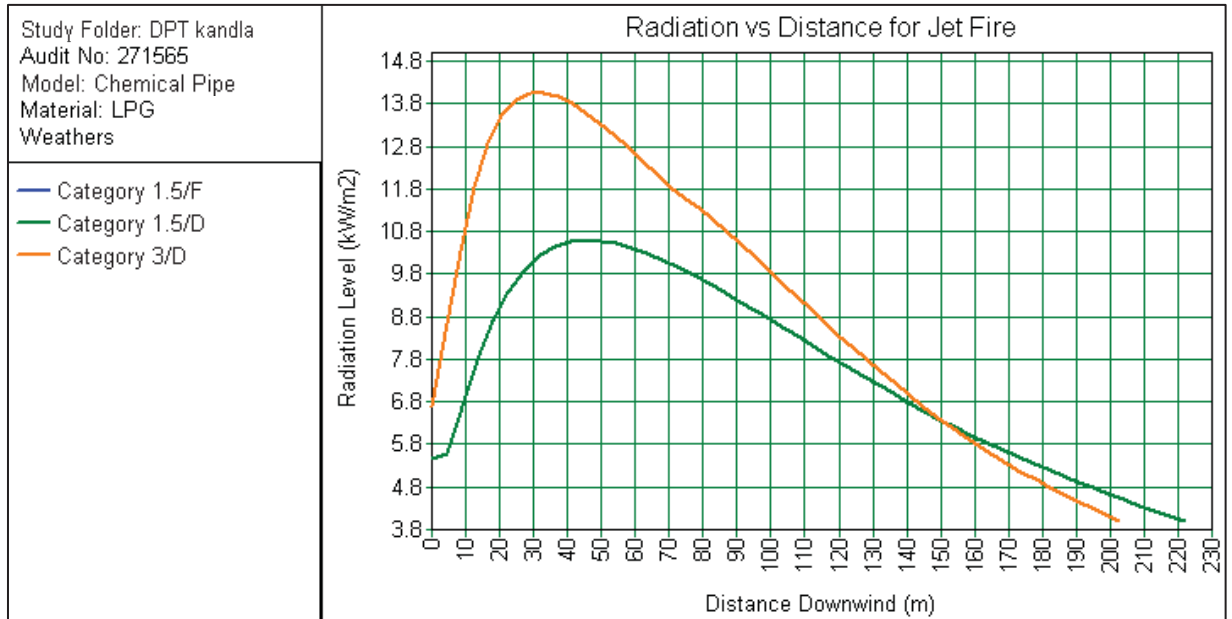


Figure 22: Radiation vs. Distance for Jet Fire due to LPG release

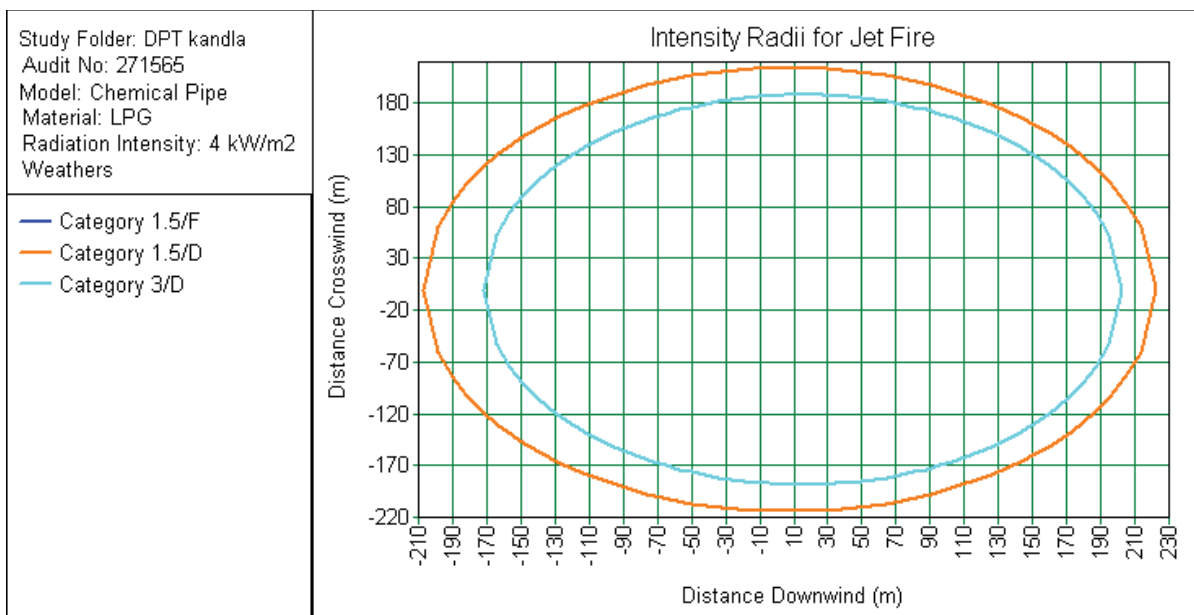


Figure 23: Thermal Intensity Radii for Jet Fire due to LPG Release

The worst case vulnerable distance (hazard effect distance) for jet fire due to release of LPG from pipelines having significant damage to human life is observed to be up to 61.59m (@12.5 KW/m² since higher thermal radiation is not observed) from the LPG piping.

- *Consequent outcome-II: Release from failure of pipelines followed by immediate ignition resulting in Flash fire.*

The hazard effect extents for Flash fire resulted due to release of pressurized LPG from failure of pipelines is presented below:

FLASH FIRE				
$\frac{1}{2}$ LFL concentration = 17293.28 ppm				
Sn.	Concentration of Interest	Effect distance (m) in weather conditions		
		1.5F	1.5D	3D
1	LFL	19.18	13.73	10.88
2	$\frac{1}{2}$ LFL	170.38	31.18	40.26

The flash fire envelope due to LPG release from pipelines are shown in figure below:

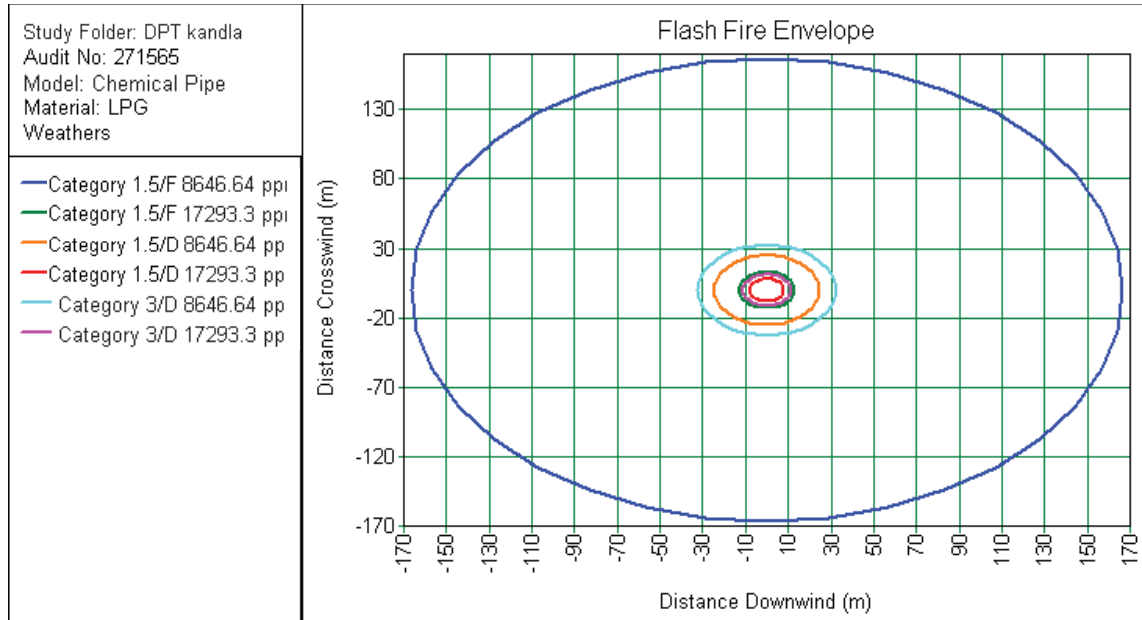


Figure 24: Flash Fire Envelope due to LPG Release

The worst case vulnerable distance (hazard effect distance) for flash fire due to LPG release from pipelines having significant damage to human life is observed to be up to 19.18m (@LFL having 100% probability of death) from the LPG piping.

- *Consequent outcome-III: Release from failure of LPG pipelines followed by delayed remote ignition resulting in Vapour Cloud explosion.*

The hazard effect extents for Vapour Cloud explosion resulted due to LPG release from pipelines and ignited at a distance of 10m from the pipeline is presented below:

VAPOUR CLOUD EXPLOSION				
Distance of ignition source = 10m				
Sn.	Blast overpressure	Effect distance (m) in weather conditions		
		1.5F	1.5D	3D
1	0.21 bar	64.01	68.02	57.46
2	0.14 bar	79.80	84.99	71.33
3	0.02 bar	279.59	299.61	246.88

The Explosion overpressure vs. distance as well as Late explosion worst case radii due to LPG release from pipelines are shown in Fig.25 and Fig.26 respectively.

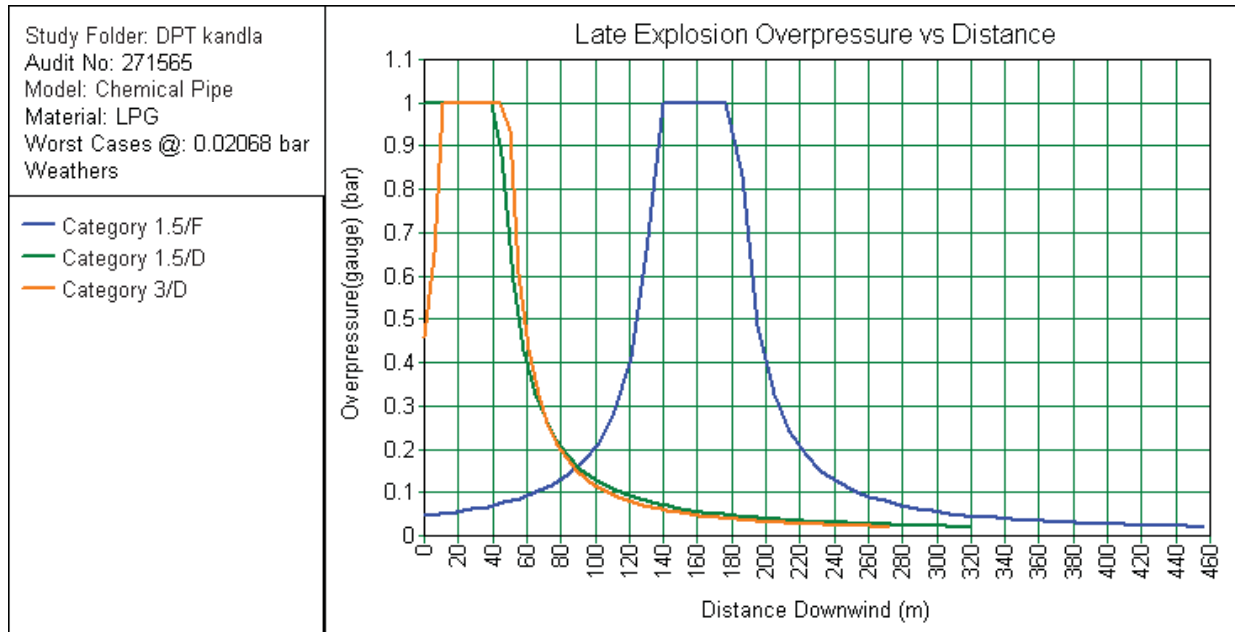


Figure 25: Explosion Overpressure vs. Distance as due to LPG Release

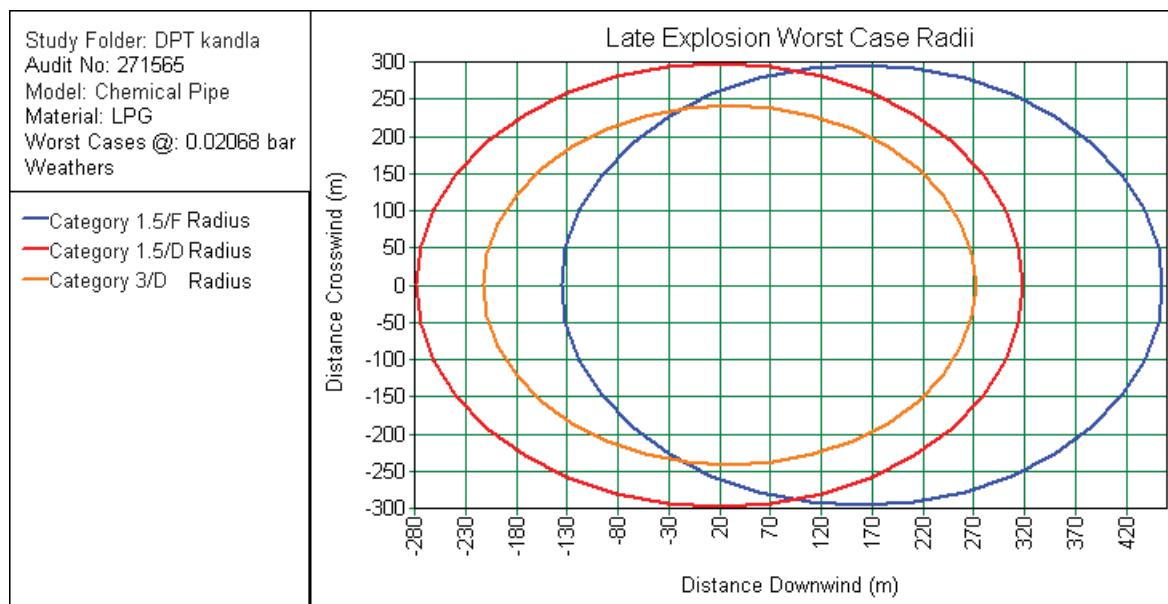


Figure 26: Late Explosion Worst Case Radii due to LPG Release

The worst case vulnerable distance (hazard effect distance) for explosion due to LPG release from pipelines having significant damage to human life is observed to be up to 68.02 m (@0.21 bar having 100% probability of death) from the LPG piping.

The maximum Hazard extents amongst all major hazardous scenarios in worst case situations due to rupture of all hazardous chemical pipelines (including LPG) is shown in Fig. 27a to 27d.

Fig. 27a: Major fire (pool fire, Jet fire) due to cat. Rupture of pipeline (MET: 3D)

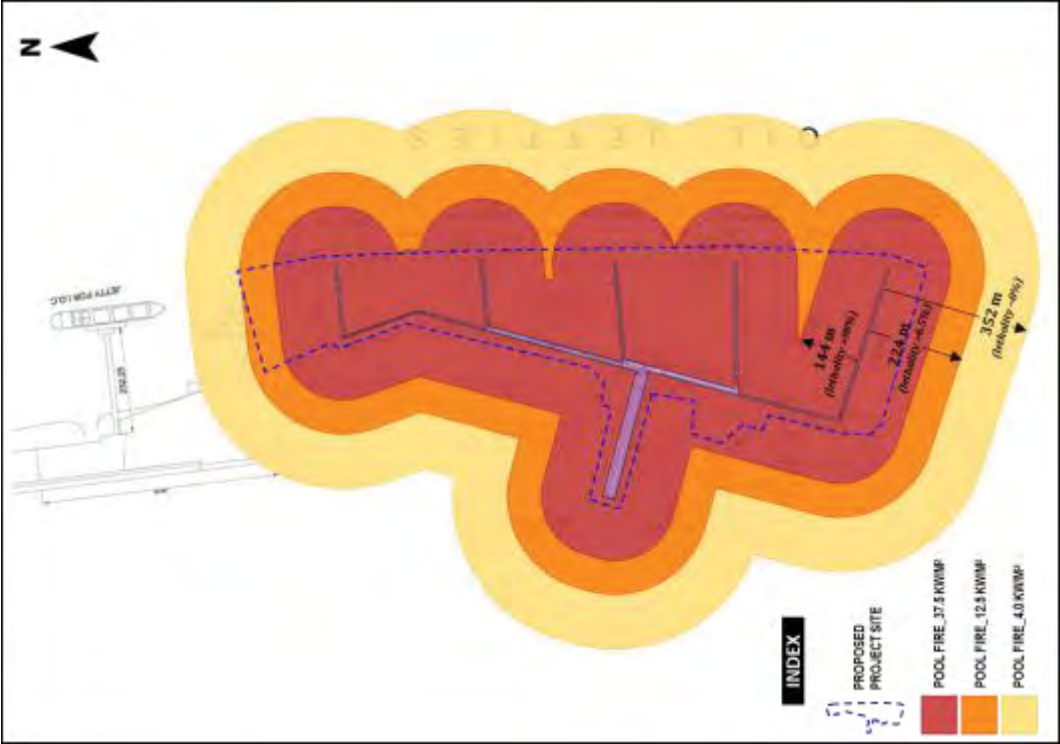


Fig. 27b: Major Vapour Cloud Explosion due to catastrophic rupture (MET: 3D)

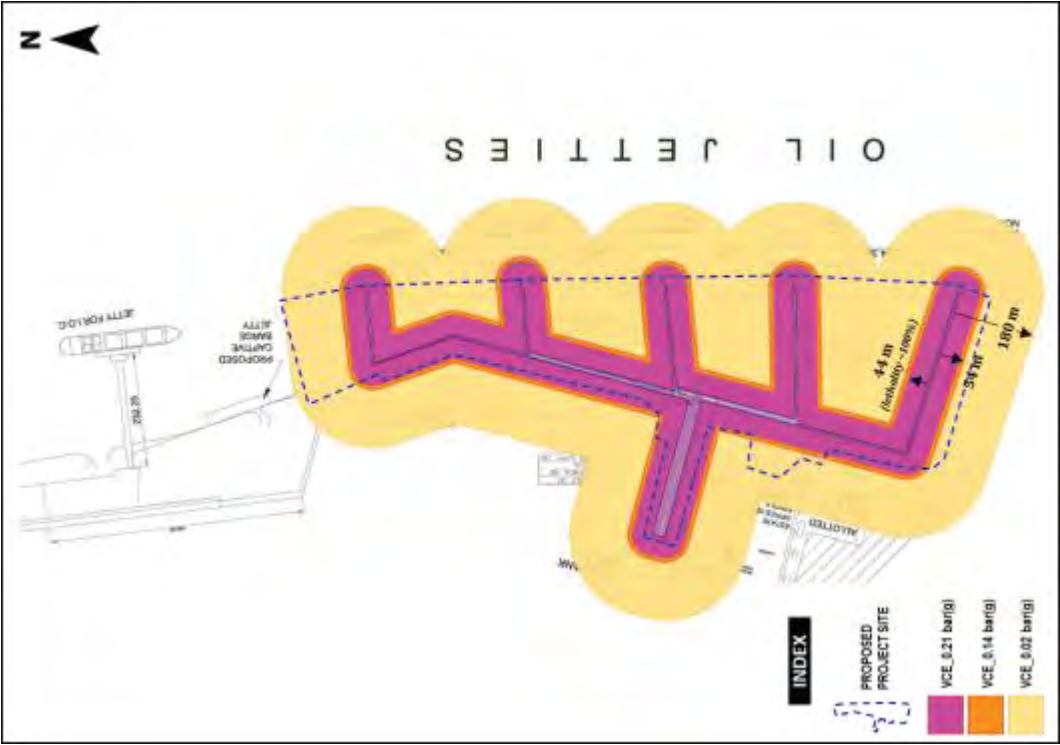


Fig. 27c: Major Flash Fire due to cat.rupture (MET: 1.5F)

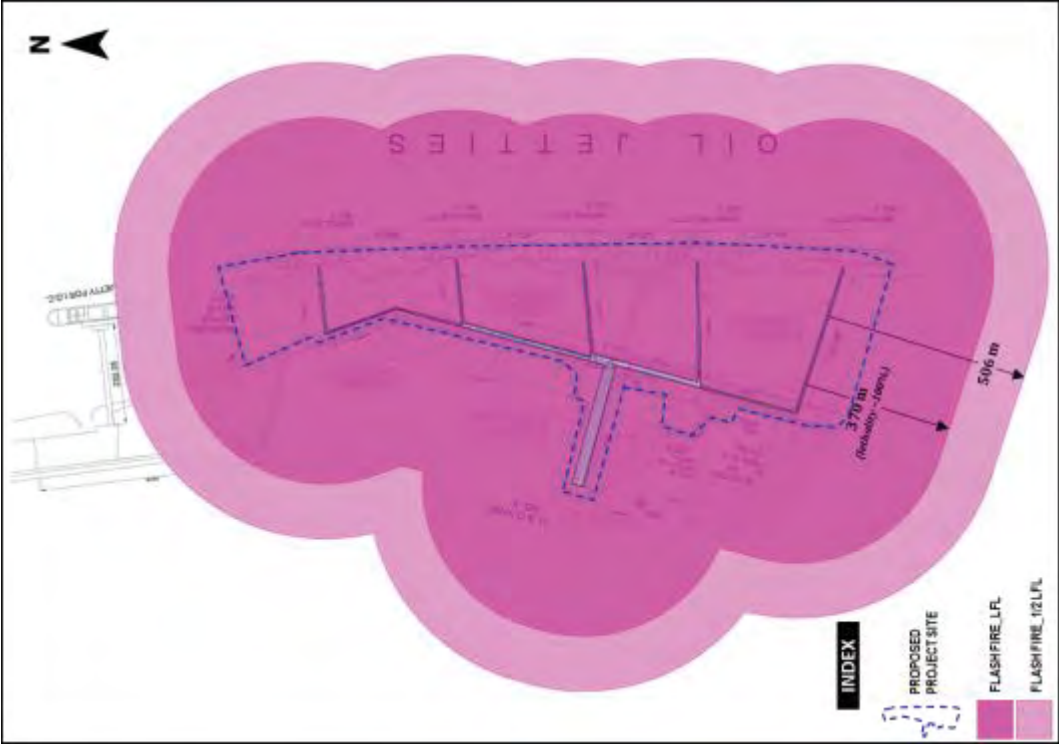
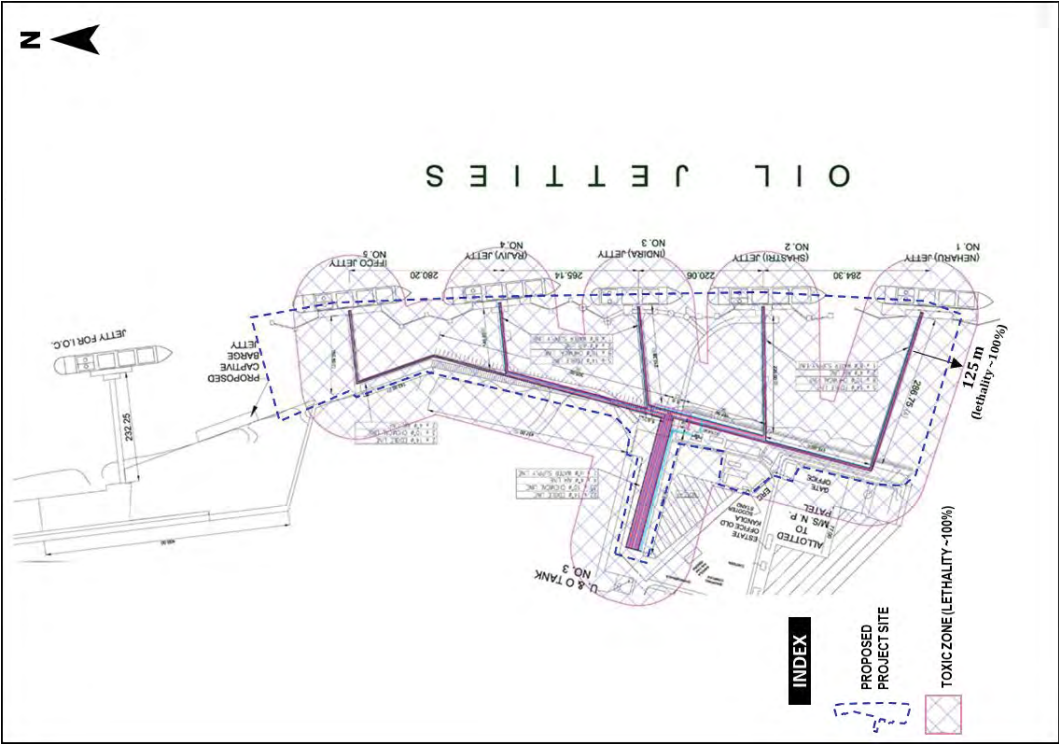


Fig. 27d: Toxic Dispersion due to catastrophic rupture (MET: 1.5F)



9.0 CONCLUSION ON MCA ANALYSIS FOR PROPOSED FACILITIES

The results of MCA analysis of all representative chemicals to be handled by the revamped Oil jetties of DPT indicates,

- Maximum fire hazard distance for causing significant damage (@37.5 Kw/m² thermal radiation) extends up to 144m in the case of spill of acetone due to catastrophic rupture of pipeline handling acetone and subsequently being ignited during worst meteorological conditions, resulting in a pool fire.
- The effect of an explosion in the chemical pipelines and resultant damage at 0.21 bar overpressure is anticipated in the case of release of acetone, having an impact extent up to 44m during worst meteorological conditions.
- The maximum damage effects due to a flash fire is anticipated from the release and subsequent delayed ignition of acetone, having an impact distance of 370m (@ LFL) at worst meteorological conditions.
- The lethal effects of a toxic chemical release is anticipated to extend up to 125 m, as modelled in case of release of Benzene during worst meteorological conditions due to catastrophic rupture of a chemical pipeline.

The nearest habitation are two small hamlets of local fishermen and boatmen, located towards western direction of Oil jetty area of DPT, situated at >600m away from the oil jetties, as indicated in Fig. 28. However, all hazard distances estimated for the worst case situation indicate that it is highly unlikely that the fire hazards due to chemical pipe rupture will affect these offsite habitations, as the maximum hazard distance observed is 370m. It is likely that no hazards will extend into any nearby settlement from the proposed project site. Also, leak detection systems shall be installed to detect leaks or cracks in the pipeline. Fire-fighting facilities will also be installed to check any fire incident that may occur.



Fig. 28: Nearest Locations From Proposed Project Site

10.0 HAZARD CONSEQUENCES DUE TO EXISTING FACILITIES

The comprehensive Disaster Management Plan of Deendayal Port Trust elaborates on the hazards as well as consequences due to existing oil jetties.

The identified representative hazardous substances that will continue to be handled by existing pipelines at Oil Jetty area of Deendayal Port, Kandla are as follows:

1. LPG (Liquefied Petroleum Gas)
2. ACN (Acrylonitrile)
3. Aniline
4. 1,3 Butadiene
5. VCM (Vinyl Chloride)
6. Propylene
7. Ammonia
8. HSD (High Speed Diesel)
9. Motor Spirit
10. SKO (Superior Kerosene Oil)

Consequence modelling for these substances was carried out using ALOHA (Aerial Locations of Hazardous Atmospheres), a computer program designed especially for use by people responding to chemical releases, as well as for emergency planning and training. ALOHA models key hazards — toxicity, flammability, thermal radiation (heat), and overpressure (explosion blast force) — related to chemical releases that result in toxic gas dispersions, fires, and /or explosions.

The modelling assumed the release of aforementioned representative chemicals handled at all existing oil jetties. A wind speed of 10 m/s, atmospheric stability class “C” and a probable inventory of 1000 liters for each chemical was considered for determining the associated consequences from each chemical.

The details of the associated hazards and their impact distances are described in detail in the comprehensive Disaster Management Plan of Deendayal Port.

11.0 HAZARDOUS EVENTS WITH GREATEST CONTRIBUTION TO FATALITY RISK

The hazardous event scenarios likely to make the significant contribution to the risk of potential fatalities are enlisted in Table 8. The risks to people at plant site are categorized as “On-site” risks while the risks to communities outside the plant premises is categorized as “Off-site” risks.

Table 8: Hazardous Events Contributing To Risk And Their Risk Ranking

			(A)	(B)	C = A*B
Sn.	Hazardous event	Consequence of significant damage	Consequence severity* (1=least severe; 5=most severe)	Likelihood* (1=least likely; 5=most likely)	RISK RANK
1.	Onsite vehicle impact on personnel	Potential for single fatalities, onsite impact only	3	3	9
2.	Entrapment/struck by Machinery	Potential for single fatalities, onsite impact only	3	2	6
3.	Fall from heights	Potential for single fatalities, onsite impact only	1	3	3
4.	Electrocution	Potential for single fatalities, onsite impact only	2	3	6
5.	Pipeline rupture releasing chemicals	Potential for multiple fatalities, onsite impact only	4	1	4
6.	Pipeline rupture releasing hydrocarbons	Potential for multiple fatalities, onsite impact only	5	1	5

*based on Historical survey of similar facilities

The above risk ranking indicates that although the most severe consequences will be due to rupture of chemical on POL lines, their chances of occurrences are very low due to implementation of better safety features in the installations and risk prevention mechanisms.

12.0 SUMMARY & CONCLUSIONS OF RISK ASSESSMENT

The risk assessment and analysis for the proposed revamped oil jetty of DPT, Kandla for most severe hazardous events is broadly summarised below:

- The nearest habitations in the vicinity of the proposed site are at distances greater than 600m in western direction, which are far away from the hazard distances observed for thermal (370m) as well as toxic effects (125m) of release and/or ignition of chemicals from pipelines. So, it is highly unlikely that a significant impact on the local community or damage to property / environment will occur due to the proposed facility.
- The most severe damage effects due to pipeline ruptures will be mostly limited to the port premises and adequate safety controls as well as implementation of recommended control strategies in the design as well as operation stage will ensure effective management of the associated risks.

13.0 NATURAL DISASTERS

The project is located in Seismic Zone V. The project area has erratic monsoons and there is virtually very little rainfall during the year in Kandla. Additionally, low rainfall coupled with erratic behavior of the monsoon in the state make the Kutch district also vulnerable to drought. Coastal areas of Kutch District including Gandhidham are also particularly prone to cyclones. Cyclones originate out at sea and become hazardous when they come ashore. They also drive the sea level up to cause coastal flooding. The risks at Deendayal Port, Kandla due to natural disasters are shown in Fig. 29(a) to 29(c).

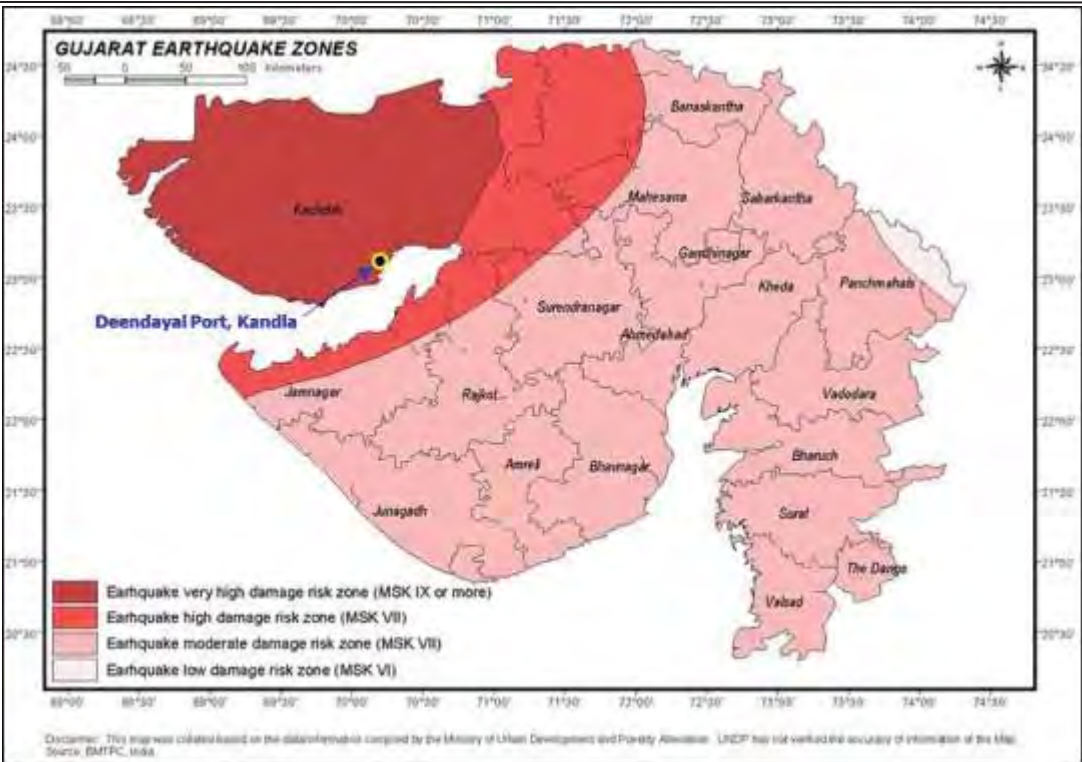


Fig. 29a: Earthquake Risk map of Gujarat with DPT, Kandla indicated

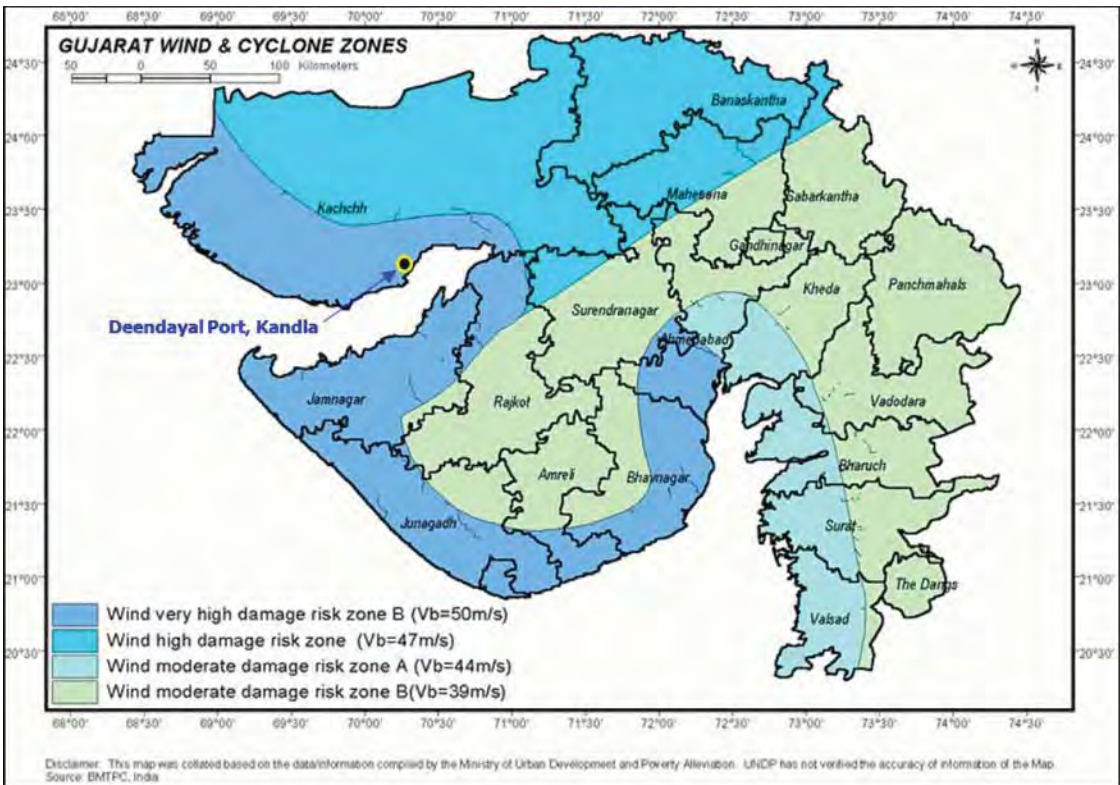


Fig. 29b: Cyclone & Wind Risk map of Gujarat with DPT, Kandla indicated

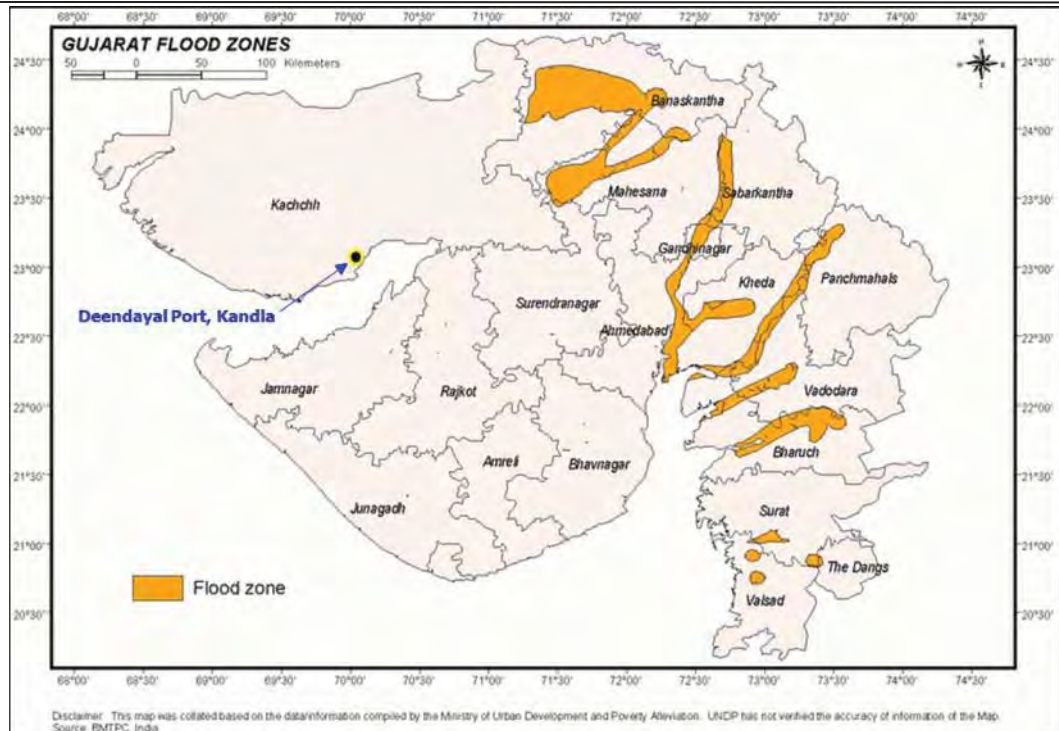


Fig. 29c: Flood Risk map of Gujarat with DPT, Kandla indicated.

The following measures will be undertaken to reduce damage due to natural disasters:

- ❖ Crisis Management Group will activate the Emergency Control Centre.
- ❖ Crisis Management Group will initiate onsite management as per Crisis management and Disaster Preparedness Plan Manual
- ❖ Incident Controller will initiate Emergency Operations at site and report to Chief Incident Controller.
- ❖ Evacuate the affected zones with the help of Warden Team.
- ❖ The Chief Incident Controller will assess the situation and report to the Chief Emergency Controller.
- ❖ Chief Emergency Controller will seek assistance of District Authorities if required.

An elaborate Emergency Preparedness & Response Plan as part of its Disaster Management Plan has already been prepared by DPT, Kandla for combating onsite as well as natural hazards. The same will be extended for the proposed facilities for effective as well as comprehensive risk and hazard management as well as disaster prevention.

14.0 GENERAL SAFETY FEATURES

- a. All personnel are also adequately trained regarding safety aspects.
- b. In addition specialized workers are given additional training in their areas of work
- c. Sufficient ventilation and lighting are provided in all workplace.
- d. Good housekeeping is maintained at all work places.
- e. First aid kit and oxygen cylinders with masks are kept ready within easy reach of all work places. There are dispensaries at the port area, which are manned round the clock by paramedical personnel. Ambulance is also available. The port has a well equipped 55 bedded hospital at Gandhidham. There are tie-ups with private hospitals at Gandhidham, Rajkot and even Ahmedabad which have the resources for giving emergency treatment to critical cases. An ambulance is also always kept ready at

the DPT's Gandhidham Hospital for evacuation of casualties. In certain cases casualties may be referred to super- specialty hospitals directly from port area.

- f. All the workmen are provided helmets & shoes. Wearing of PPE (Boots, Helmet, Respirator, ear plug/muff, hand gloves, safety belt etc.) is enforced.
- g. Rest rooms and sanitary toilets are available for workers.
- h. Periodic inspection, proper maintenance and timely replacement of worn out parts, training of personnel.

OIL SPILL CONTINGENCY PLAN

1.0 GENERAL

Deendayal Port Trust, Kandla is one of the thirteen “Major Ports” of India. It is located on the shores of Gulf of Kutch. The Gulf of Kutch hosts highly diverse inter-tidal ecosystems including mangroves and coral reefs. The area is close to international shipping lanes and approaches to another five ports. Presently Deendayal Port has oil (crude oil as well as products) handling facilities, including Single Point Moorings (SPMs) near Vadinar, SPM off Veera and oil jetties on the western bank of Kandla Creek, where POL (but no crude oil), vegetable / edible oils and chemicals are handled. The oils handled by different facilities in DPT's area are given in Table 7.11.

Table 7.11: Details of Oils Handled and Characteristics

Sl. No.	Type of Oil	Specific Gravity	Genre	Characteristics	Examples
1	Light Oil	<0.84	White Oil	Non Persistent, Volatile	Products including ATF, SKO, MS, HSD, Naphtha
2	Crude Oil	>0.84	Black Oil	Persistent, Viscous, Emulsion, Fresh oil amenable to dispersants	Arabian Light, Arabian Heavy, etc.
3	Heavy Oil	>0.95	Black Oil	Persistent, Viscous, Emulsion, Generally not amenable to dispersants	Fuel Oils, LSWR
4	Edible Oil, Crude / Refined	>0.92	Black Oil	Persistent, Viscous,	

As per risk classification of ports and allied facilities as per National Oil Spill Disaster Contingency Plan (NOS-DCP), based on type of cargo handled, quantity of bunkers carried on-board ships calling at the port, single point mooring facility at the port and ship-to-ship (STS) transfer operations at the port, DPT belongs to “Risk Category A” i.e. Ports handling crude oil / tanker visits / SPM / STS.

DPT had decided to develop “Oil Spill Disaster Contingency Plan” and engaged the services of M/S KITCO Ltd., Kochi to carry out necessary studies for the same.

1.1 Oil Spill Response (OSR) Inventory for DPT Limit

The planning standard for OSR Resources for “Risk Category A” Ports is as follows:

- Inflatable booms : 2000 m
- Skimmer (20 TPH) : 4 nos.
- OSD Applicator : 6 nos.
- Oil Spill Dispersant : 10,000 litres
- 10 tonnes Flex Barges : 4 nos.
- Current buster booms : 400 m
(If tidal current >2 knots)
- Sorbent boom : 500 m
- Sorbent pads : 2000 nos.
- Mini Vacuum pumps : 5 nos.
- OSD Applicator : 5 nos. (for shoreline clean up)
- Fast Tanks : 5 nos.



- Work boats : 2 nos.
- Tugs : 2 nos.
- Manpower : 10 nos. for IMO Level 1 + 4 nos. for IMO level 2 + 10 others

The port already has 1200 m of inflatable booms. More are being / will be acquired. Deendayal Port Trust has 2 nos. 49 TPH fast flow skimmer a 12 TPH Brush Skimmer, which meets the minimum requirements. 3 tugs each have 12000 litres of oil spill dispersant storage capacity on board, which meets the minimum requirements.

As per NOS-DCP, to cater to a Tier 1 oil spill at Deendayal Port Trust, the port should have response equipment for containing 700 metric tonnes (MT) of oil.

Considering the worst Tier 1 Spill (i.e. 700 MT), it has been estimated that the area of impact shall be approximately 3.5 km² and approximately 1870 m length of coastline will be affected. The average response time has been estimated to be 60 minutes.

1.2 Oil Spill Incident Management Mechanism

Effective emergency plans require that in the event of an accident, there are nominated personnel with clearly defined responsibilities. The Oil Spill Response Organisation Chart for Deendayal Port is illustrated in Fig.7.24.

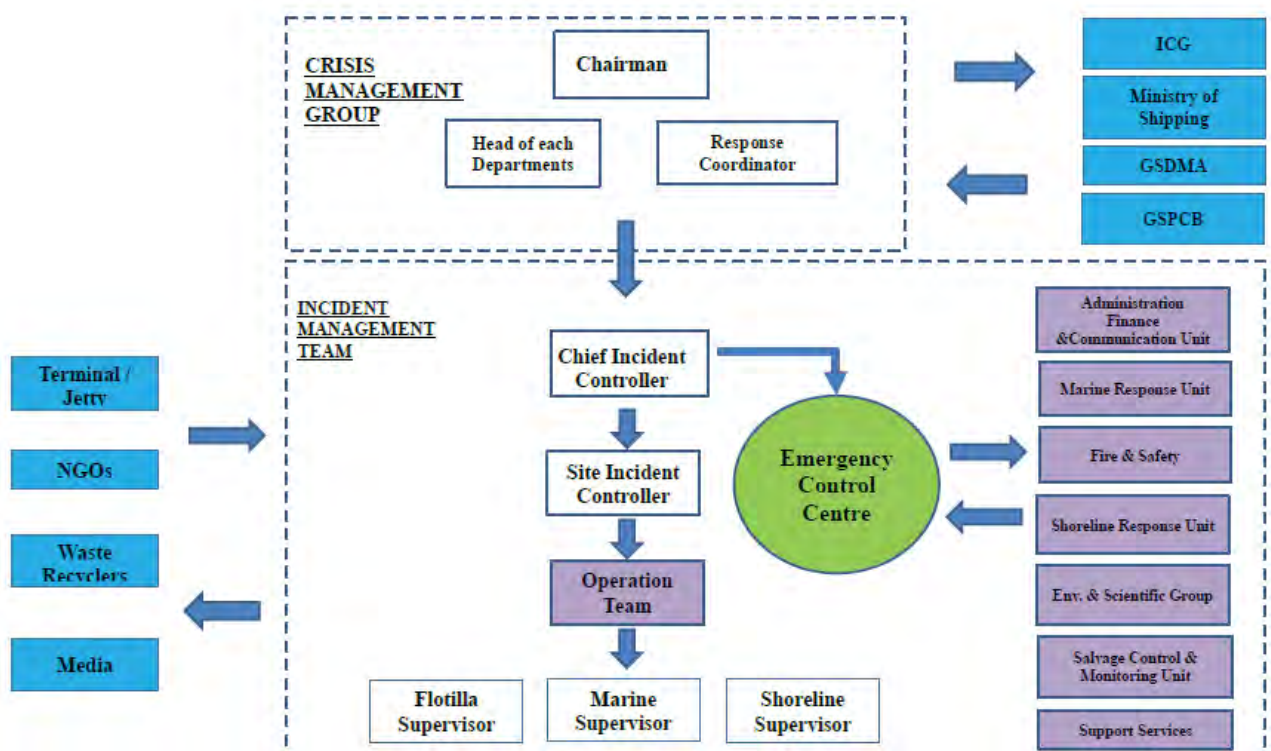


Fig.7.24: Oil Spill Response Organisation Chart for Deendayal Port

A Crisis Management Group has been set up at Deendayal Port Trust as the principal authority for oil spill preparedness and response within the port. This group is headed by the Chairman, DPT and its other members include the Dy. Chairman, Chief Engineer (Civil Department), Chief Mechanical Engineer, Traffic

Manager etc. In case of an oil spill an appropriate person shall be nominated as the Response Co-ordinator who will directly interact with various divisions, departments & agencies as required.

There shall be an Incident Management Team (IMT) which shall take up the response activities with its operation team and independent supporting units who shall actually deal with the response activities in the field. Incident facilities including Emergency Control Centre, Incident Command Centre, Forward Command Point, Staging Areas, Safe Forward Point, Joint Information Centre, Waste Management & Decontamination blocks will be directly functioning under the IMT.

The IMT shall be headed by the Chief Incident Controller (CIC). Normally the Dy. Conservator shall be the CIC in event of an oil spill. The key responsibilities of the CIC are:

- Preparation, review and updation of the Oil Spill Contingency Plan
- Assessment of situation and declaration of an oil spill emergency
- Activation of Emergency Control centre
- Approval of Incident Action Plan prepared by Site Incident Controller (SIC) / SICs during spill
- Mobilisation Oil Spill response Resources
- Co-ordinate surveillance and monitoring of oil spill events
- Co-ordination with Crisis Management Group (CMG) and other personnel on direction from CMG
- Continuous review of situation and decide on appropriate response strategy
- Taking stock of casualties and ensure timely medical attention
- Ordering evacuation of personnel as and when necessary
- To be responsible for ensuring that appropriate local and national government authorities are notified, preparation of media statements, obtaining approval from the CMG and releasing such statements once approval received
- Assessing the situation and requesting CMG for organising consultation with Indian Coast Guard (ICG) and District Authorities when Tier 2 or Tier 3 spill is to be declared
- Ensuring correct accounting and position of personnel after the emergency.

The CIC shall report to the CMG through the Response Co-ordinator.

An Emergency Control Centre (ECC) has been established at DPT's office with 24 hour control room at the port office under the CIC's supervision. Operations to handle the emergency shall be directed and co-ordinated from the ECC and hence is provided with necessary communication systems (telephones as well as two-way radio). The ECC has necessary displays for enabling ECC personnel can constantly monitor the situation and take necessary action as deemed necessary. The CIC is in charge of ECC.

In case of an oil spill, a senior officer, preferably the Dy. Head of Marine Department shall be nominated as Site Incident Controller (SIC), who shall report to the CIC. The key responsibilities of the SIC shall be:

- Assess the situation at the site and communicate to the ECC through which it can communicate among groups and organise joint activities.
- To ensure that the response to the oil spill pollution emergencies is in line with entity procedures and to co-ordinate business continuity or recovery plan from the incident.
- Request for any specialist support to the CIC
- Give feedback on seeking assistance of mutual aid members and external agencies.
- Through respective co-ordinators will be responsible for:
 - Communication between units

- Updation of situation boards and charts
- Recording decisions

There shall be an Operational Team manned by personnel trained at Level I IMO training. The Operational Team may be headed by the SIC or a separate team leader. The operational team will have ability to conduct marine as well as shoreline operations. Marine response includes offshore and coastal water operations whereas shoreline team will be positioned on land. In the interface areas like creeks, salt-pans etc. Marine and Shoreline teams may work together. The responsibilities of the Operational Team include:

- Obtain briefing from incident command
- Identify level of priority
- Estimation of quantity of spill, possible trajectory identification
- Surveillance of oil spill and monitoring of water quality.
- Developing tactics in support of Incident Action Plan (IAP)
- Response resource allocation for each division or sector and assessment
- Deployment of response resources including flotilla
- Maintain a log of operations
- Review of operations

Seven (7) Emergency Response Units have been created for achieving effective management of emergencies. These units report directly to the CIC through a co-ordinator. The Emergency Response Units and their responsibilities are:

Emergency Response Units	Responsibilities
Marine Response Unit	Surveillance, Monitoring, Containment, recovery & temporary storage of recovered oil
Shoreline Response Unit	Shoreline assessment survey, shoreline cleaning, storage, disposal & transportation
Salvage, Control & Monitoring Unit	Monitor & control salvage operations
Environmental & Scientific Unit	Providing balanced information on likely impacts of oil spill, advise on environmental priorities & preferred response options,
Fire & Safety Unit	Overall responsibility for fire prevention and fire-fighting in case of fire, evacuation of non-essential personnel, control of entry to affected area, first aid & casualty evacuation, enforcement of safety procedures
Administration Unit	Mobilise oil spill responders and resources, administrative & logistic support to various teams, co-ordination with mutual aid members & external agencies, all financial, legal, procurement, clerical, accounting & recording activities
Finance Unit	Arrange for emergency purchases, monitor & maintain records of costs incurred, arrange for recovery of costs under relevant compensation conventions

1.3 Initial Procedures

The first step in responding to an oil spill is reporting the matter to the concerned authorities. The same shall be done by the captain or other person having charge of the ship concerned or a representative of DPT. Even any individual, who notice spillage of oil, may inform DPT officials or ship's personnel. The pollution shall be reported in a specified format usually referred as Marine Pollution Incident Report (POLREP). Oil spills within DPT's area have to be reported to DPT. The report shall have the following information:

- ❖ Identity of the ship / facility
- ❖ Location, time and type of incident

- ❖ Quantity and type of the substance involved
- ❖ Weather, sea state and tidal conditions in the area.

The report of the incident received will be communicated to the ECC and designated SIC by the CIC as per the instructions of the Crisis Management Group. Irrespective of the quantity of the spill, even a threat of marine pollution shall be reported to Indian Coast Guard (*In case of Tier 1 spills the role of the Coast Guard is limited to monitoring and guidance*). After giving due consideration to the importance of the situation, the notification shall be sent to:

1. District Disaster Management Authorities of Kachchh, Morvi, Jamnagar and Devbhumi Dwarka (which lie on the coasts of Gulf of Kutch).
2. State, District & Local Disaster (Oil Spill Crisis) Management Groups.
3. Indian Coast Guard (Regional HQ at Gandhinagar, District HQ Porbandar and nearby stations – Vadinar and Mundra)
4. Gujarat Pollution Control Board

Quantity of the spill can be assessed from the ship's captain or designated person in case of a known source with which the Response Tier could be determined. Otherwise visual judgement of experienced persons will help to determine it. OOSA of Indian National Centre for Ocean Information Services (INCOIS) can be effectively utilised for this.

Since gauging the thickness and coverage of floating oil is a difficult task, accurate assessment of quantity of any oil observed as sea is virtually impossible. At best, the correct order of magnitude can be estimated by considering certain factors. Approximate quantity of floating oil can be determined from the relation between appearance, thickness and volume of floating oil at sea as follows:

Sl. No.	Oil Type	Appearance	Approx. Thickness	Approx. Volume (m ³ /km ²)
1	Oil Sheen	Silvery	0.0001 mm	0.1
2	Oil Sheen	Iridescent	0.0003 mm	0.3
3	Crude & Fuel Oil	Black / Dark Brown	0.1 mm	100
4	Water-in-Oil Emulsion (Mousse)	Brown / Orange	>1 mm	>1000

By estimating the percentage coverage of the oil type in question, the actual area covered relative to the total sea area affected can be calculated from timed over flights at constant speed. Aerial photography will sometimes allow the percentage of floating oil to be calculated more accurately and the use of instant picture cameras can therefore be valuable.

It is important to be able to forecast the probable movement of a slick as well as likely changes in properties of the oil after it has spilled. This helps in identifying sensitive resources in the path of the slick and to take appropriate response measures. Movement of oil slicks depend on water currents, wind speed, waves and tides.

It has been empirically found that floating oil will move downwind at about 3% of the wind speed. Surface currents dominate the movement of oil slicks unless the winds are extremely strong. Close to land tidal currents must be taken into account but in open sea, their contribution is minimal.

Control room will be activated at the ECC for control and co-ordination.



Information collected at the field shall be recorded in a Field Logbook. Logbook entries will be signed by the individuals making them. Site observations include oil type, existing and forecast sea / wind conditions, surveillance, beach report. Surveillance and sampling shall be the first responses immediately started after occurrence of oil spill.

Based on already available data from the resources map and sensitivity map, resources immediately at risk and requiring protection based on priority is identified. Identification of the responsible party or source of an oil spill incident may require the laboratory analysis of oil samples. This is one part of the overall task of investigating oil spills and suspected sources. Comparison of the spilled oil with its potential source samples can provide evidence of the source of the oil. It is possible to identify the difference between different oils and similarities between spilled oils and their sources. Early detection of accident and emergency response is essential.

Irrespective of the final response selected, monitoring of oil spill will commence immediately after the oil spill and will continue until the response operation is terminated. The information gathered through monitoring and evaluation will be used by the Incident Management Team to steer the response. And ensure that the most effective and efficient response strategies are adopted. Monitoring and evaluation can be carried out through:

- Vessel Surveillance
- Aerial Surveillance
- Satellite Surveillance
- Surface Plume Tracking
- Spill trajectory modelling.

Vessels available on the scene will conduct the initial visual surveillance by following the leading edge of the slick. This location information will then be communicated to the Incident Management Team to guide aerial surveillance aircraft to the slick.

Subsequent to initial vessel surveillance, aerial surveillance shall be carried out to monitor the spill and may be continued throughout the incident management process to provide feedback to the command centre on daily progress and to help evaluate the success of the responses. Along with the aerial surveillance preliminary shoreline survey shall be carried out.

In case considerable part of the spilled oil sinks due to environmental conditions and / or oil characteristics (as in the case of crude petroleum, ships' bunker fuel, lubricants), under water survey may be required. The survey may be undertaken using visual assessment, divers, remotely operated vehicles, acoustic sensors or sorbents. Environmentally hazardous area must be marked specifically based on the secondary data already available so that many accidents resulting in loss of life and property can be averted.

Satellite surveillance of oil spill may be carried out if necessary through Space Applications Centre, Ahmedabad.

The spilled oil shall be sampled and analysed to determine the source of the spill and therefore fix responsibilities and also chalk out the response strategy. Along with the oil abiotic resources (e.g. water, air, sediments) as well as biotic resources shall be sampled and analysed. The testing will be carried out throughout the response period to determine the behaviour of the spilled oil in the environment and the efficacy of response measures.



1.4 Operations Planning

The Chief Incident Controller (CIC) shall be responsible for assembling the response team. He shall first assess the incident, by considering the problems in detail, assessing the severity and possible development of the situation and response resources. Once the operations start, he will assume command and appoint a Site Incident Controller (SIC). An Operational Team shall be constituted considering the size and complexity of the situation.

Combinations of response options are needed even for small spills since all the response options are not equally feasible at all places as well as in all situations., especially when the pollution status changes with time. The possible options are:

- ❖ No action other than monitoring and evaluating the oil
- ❖ Containment and recovery of the oil at sea / creek
- ❖ Chemical dispersion of oil at sea / creek
- ❖ Burning the floating oil
- ❖ Shoreline clean up.

Immediate response priority may be exercised depending on the quantity of oil spilled and location of spill proximity of resources and their sensitivity.

After estimating the quantity of spill, analysing the sea and wind state and determining the constraints of operation, immediate response resources including the equipment and personnel shall be mobilised. Since Tier 1 response resources are already available at the port, generally no resources need to be channelised from other operators including those within the organisation unless there is an intensive response operation planned that is to be completed in a very short span or there is a breakdown of equipment.

CIC will hold regular meetings with the Incident Management team to focus on the critical success factors for the incident and assess the effectiveness. If necessary the plans will be revised. The flow diagram showing the operation planning for response is illustrated in Fig. 7.25.

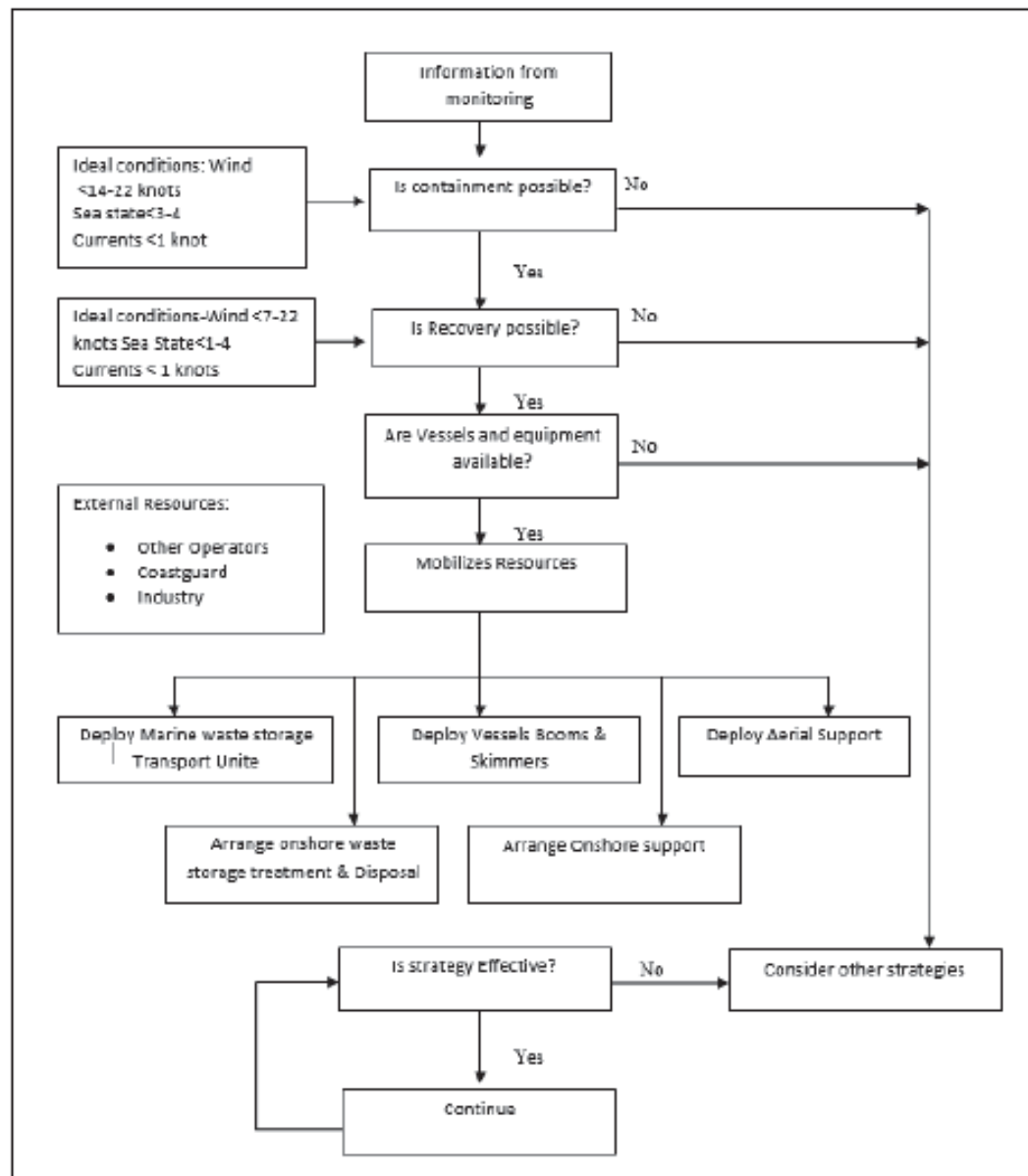


Fig.7.25: Oil Spill Response Planning Chart for Deendayal Port

In case of threat perception, the response decision is to be arrived after prioritising the threat perception and areas where the threat perception is likely to cause maximum damage. Certain sacrificial areas may have to be considered for the overall response to the threat perception. The general strategy would be ordered for containment and recovery using existing techniques, which may involve mechanical recovery equipment or use of chemical dispersants. The Dispersion Decision Tree is illustrated as Fig. 7.26.

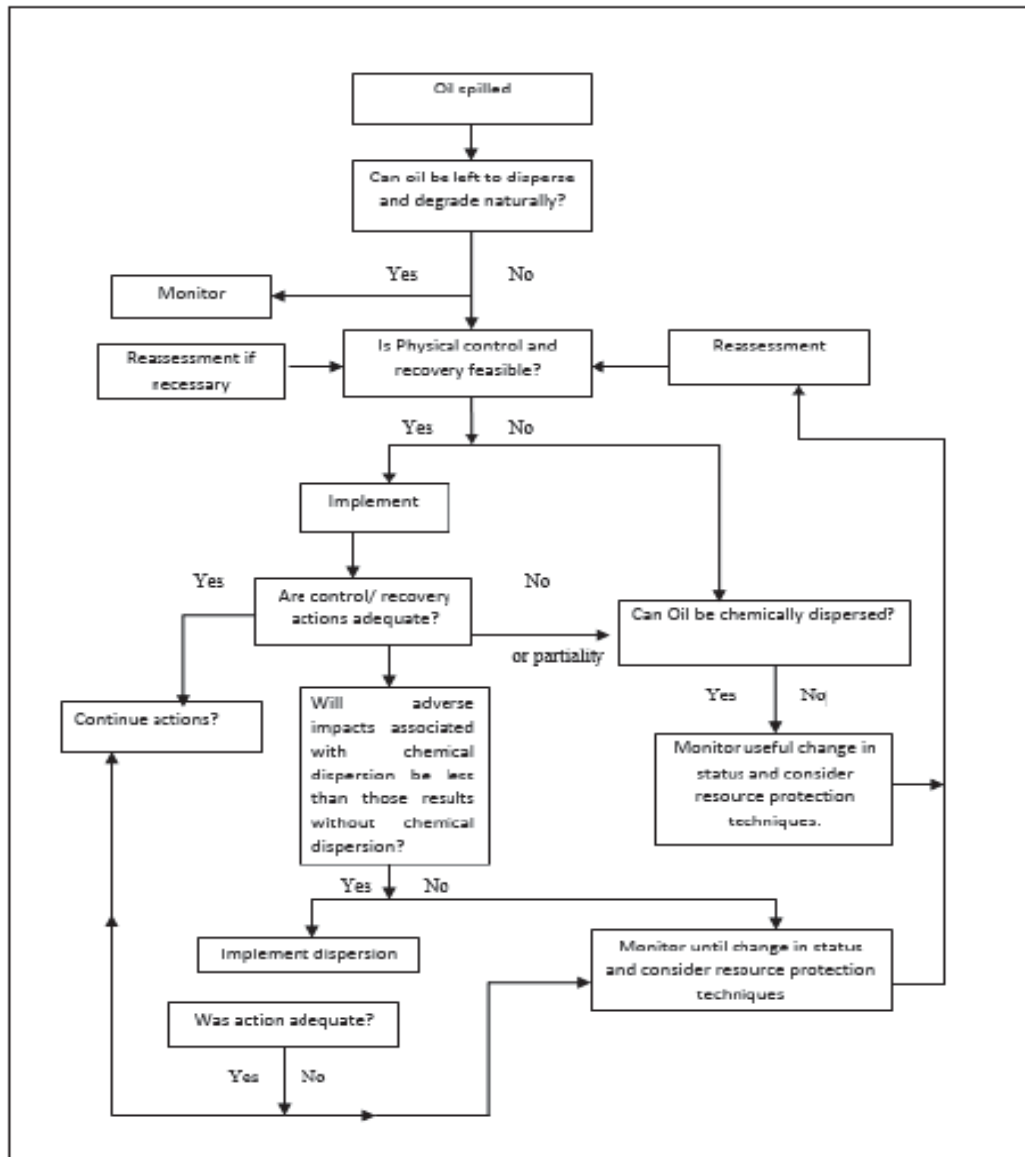


Fig.7.26: Dispersant Decision Tree for Deendayal Port

1.5 Control of Operations

The equipment and facilities for combating Tier 1 oil spill are already available with DPT. Additional response is beyond the scope of the local contingency plan for each port. Memorandum of Understanding (MoU) has been signed with neighbouring oil companies (IOCL, BPCL and HPCL) to pool resources for better response during Tier 1 oil spill. Oil spills beyond Tier 1 is the responsibility of Indian Coast Guard (ICG) who shall take over the operation if the spill management is beyond the capabilities of DPT (& associates) and in case the spill is outside the port limits regardless of the size of the spill.

Daily reports shall be made in form of incident logs, minutes of meetings, notes on briefing etc. They shall be circulated between respective groups and their officials for different purposes such as informing, evaluation, recommending, approving, documentation record keeping and circulation.

1.6 Termination of Operations

Marine response operations shall be terminated when:

- ❖ Entire oil spill has been removed
- ❖ Surface oil slick has broken up and there is negligible chance of impact on a shoreline
- ❖ Slick has gone out to sea and is beyond the range of response options and is likely to degrade naturally
- ❖ Oil has already impacted shorelines and is unlikely to be refloats (in such a case, however, the marine response team will remain on stand-by until shoreline response has been terminated).

Shoreline clean up operations may be terminated only in consultation with instruction from the respective government authorities under the following circumstances:

- ❖ All accessible shorelines are free of oil
- ❖ Clean up is having no further net beneficial effect or having deleterious effects on the shoreline or associated plants and animals.
- ❖ Remaining oil is judged to be acceptable or of little or no adverse effect

The shoreline inspection team will determine when each shoreline segment has been cleaned to a reasonable degree, based on minimising risk of impact to the environment and preventing human contact with the spilled oil. Guidelines provide criteria for assessing marine / shoreline status before the declaration of termination of operation as follows:

Sl. No.	Type of Environment	Decision Criteria
1	Water Surface	No recoverable floating oil should remain on the water surface
2	Sand Beaches	The shoreline should be free of liquid oil. Tar-balls, tar patties, oiled stranded vegetation and oiled debris that could contaminate wildlife should be removed to the extent removal using reasonable clean-up techniques is feasible. Oil stain on sand that does not produce rainbow sheen may be allowed to weather and degrade naturally.
3	Marshes	Marsh vegetation should be free of oil that could contact and contaminate wildlife. Oil that is not likely to affect wildlife may be allowed to weather and degrade naturally.
4	Riprap, sea walls and other man-made structures	Oiled riprap and seawalls should be free of bulk oil stain (defined as a thin layer that cannot be scraped off using a finger nail), which may be allowed to weather and degrade naturally.
Source: Oil Spill Response Plan, Shell, 2011		

CIC will announce the termination on consultation with the Crisis Management Group after receiving the report from the SIC. The following checks shall be carried out prior to announcement of the termination:

- All personnel are accounted for
- All equipment are recovered, repaired and cleaned
- All vessels return to their respective berths
- All external equipment are returned to the correct owner / location

1.7 Decontamination and Demobilisation

The Decontamination Plan serves to identify general procedures to be followed by vessels involved with oil spill response operations. All these operations involve transiting through slicks, operating within oiled waters or recovery operations, the vessel hulls, decks, machinery tanks, piping deck gear and other areas will be impacted with oil. This plan will be used for all vessels and support equipment, either contaminated or



suspected of being contaminated with oil, to return to a non oil state. The primary focus of this operation will be to expedite clean-up of oiled vessels and response equipment in a safe, organised and efficient manner while minimising waste generation and further damage to the environment.

The affected area will be placed inside standard containment boom during the decontamination process. If weather conditions permit, smaller vessels will be used as platforms to facilitate clean-up operations. For tug / vessel, the hull of the vessel will be wiped with cotton rags by hand. A citrus based cleaning solution will be used to remove residual oil from the hull. Personnel involved in this operation shall wear modified PPE Level D including rain gear, gloves, eye protection and floatation work vest. Pre-planning for protection of adjacent areas shall be accomplished in order to minimise cross contamination. Floating oil from sheen-emanating vessels will be minimised with sorbents as necessary to reduce potential loss outside the containment boom. Floating sorbent materials shall be utilised in natural collection points as needed to retain free-floating oil. These sorbents will be tended daily.

A Hypalon line or like (secondary containment) will be placed under each decontamination pool with the perimeter sufficiently bermed to allow for waste water and rain-water evacuation. All waste water will be pumped to a poly portable storage tank vacuum truck for disposal. All pumps, hoses and piping will be left in place to facilitate speedy evacuation of retained oil / water. The final disposal of wash water, oiled sorbents and materials will be accomplished in accordance with approved Disposal Plan. A citrus based cleaning solution will be used as a degasser and will be applied by a Hudson sprayer as applicable. Because the cleaning solution is citrus based it does not leave a petroleum sheen on the equipment after the cleaning process. Actual pressure washing, if required, will utilise a Landa (or like) hot / cold pressure washer with a temperature range up to 220o F and a pressure rating of 3000 psi. Every attempt will be exercised to mitigate noise generating equipment by placing it in insulated areas. Once the piece has been determined clean to the owner's standard, the equipment will be demobilised.

1.8 Mutual Aid

Several oil handling installations are in operation in the vicinity of Deendayal Port's Oil Jetty area (*it may be noted that Essar Oil Refinery and Reliance Industries Ltd.'s Jamnagar Oil Refinery – one of the world's largest oil refineries area located near in vicinity of DPT's SPM's at Vadinar, but this is not covered in the present report*). These installations are important stakeholders for mutual aid. A MoU has been signed between the three Public Sector Oil companies (IOCL, BPCL & HPCL) and DPT for mutual assistance during oil spill greater than Tier 1. Also it may be noted that a spill even though happening within Tier 1 Limit (700 MT); its occurrence in a sensitive area can make it escalated to a higher tier.

Presently DPT is having Oil Spill Response (OSR) equipment corresponding to the Risk Category A ports for combating Tier 1 spill, as per the Oil Spill Contingency Plan. The latest annual return submitted to Indian Coast Guard in this regard is given in Table 7.12.



Table 7. 12: Annual Return on Preparedness for Oil Spill Response Under DPT

Equipment	Description	Length	Quantity (nos.)	Operational Status
Containment Equipment	Pressure Inflatable Boom	200 m	6	Working
	Boom Reels	200 m	6	Working
	Permanent Boom	1000 m	1	Working
	Diesel Hydraulic Power Unit		2	Working
	Pollution Response Centre		1	Working
	Signal Station for communication		1	Working
	Anti Pollution Craft		1	Working
	Oil Absorbent Boom (with IOCL)		130	Working
	Inflatable Boom (with Essar Oil)	450 m	1	Working
	Light duty Oil Containment Boom	600 m	1	Working
	Description	Capacity	Quantity (nos.)	Operational Status
Recovery Equipment	Fast Flow Skimmer	40 – 49 m ³ /hr	2	Working
	Brush Skimmer	12 m ³ /hr	1	Working
	Disc Skimmer (with IOCL)	20 m ³ /hr	1	Working
	Disc Skimmer (with Essar Oil)	2 m ³ /hr	1	Working
	Disc Oil Absorbent pillow (with IOCL)	12' x 8' size	80	Working
	Debris collection vessel		1	Working
	Description	Capacity	Quantity (nos.)	Operational Status
Temporary Storage Facility	Storage Tank	10 m ³	5	Working
	Storage Tank	250 m ³	1	Working
	Storage Tank (with Essar Oil)	25 MT	2	Working
	Portable Tank	4 m ³	1	Working
	Floating tank (with IOCL)	25 m ³	2	Working
	Floating tank (with IOCL)	12.5 m ³	4	Working
	Floating tank (with Essar Oil)	5 MT	2	Working
Storage Facility	Permanent Storage Tank	5 m ³	1	Working
	Description		Quantity (nos.)	Operational Status
	OSD (Oil Spill Dispersant) Spraying boom fitted on tugs –spray system - 1		3 tugs for Kandla. Storage tank of cap. 4 m ³ on each tug. 3 tugs for Vadinar. Addl. 2 hired tugs at Kandla& 3 hired tugs at Vadinar	Working
	OSD booms – 5 m long – 2 nos.			
	Pump units – 70 litres / minute – 2 nos.			
	Off-loading pump – 1 no.			
	Oil transfer pumps - 30 m ³ /hr – 2 nos. (with Essar Oil)			
	Dispersant Spray Systems – 2 nos. (with IOCL)			
	Dispersant Spray Systems – 1 no. (with Essar Oil)			
	Make		Quantity	
Oil Spill Dispersant	NIO & ICG approved (Nova Chemicals) Dispersant II & II		5 m ³	
	NIO Approved Dispersant – III (with IOCL)		3.3 m ³	
	NIO & ICG approved Dispersant (with Essar Oil)		25 m ³	
	Oil Spill Dispersant			

Besides the above, there are personnel with training to deal with oil spills.

In addition to the above, Tier 1 Oil Spill Response Equipment are also available at Navlakhi Port (of Gujarat Maritime Board) and Mundra Ports (of Adani Ports), located on the shores of Gulf of Kutch. Tier 1 Oil Spill Response Equipment are also available at Pipavav Port, Hazira Port, which are major ports and Gujarat Maritime Board's minor ports located on the shores of Gulf of Khambat. Comprehensive Oil Spill Response Equipment are available with Indian Coast Guard. ICG has two stations on the shores of Gulf of Kutch, Jamnagar which is close to DPT's SPMs at Vadinar and Mundra. There is a civil airport at Gandhidham and Indian Air Force bases at Jamnagar and Bhuj (~ 60 km from Kandla), from where aircraft for oil spill surveillance & monitoring can operate.

Thus it can be concluded that in case of higher Tier requirements of oil spill within DPT's limits enough resources and mutual aid are available.

1.9 Oil Waste Disposal Mechanism

Disposal of oil waste is one of the most serious challenges of any oil spill response campaign. Oil waste during oil spill comprises of recovered oil, oily debris including contaminated protective clothing & equipment used for clean-up operations. The appropriate disposal option depends on type & amount of oil, location of spill, environmental & legal aspects and economic considerations. It can be seen that only heavier oils such as crude oil, fuel oil, lubricants etc. Require clean-up and response operations while non-persistent oils does not require clean-up and subsequent disposal. Extreme care is to be taken while oil collection since the earlier it is collected, less likely the contamination and hence easier the recovery operations. Weathering makes the oil more viscous. Oil directly collected from the water will be having less debris but will be highly emulsified. Thus oil waste can be classified as:

- Oil contaminated with water
- Emulsified oil contaminated with water
- Oil collected from the shore contaminated with sand and / or mud
- Oil collected from the shore contaminated with vegetation, drift-wood, plastics etc.
- Solid tar balls.
- Oil contaminated rags, absorbent pads, PVC sheets, PPE etc.

Each type of waste will require a different method of treatment and disposal.

Storage of oil waste collected during oil spill is important prior to disposal. Initially they will be stored in temporary staging areas located close to the spill location and further they may be collected and transferred to a suitable location within DPT areas before disposal if possible. Steps involved in oil waste disposal are:

- ❖ Construction of waste storage areas
- ❖ Sampling of disposed materials
- ❖ Testing of accumulated materials for identification of hazardous materials
- ❖ Segregation and transportation of waste
- ❖ Dismantling of waste staging areas
- ❖ Decontamination of the location
- ❖ Collection & Disposal of wash-down / rinsate.

Wastes accumulated in temporary storage location should be categorised, segregated, inventoried and transported off-site for recycling / disposal. No additional permits are needed for collection and temporary

storage of the waste from an oil spill emergency as long as the waste is properly contained., labelled and stored.

Bulk oil should be stored separately from oily debris so that effective treatment and disposal methods can be followed. Storage tanks for bulk viscous oil (e.g. Ships' bunkers), should have heating coils. If special purpose containers are not available, bulk oil from shorelines can often be held within compacted earth walls or in simple storage pits lined with suitable oil proof material. Pits should be filled in after complete removal of the oil as far as possible, the area restored to its original state. Plastic bags should be regarded as a means for transporting oil material rather than storage since they tend to deteriorate rapidly under the effect of sunlight. It should also be borne in mind that if the contents are ultimately to be treated in some way prior to disposal, it will usually be necessary to empty the bags and dispose the off separately.

It is beneficial to reduce the amount of material to be transported by separating oil from water and sand during temporary storage. Water-in-oil emulsion can be broken to release the water; oil seeping from heaped beach material and debris can be collected in a ditch surrounding the storage area; sieving techniques can be used to separate clean sand from tar balls.

Segregation of the wastes can be done prior to transportation or after it. Preferred segregation of oil waste are as follows:

Sl.No.	Phase & Type of Waste		Preferred Segregation
1	Liquid	Oil	Non-emulsified oils
			Emulsified oils
	Waste water		Water from temporary storage
			Water from emulsion separators
2	Solid	Oil	Water from chemically demulsified oil
			High pour point oils
			High viscosity emulsions
		Oily debris	Tar balls
			Oil mixed with cobble or sand
			Oil mixed with wood, vegetation, plastics or sorbents

Disposal of oil waste has to be done considering the type of oil, availability of space, expenditure. In DPT's case, DPT has licensed a number of waste disposal contractors who are regularly collecting and disposing off wastes generated at the port. The waste generated during oil spill episodes will be disposed off through these contractors.

2.0 DISASTER MANAGEMENT PLAN

The objective of DMP is to describe the facility emergency response organization, the resources available and response actions applicable to deal with various types of emergencies that could occur at the facility with the response organization structure being developed in the shortest time possible during an emergency. Thus, the objectives of emergency response plan can be summarized

- ❖ Rapid control and containment of the hazardous situation.
- ❖ Minimizing the risk and impact of event / accident.
- ❖ Effective rehabilitation of the affected persons and preventing of damage to property.

The various emergencies that can occur in the port area are:



- ❖ Leak / Spill and fire and explosion at the chemical jetties of hazardous chemicals.
- ❖ Accidents in the shipping channel
- ❖ Medical Injury
- ❖ Severe Weather
- ❖ Earthquake and Tsunami
- ❖ Sabotage
- ❖ Civil disturbance
- ❖ Hostage situation

2.1 Procedures to be Followed In Case of Leak / Spill and Fire and Explosion at Oil Jetties

- ❖ Emergency equipment should be placed more than 60 meters away from the unloading hoses / source of leak to prevent damage to them due to over pressures.
- ❖ All fire fighting operation should be carried out from a 57 meter distance from the unloading hose, unless fire suits and close proximity suits are used by the fire fighting personnel.
- ❖ Whatever is the emergency (fire) at the berth, the sprinklers / water curtain at the berth edge should be activated.
- ❖ All persons not directly connected with the operation should be moved beyond 88 meters from the fire / leak
- ❖ There should be no source of ignition in the oil jetty areas.
- ❖ The complete chemical jetty complex is a flame proof zone at all times.

In case of Instantaneous release and evaporation of chemicals,

- ❖ All emergency equipment should be placed more than a certain distance, specifically worked out for the particular chemical which has leaked, away from the source of leak.
- ❖ Fire fighting should be carried out from a distance of more than a certain distance, specifically worked out for the particular chemical which has leaked, away unless fire suits / fire proximity suits are worn by the fire fighting personnel.
- ❖ All persons not directly connected with the emergency operation should be moved more than a certain distance, specifically worked out for the particular chemical which has leaked, away from the source of leak.
- ❖ If necessary for the chemical involved, all supporting personnel must be ready with BA sets.
- ❖ The nearby shanty should be evacuated.
- ❖ All security staff must have respiratory protection.
- ❖ All other fire fighting precautions should be adhered to.
- ❖ If necessary for the chemical involved, All persons handling the emergency should be sent to the DPT's Hospital for checking for poisoning.

In case of Instantaneous release / evaporation puddle / burning puddle of flammable liquids (e.g. HSD, Motor Spirit etc.), fires should be handled with care, by wearing fire suits / proximity suits and foam should be used for firefighting.

The following general guidelines are strictly followed in case of a chemical leak / spill:

1. Stop all loading/ unloading operations and close valves.
2. All emergency operation should be carried out from upwind direction. This may always not be possible. All persons handling a chemical leak / spill should wear chemical protection suit and



respiratory protection like gasmask / BA sets.

3. Fires float Agni Shanti, and any available tug should be immediately put on alert.
4. Deputy Conservator / Harbour Master should be informed of a chemical spill however small it may be.
5. CISF should have access to respiratory protection as they may not be able to leave their post.
6. In case of a major chemical leak / spill the neighbouring shanty should be evacuated especially if chemicals like, Acrylonitrile, Benzene, Aniline, 1:3 Butadiene, Vinyl Chloride, Styrene has spilled.
7. Attempts could be made to salvage the spilled chemical or dispersant could be applied to the spill.
8. The chief fire officer should be kept informed of the chemicals being loaded / unloaded at the port chemical berths on a daily basis.

Important firefighting methods and spill handling methods of the concerned chemicals should be then informed to the fire fighters. They should also be apprised of the health effects and water solubility of the concerned chemicals.

Fire Protection Facilities

Deendayal Port has its own dedicated Fire Department. There is a Head Quarter Fire Station located at the Oil Jetty Area. There is a 2nd Fire Station near the West Gate (named as Tilak Fire Station) and a third fire station near Berth No. 10 (named as Azad Fire Station)

The resources of the Fire Department are:

- 3 nos. foam fire tenders
- 1 no. multi-purpose fire tender
- 5 nos. water fire tenders
- 8 nos. trailer pumps
- 10 nos. portable pumps
- 1 no. tank lorry
- 1 no. fire jeep
- 1 no. safety jeep
- 1 no. ambulance
- Fire ladders
- Gas testing machines
- Personal protective equipment including flame proof suits, self contained breathing apparatus etc.

The present available manpower of the fire station is:

- 1 no. Fire cum Safety Officer
- 1 no. Deputy Fire Officer
- 15 nos. Station Officers
- 27 nos. Leading Firemen
- 25 nos. Pump Operators cum Drivers
- 31 nos. Firemen
- 36 nos. Trainee Firemen

All three fire stations are manned round the clock with Station Officers and fire crews. Each fire station, at least one fire tender, 1 trailer pump, 1 portable pump and other accessories are available.



There is a fire water system comprising of pipelines and fire hydrants. Sea water is usually used for fire fighting.

Each oil jetty has fire pumps.

- ❖ Oil Jetty 1 has 1 no. 500 m³/hr. cap. electrically powered fire pump, 1 no. 500 m³/hr. cap. electrically powered flushing pump, and 1 no. 500 m³/hr. cap. diesel powered fire pump;
- ❖ Oil Jetty 2 has 2 nos. 820 m³/hr. cap. (each) diesels powered fire pumps, 2 nos. 30 m³/hr. cap. (each), electrically powered jockey pump, 1 no. 22 m³/hr. cap. electrically powered foam pump, 1 no. 22 m³/hr. cap. diesel powered foam pump, 6 nos. water curtains of 180 m³/hr. cap. and 2 water-cum-foam monitor towers of capacity 3000 litres per minute at 7 kg/cm².
- ❖ Oil Jetty 3 has two foam pumps (1 electrical & 1 diesel powered), two nos. water curtains of 180 m³/hr. cap. each and 2 water-cum-foam monitor towers of capacity 3000 litres per minute at 7 kg/cm².
- ❖ Oil Jetty 4 has 1 no. 500 m³/hr. cap. electrically powered fire pump, 1 no. 500 m³/hr. cap. electrically powered flushing pump, 1 no. 500 m³/hr. cap. diesel powered fire pump, two foam pumps (1 electrical & 1 diesel powered), two nos. water curtains of 180 m³/hr. cap. each and 2 water-cum-foam monitor towers of capacity 3000 litres per minute at 7 kg/cm²;

The following general guidelines are strictly followed during fire-fighting:

1. Stop all loading/ unloading operations and close valves.
2. All fire fighters will be apprised of the chemicals and POL products normally handled at the jetties. A set of MSDS is available at the fire station.
3. As a general rule all firefighting will be carried out from a distance of 60 meter (Average heat radiation experience of 2 kW/m²). If the firefighters are required to go closer to the fire then fire suits / close proximity suit must be worn. If necessary, water cover could be provided to the fire fighters going closer to the fire.
4. The water curtain along the edge of the berth will be activated for fire/leak/ spill emergency at the berth.
5. Fire-float Agni Shanti, and any available tug should be immediately put on alert.
6. All emergency equipment should be placed beyond the over pressure distance of about 60 meters (Average over-pressuredistance for 1.0 psi experience) to avoid damage to them.
7. The remote water/ foam monitor should be operated to control the fire at the jetty. If properly used the fire will be immediately controlled.
8. All persons not connected with handling the emergency should be moved beyond the TEEL –1 ERPG– 1 level distance which is an average distance of 1 km. But if toxic chemical release takes place then the people from the shanty should be moved beyond 3 km distance of the fire.
9. All security staff (CISF) should also have access to respiratory protection as they may not be able to leave their post.
10. External help should be obtained as soon as it is felt that the emergency is grave.
11. CISF guards will keep note of all incoming aid equipment.
12. After the emergency is over the Deputy Conservator / Harbour Master will assign a senior management

team to verify that there is no longer a threat of further fire / leak / spill, to assess damage and initiate repairs as needed.

13. Any emergency at the chemical jetties or at the dry cargo berths will be informed to the Deputy Conservator /Harbour Master, who will activate the DMP if necessary.

2.2 Procedures to be Followed In Case of Accidents in Shipping Channel

In case of any fire on board in any tanker or ships carrying containerised chemicals on board,

- The Ship Master or the Pilot should raise & alarm and inform Kandla Tower on VHF Channel 8 or 16 about the intensity and location of fire.
- Kandla Tower will inform the Dy. Conservator, Harbour Master and FCSO.
- Master should immediately ensure that the loading/discharging operation is suspended and all the connected valves are closed.
- Master of the vessel should immediately gear up his fire-fighting equipment and post his staff for extinguishing the fire.CO₂ should be injected in the affected compartments.
- Dy. Conservator after contacting the ship will inform Chairman and Dy. Chairman about the situation.
- Harbour Master, will arrange for availability of chemical dispersant and its equipment and keep them in readiness in case of any oil spillage.
- Tugs, with personnel and equipment should immediately start for tanker. Harbour Master on board 35 Ton B. P. Tug also to reach the tanker.
- Dy. Conservator to remain in constant touch with the Master/Pilot of the Tanker to assess the situation.
- In case no power is available on deck, the floating hoses connected on board can be disconnected by means of mechanical puller. Hose can be heated up slightly and the weight can be taken off. The Special Clamps on the flange can be removed. This operation takes about 20 m for each hose.
- If it is found necessary to safeguard jetty and the tanker is required to be removed from the jetty, one tug should remain near to tow the tanker and when given orders should pick up the fire spring and take the weight off the moorings. Master and the Pilot should take due precautions and safety measures and by using Fireman's suits to send the personnel to forward of the vessel for unmooring the tanker. Two lines to be passed on to the tug for towing to a safe anchorage. In case, the magnitude of fire is more and beyond the control, other agencies such as Indian Coast Guard,ONGC to be called for assistance.

In case of any running aground of any tanker,

- Master or Pilot of the vessel should immediately contact Kandla Tower on VHF Channel 8or16 and give the detailed information and the seriousness of grounding. Kandla Tower Signal Station will in turn inform Traffic Manager, Dy. Conservator and Harbour Master, Deendayal Port Trust. Dy. Conservator will inform Chairman/Dy. Chairman.
- Harbour Master will immediately proceed to site and will immediately board the vessel and after assessing the situation will inform Dy.Conservator about the seriousness of the crisis.



- Dy. Conservator in the meantime will remain at Kandla Tower and will be in constant touch with the vessel and if required give necessary guidance to Master / Pilot.
- Dy. Conservator to direct Sr.Hydrographic Surveyor to proceed to grounded vessel and check the exact position of the ship and also the grounding around.
- Tugs and Launches available at Kandla should remain in readiness and wait for the order of action from Dy. Conservator /Harbour Master.
- Fire-Cum-Safety-Officer along with staff and equipment salvage pump set to remain onboard fire float.
- Master of vessel to obtain soundings of all the tanks and to maintain a record of the same to ensure any leakage. He should also soundings around the ship and plot the month chart.
- Master should inform his Chief Engineer to change over to highest suction for cooling water.
- If found necessary, Dy.Conservator can decide and ask for a small tanker/salvage tug which can be brought alongside of the grounded ship and part of cargo can be discharged to this daughter ship. This will help to lighten the grounded ship.
- Master should instruct his staff to prepare all her ropes including insurance wire for towing, pulling operation.
- Tug to immediately proceed to grounded vessel and take tow lines and start pulling the vessel under the instruction of Harbour Master. If required, Dy.Conservator can decide and send more than one tug also to the grounded ship for assistance. In case the vessel cannot be re-floated within a day, a navigational warning should be sent to the Chief Hydrographer, Dehradun and the same will be transmitted through Mumba iRadio and Navtex.

In case of grounding and/or breaking up of a ship outside Deendayal Port Limit,

- Kandla Port has not had any major incident of grounding/sinking or breaking of a ship in recent past. However, minor incidence of grounding could be tackled by Port's own personnel and equipment.
- If there is any major breaking or grounding of a ship outside the limits of Kandla Port, the Port can activate its own crisis management plan to deal with the situation. On receiving message from the Master of the Vessel/ or from Principal Officer, MMD or Coast Guard, Mumbai, Dy.Conservator / Harbour Master, DPT will immediately inform Chairman/Dy. Chairman, DPT.
- Harbour Master will instruct Flotilla Superintendent/Tug Master, Fire-Cum-Safety Officer to keep the tugs, launches in readiness. Crafts with chemical dispersant spraying system at Kandla and VA dinar should rig the booms etc., Store enough stock of chemical dispersant and stay in readiness. In case, there is any major oil spillage port to activate its oil spill crisis management plan.
- Port Signal Station to be made Control Room and to remain in constant touch with the Ship. Master should immediately send messages and inform nearest Port or Coast Guard about the latest situation of the Ship.
- Port command team headed by Dy.Conservator will mobilize the resources available with Port to help the Ship.

- Indian Coast Guard, to utilize the services of Helicopter and indicate the location and magnitude of the oil spill. They should keep the nearest port informed about the oil spill/sleek.
- If the oil sleek is dangerous/approaching the limits of Kandla Port Trust, the Harbour Master along with one Senior Pilot and Safety Inspector (anti-pollution Scheme) to proceed on chemical dispersant Spraying craft and to reach oil slick and under his guidance all available port crafts can spray chemical dispersant. They can go up & down and try to stop / minimize the oil slick danger to port, Harbour Master to keep Dy. Conservator informed about the situation.
- Indian Coast Guard, IOC, ONGC and other agencies who have the system to recover the floating oil should be directed with oil recovery vessel to the area.
- If it is necessary, Dy. Conservator can requisition a privately owned small tanker or tank barge, which can recover the oil, store it for eventual disposal ashore. If the oil slick is very large and beyond the control of the Port, the Chairman should inform the Ministry and seek their guidance for mobilizing equipment from outside Parties.

2.3 Procedures to be Followed In Case of Medical Injury

- ❖ In case of any medical injury, the injured person shall be immediately taken to the nearest First Aid Centre located in the port area, which are manned round the clock by a staff nurse.
- ❖ The staff nurse on duty at the First Aid Centre shall administer first aid and summon the ambulance if necessary for evacuation of the casualty to DPT's Hospital at Gandhidham. DPT's Gandhidham Hospital shall be informed and make arrangements to receive the casualty. The nature and seriousness of the injury shall also be communicated.
- ❖ DPT's Gandhidham Hospital has limited resources. If the injury is too serious to be handled at DPT's Hospital, the Chief Medical Officer (CMO) shall instruct that the injured person may be directly evacuated to one of the Super Specialty Hospitals in Gandhidham, Rajkot or even Ahmedabad. The CMO shall also inform the concerned hospital.
- ❖ On receipt of the casualty at DPT's Gandhidham Hospital, the medical officer on duty shall evaluate the injury and request assistance of empanelled specialist doctors or may refer the case to outside hospitals.

In case of food poisoning in any of the port's canteens, the following will be done:

- ❖ Disaster Controller will inform the personnel on duty at the dispensaries in the port area for immediate first aid and also inform the Chief Medical Officer (CMO) at DPT's Hospital at Gandhidham.
- ❖ The CMO will contact the super speciality hospitals located at Gandhidham and seek their help, if necessary.
- ❖ Security will help in evacuating the affected people, in co-ordination with the Medical Officer.

2.4 Procedures to be Followed In Case of Severe Weather

Even though Kandla is within the cyclone area of storms originating in the Arabian Sea and those that enter across the Indian Peninsula from the Bay of Bengal, cyclones are not as severe or frequent as in the Bay of Bengal. Historically, there has been major cyclone in the region in the year 1998. Hence the exposure to this peril is high.

As soon as the message on anticipated cyclone/flood/natural calamity is received from the State Government Authority/Indian Meteorological Department/Cyclone Warning Centre/Indian Navy, etc. by any official of the Port Trust, the same shall immediately be informed to the Deputy Conservator (Nodal Officer), who in turn shall get such message confirmed from the above sources and apprise the Chairman and Dy. Chairman accordingly. On approval of Chairman, the Action Plan as stipulated hereunder shall be put into operation for which the Deputy Conservator shall inform all the officers-in-charge of the Control Rooms as well as the Heads of Departments, including Chief Operation Manager, OOT, and Vadinar about the decision of the Chairman, DPT.

Based on the past experience, after detailed discussions and experience sharing process, the actions suggested in the plan have to be taken immediately by the concerned staff members/officials as shown against their names/Designations as soon as the warning of cyclone or any other natural calamity is issued. All staff members/officials should know that they shall come into action on their own as soon as the warning is issued, without waiting for any further instructions. Failure on the part of any employees/officials to carry out the earmarked action plan shall attract severe consequences, which all must note.

CONTROL ROOM

There are three control rooms, one at Kandla at Signal Station Seva-Sadan-III, the second at AO Building, Gandhidham and third at A.O Building Offshore Oil Terminal, at Vadinar. The Control Room at Kandla is under the direct supervision of Harbour Master, whereas Dy. Secy.(G) is the overall in charge of the control room at A O Building, Gandhidham. XEN (M&E) is the overall in charge of control room at Vadinar. They shall rush to the respective control rooms as soon as the action plan is put into force. The officials named in the duty roster of various departments elsewhere in this Action Plan shall also report to the respective HODs for coordination and to perform duties as may be assigned by the higher authorities. The overall in charge shall draw up roster of the said employees and assign duties for the coming five days. The staff should report to the respective control rooms. The Radio Radar Technician will remain in control room to attend all communication equipment.

The overall in charge of the Control Rooms shall ensure the presence of the staff to which various duties have been assigned.

The overall in-charge for setting up of Control Room at Kandla will be Dy. Conservator and Secretary for A. O. Building, Gandhidham. They shall ensure setting up the Control Rooms at the respective places within two hours of warning and the matter reported to Chairman/Deputy Chairman.

Commandant, CISF shall remain in contact with in-charge of Control Room at Kandla regarding the positions of the cyclone.

Functions of Control; Room

It shall remain in touch with the Indian Meteorological Department and also offices and officials

- Information from the above Offices/Officers will be collected and transmitted to the overall in charge of Control Rooms/ Dy. Conservator/Harbour Master/ Traffic Manager/Senior Commandant, CISF/Chief Mechanical Engineer on hourly basis. The information should also be passed on to Secretary/Dy. Chairman/Chairman every 03 hours.
- Two dedicated telephones shall be kept in the Control Rooms, one for receiving and the other for outward calls.



- Each control room will enter messages in Log Books continuously and simultaneously report to the overall in-charge after every one-hour. The information shall be passed on to Chairman/Deputy Chairman directly depending upon the importance. It shall be the responsibility of the Control Room Staff to ensure that timely information is passed on and timely proper monitoring done.

Immediately after the initial signal for Cyclone storm is received, the Dy. Conservator, Harbour Master, Pilot and Signal Superintendent shall continuously monitor the movement of the cyclone on hourly basis. These officials shall obtain the information from India Meteorological Department (IMD). The information so collected shall be maintained by making hourly log entry in a register.

As soon as the cyclone warning Signal No. 5 or above is hoisted, the Harbour Master and Pilot shall monitor it through internet and give two-hourly reports to Dy. Conservator, Secretary, Chief Engineer, FA&CAO, Dy. Chairman and Chairman. Dy. Director (EDP) along with Junior Engineer (PMC) and Exe. Engineer (Design) will monitor the website in the A. O. Building, Gandhidham.

The Harbour Master, Pilot and Signal Superintendent shall be deputed to the Control Room immediately on starting of the control room with relevant charts.

The above persons shall immediately reach the Control Room and stay there till the emergency is called off. They shall plot the movement of cyclone on hourly basis and bring the position to the notice of Traffic Manager, Chief Mechanical Engineer, Dy. Conservator and Dy. Chairman/Chairman.

After scrutinizing the movement of the cyclone on the charts, Dy. Conservator shall, in consultation with Chairman /Dy. Chairman, if required, take a decision for evacuation of ships immediately as soon as the cyclone is in close proximity to the danger line as defined above.

All pilots should remain stand by as soon as the warning of Cyclone No. 5 level and above is received. All pilots shall be stationed at Kandla and shall not leave the port without prior permission.

Dy. Conservator shall station himself at Control Room at Kandla and remain continuously in touch with the pilots. The pilots should be in a position to mobilize themselves for evacuation of vessels and securing all Port crafts at shortest possible time.

Grant of leave to key officials during the cyclone season (May to July) shall be restricted.

Immediate Stopping of Operations at the Port.

- All the Pilots of the Port should reach Kandla immediately in case of emergency. Any Pilot not traceable in emergency shall be liable for disciplinary action.
- Dy. Conservator / Harbour Master / Pilots should be available at Kandla during emergency.
- Removal of vessels whenever the Cyclone is located in close proximity to the danger line plotted between 65° E Longitude 18.2°N Longitude and 73° E Longitude 18.2°N Longitude.

Under such a situation, the ships shall be removed during the first/next available tide. It will be the duty of Harbour Master and Dy. Conservator to ensure that the ships are removed during the first / next available tide as soon as the storm approaches in the close proximity to the danger line as defined above without seeking any further instructions from higher authorities. This action shall be taken automatically and suo-moto without any confusion and for this purpose Traffic Manager shall stop all loading and unloading

operations immediately upon instructions from Dy. Conservators as to enable him to remove the vessels in time. The removal shall be done with the help of all the available pilots plus all contract/empaneled pilots together at one go in the shortest possible time so as to ensure that all the vessels cross the bar before the tide restriction sets in.

Dy. Conservator shall ensure that all ships are moved out of the Harbour at the earliest. All pilots shall immediately report at Kandla and stay there till the Action Plan is in operation. Dy. Conservator/Harbour Master shall immediately plan removal of vessels to the OTB as soon as the Action Plan is put into operation irrespective of the signal number, which must be hoisted. If it is impossible to remove them, then all other steps should be taken to ensure safety of the vessels at the Port, as also it would not cause any damage to the Port.

Superintendent Engineer (Mechanical) shall enlist the engine side staff of the Floating craft to be kept on stand-by for shifting of crafts to safer places. He will be the in charge of manning these crafts as per the requirement.

For shipping tugs, Marine Engineer / Engineer In-charge (Tugs) /will be the in-charge for manning the engine side staff for operation of the shipping tugs as per the requirement. Assistant Engineer(DT) and, Assistant Executive Engineer(FC) shall co-ordinate with Marine Engineer / Engineer In- charge (Tugs).

After the cyclone warning Signal No.5 or above is hoisted at the Port Traffic Manager shall ensure that the loading/unloading operations at the Port are stopped immediately, hatches closed, ships' derricks properly secured and all laborers evacuated from the port area. Public address system shall be installed at the cargo jetty area, which shall be under the charge of TM. He shall use it for necessary arrangements relating to the evacuation. Senior Commandant, CISF shall ensure that Public Address System is fitted on vehicles provided to CISF.

Traffic Manager should ensure that responsible persons make announcements in a proper way so as not to create any misunderstanding/ panic.

Chief Mechanical Engineer shall ensure that immediately the cranes are secured and properly locked after closing of loading and unloading operations from ships as per procedure and report submitted to Chairman/Dy. Chairman after the operation of this action plan.

The Superintending Engineer (Mechanical) and the Superintending Engineer (Electrical) shall constantly monitor the safety of Cranes

The above officials and, Assistant Engineer (Elec.) shall arrange to secure all the cranes and keep them properly locked as per the procedure and send a report to the Chief Mechanical Engineer.

SECURING ALL CRAFT

Dy. Conservator / Harbour Master shall immediately arrange for securing all the Port Crafts at safer places so that there is no loss to the port and send a report to the Chairman/Dy. Chairman as early as possible after operation of this action plan. Flotilla Superintendent shall be overall in-charge of each craft for ensuring their safety.

For parking of crafts in emergency, their places are mainly identified, viz. Bunder Basin, Launch Jetty and maintenance Jetty (As per):



- Maximum number of crafts such as Mooring Launches, G. S. Launches, and Pilot Launches will be placed in Bunder Basin.
- In the inner side of Passenger Jetty, one Pilot Launch and one G.S. Launch will be kept.
- Three Tugs will be kept in the inner side of Maintenance Jetty.

Priority will be given to the Port Crafts for parking in the Bunder Basin and other areas. Rest of the places available in the northern side of Bunder Basin area will be allotted to the self-propelled barges and private crafts. Dumb barges will be allowed on the beach between maintenance jetty and Oil Jetty area.

Berthing Supervisor will render all possible assistance to FS, being the overall in-charge of the crafts.

Necessary instructions shall be issued to all those people have valid license for operating boats and water craft in the port area immediately. The work of informing these parties will be carried out by Office Superintendent of Dy.Conservator's Office and will personally ensure that the instructions are carried out and report to HM within two hours of the Action Plan coming into operation. The representatives of the above parties shall reach Kandla at once, failing which Dy.Conservator shall cancel the license granted to them and take over the barges/crafts of the party who violate the instructions.

EMERGENCY EVACUATION OF PEOPLE RESIDING IN NEARBY AREAS

There are number of salt pans in the Kandla area. Many of the salt pan workers are residing in their respective units. There are also some townships of DPT for their own personnel, CISF, Customs and P & T Department. The Juna Kandla Village is located close to the Oil Jetty Area. There are also some unauthorized shanty towns near the port area.

On Hoisting of No. 5 Signal or above in Kandla Port, immediately action shall be initiated for evacuation of people of nearby areas by the persons responsible as mentioned hereunder:-

The evacuation of the inhabitants of nearby areas at Kandla is to be done as these areas are sensitive and prone to natural calamities like cyclone, high-tide and other disaster like Gas Leak, etc.

OSD(Estate)Asst. Engineer (C) shall ring up all salt lease holders directing them to evacuate their people from their Kandla sites and report thereof submitted to the Chairman/ Dy. Chairman. The Dy. Secretary(Estate)will be overall in-charge of the proposed action.

Safety Officer & Librarian shall inform the Public/Private Sector Tank Farms in Kandla about the situation and advise them to shift their people out of the respective areas to safe places.

Traffic Manager/Additional Traffic Manager shall arrange to inform all the Stevedores / Agents and other Stakeholders to remove their workers from the operational areas at Kandla.

Asstt. Commandant-CISF, OSD (Estate),Ex. Engineer (Roads)-KPT, Executive Magistrate of State Govt. of Gujarat i.e. the Mamlatdar, Gandhidham and Police Inspector, Kandla shall jointly ensure evacuation of people from Kandla areas. The persons entrusted with the evacuation programme as indicated here below will have to report the progress in evacuation to the Dy. Secretary(E)who shall appraise all developments in this regard to Chairman and Dy. Chairman, DPT over telephone from time to time.

The Traffic Manager/ Commandant, CISF shall ensure that the Cargo/ Oil Jetties are completely evacuated and there is no fresh entry into the operational areas.



The Public Announcement for faster evacuations to be made by(a) CISF on behalf of DPT and(b) Police Inspector, Kandla Police Station in consultation with DPT officials.

The Temporary Evacuation Centers (TEC) will be set up in the Gandhidham area in places like Schools/ Community centers etc. as may be decided in consultation with the State Govt. Officials.

Executive Engineer (TD) will have to ensure opening, cleaning and providing water facility in the temporary shelters at Gandhidham in premises coming under the administrative jurisdiction of Deendayal Port that may be identified for the purpose by the Collector / Mamlatdar /concerned state govt. authority. The toilet blocks attached to these buildings are to be kept in usable condition.

Executive Engineer (Electrical) shall ensure providing of lights and continuous electric supply in the temporary shelters as mentioned above.

Labour Officer and the Head Master of BVM School will have to ensure opening of the School and shifting of school furniture as may be directed.

The requirement of amenities/ medical aid etc. in the temporary evacuation centers will be taken care of by the Executive Engineer (TD)/(R), Senior Engineer (PL),Supdt. Engineer(E) and Doctors of Medical Department.

The Traffic Manager shall provide sufficient number of vehicles as maybe requested by Dy. Secretary(E)for evacuation purposes.

DPT's hired buses shall be deployed for evacuation. Additional vehicles will be arranged with help of concerned State Govt. Departments, if required.

Dy. Secretary (Personnel) shall ensure that the telephone of all the Head of Departments and other responsible officers of different Departments are functioning properly by ringing personally. In case any of the telephones does not function or give satisfactory service, he shall take up the matter with the higher authorities immediately.

TRAFFIC MOVEMENT

Commandant, CISF with the help of Police shall ensure that all incoming traffic to the Port is stopped except those which are coming for rescue operations and essential services at three places i.e. KASEZ Junction, Railway-crossing and Khari Rohar Road. He shall immediately erect two temporary tents and post sufficient number of personnel of CISF in coordination with Police, who shall identify which person has to be allowed. Commandant, CISF shall also ensure that those allowed do not cause any hindrance for those who are supposed to function as per the Internal Action Plan.

STAFF ATTENDANCE

The following personnel must report for duty:

- o All Operational Staff particularly those of Floating Craft Section and Power Supply Section.
- o All Head of Departments and all Class-I &Class-II Officers shall be present in their office timings. Besides, a list of very essential officers, who will be required to be present even beyond the normal duty hours, as and when required,



- o All P.A.s/Stenographers/Peons of Head of Departments and Deputies.
- o All Office Superintendents/Superintendents (Accounts)
- o All Head Clerks and Divisional Accountants.

The above officials shall be present in the office, unless otherwise directed.

All Head of Departments may hold a meeting with Class-I, & Class-II and staffs and explain their functions as per the provisions of Action Plan during the Natural Calamity and submit a Compliance Report to Chairman/Dy. Chairman on priority basis.

Timely supply of Drinking Water/Food Packets to the staff during the operation of the Action Plan shall be ensured.

As soon as this Action Plan comes into force, the vehicle pool stands formed; the vehicle pool shall be controlled by Senior Engineer (Pipeline) and Senior Labour Officer. The following vehicles will be there in the Pool:

All Ambulances Under CMO

Senior Engineer (Pipeline) shall ensure the availability of drivers. All vehicles shall be parked in the location as decided by the Senior Engineer (PL) and Senior Labour Officer (PO), from where it can be taken for immediate use as soon as the people move into action.

Secretary, Dy. Secretary (G) & Dy. Secretary (P) shall ensure the smooth movement of workers/employees.

Generators have been installed at Kandla, Gandhidham and Gopalpuri to supply power to various installations in case of power failure. In addition, if any additional generator sets are required at Kandla or Gopalpuri, arrangements for additional generators shall be made immediately giving preference to the operational area.

Portable Fire pumps shall be deployed for dewatering

Executive Engineer (Dry -dock) shall ensure that heave-up barge "Bhimsen" is shifted to Bunder area and secured properly; Assistant Engineer (Mechanical) shall attend the above work.

Executive Engineer (Dry Dock) and AE(DD) shall ensure that the Steel Floating Dry Dock and the Electric Wharf Cranes at the maintenance jetty are properly secured as per procedure and compliance reported to Chief Mechanical Engineer and Dy. Chief Mechanical Engineer shall monitor the safety of the Steel Floating Dry Dock.

PERIODICAL REPORTING BY ALL HODS

All Head of Departments shall have to send Action Taken Report to the Secretary/ Control Rooms in writing by Fax or through telephone with regard to the action taken by them as per the Action Plan. If the report is not received from the Head of Departments, the Officer In-charge, Control Room shall obtain the information, compile it and submit the same to the Chairman / Dy. Chairman on 12 hourly basis i.e. twice a day.

Chief Engineer

The Chief Engineer shall ensure through all road blockages are cleared. He will also ensure that water logging in the colonies is cleared. A report shall be submitted to the Chairman/ Dy. Chairman every day.



Chief Mechanical Engineer

Chief Mechanical Engineer, Dy. CME/S.E (E) shall ensure that all generator sets are properly functioning. They will ensure quick restoration of power supply. They will report to the Chairman/ Dy. Chairman everyday.

Action Plan– Land Fire Station

As soon as any information regarding fire is received, the Duty Station Officer of the Fire Station shall proceed to the scene of fire with fire tenders and crew. Station Telephone Attendant should inform other officers like Fire-cum-Safety Officer, Dy. Conservator and Port Control. Telephone Attendant should inform hospital and if fire is in wharf should inform Traffic Manager. Fire-cum-Safety Officer after appraising the situation should inform Deputy Conservator directly or through the Telephone Attendant immediately

2.5 Procedures to be Followed In Case of Earthquake and / or Tsunami

Kandla is located in Seismic Zone – V i.e. the highest risk zone.

Gujarat is prone to tsunami risk due to its long coastline and probability of occurrence of near and offshore submarine earthquakes in the Arabian Sea. Makran Subduction Zone (MSZ)- South West of Karachi is an active fault area which may cause a high magnitude earthquake under the sea leading to a tsunami. In past, Kandla coast was hit by a Tsunami of 12 m height in 1945, due to an earthquake in the Makran fault line. Tsunami prone areas in the State include coastal villages of Kutch, Jamnagar, Rajkot, Porbandar, Bhavnagar, Anand, Ahmedabad, Bharuch, Surat, Navsari and Valsad districts.

In case of an earth-quake and tsunami, the procedures described for Actions in case of Severe Weather shall be followed. In addition, the following steps may also be taken:

- As soon as the earth-quake strikes, booms of all cranes should be lowered till all clear notice is received. Electricity connection shall also be cut off till further notice.
- All activities shall be stopped until after shocks have subsided and clearance is received from India Meteorological Department.
- In case there is a tsunami warning, Harbour Master shall order all ships to leave the port and move out to sea at maximum speed.
- Fire Department Personnel and Oil Spill Response teams shall be put on high alert.
- After all seismic activity has subsided all buildings and structures shall be thoroughly inspected for structural integrity and safety before allowing anybody inside. Entry into buildings shall be strictly regulated by CISF personnel.
- Damaged structures / buildings deemed to be too damaged may be partially or completely demolished after disconnecting all utilities.

As soon as the aftershocks have completely subsided, the Chief Incident Controller shall direct the Rescue and Repair Services to:

- Extricate persons from the debris of collapsed structures and save human lives.
- Hand over the extricated persons to first aid parties.
- Take immediate steps for the temporary supports or demolition of structures, the collapse of which is likely to endanger life or obstruct traffic.
- To cut off supplies of gas and electricity.



Trained Rescue parties shall be formed at berth levels, which will be provided with the following equipment:

1. Self-contained oxygen breathing apparatus
2. Blower type gas mask
3. Resuscitators
4. Petromax lamp / Torches
5. Axe/hand saw
6. Bamboo ladder
7. Necessary Safety appliances
8. First aid box
9. Blankets

On-site emergency planning rehearsals need to be carried out from time to time. It requires monitoring by experienced persons from other similar factories or by senior officials from the State Inspectorate of Factories and/or the Directorate of Fire Services, who can help in updating the emergency plan procedure.

2.6 Procedures to be Followed In Case of Sabotage and / or Civil Disturbance

Access to the Deendayal Port is controlled by walls & fences. The entrances are manned by CISF personnel.

If a civil disturbance or sabotage threatens or actually damages the port property– the Harbour Master will communicate with local civil authorities or will request immediate assistance from police, coast guard, navy / air force.

Bomb Emergence Management

In the event of receiving a bomb threat by telephone call, the following should be asked and noted for relaying it to the army/air-force/navy:

In view of the high priority given to Ports, they have high risk of becoming targets of the terrorist groups. Therefore the possibility of receiving bomb threats cannot be ruled out. The golden rule is consider all bomb threats as genuine and act accordingly keeping in mind the safety of the people in the Port and the property.

The objective is:

- a) To avoid/minimize any loss or damage to life and property
- b) To eliminate panic and build-up confidence.
- c) To be prepared for proper handling of any critical situation.

Immediate actions:

- a) Bomb threats may be received in writing email, SMS or may be received on phone.
- b) When the call is received on phone, keep the caller on the line as long as possible. Request him to repeat the message, listen carefully as every word spoken by the person has to be recorded mentally and penned down.
- c) If the caller does not indicate the location of the bomb or the time of possible detonation, it is advisable to try to ask him for this information.



- d) Inform the caller that the port area is occupied and the detonation of a bomb would result in death or serious injury to many innocent persons.
- e) Pay particular attention to peculiar background noises such as motors running, background music and any other noise which may give a clue as to from where the call is being made.
- f) Listen closely to the voice (male, female), voice quality (calm, excited), accents and speech impediments. Immediately after the caller hangs up report should be made to the security officer on-duty about all the above details.
- g) Fill up the bomb threat call details in the format as given below.
- h) Call all identified personnel(As indicated for any emergency)

As soon as an emergency is envisaged /occurs the Emergency chief or his alternate shall promptly communicate the information by a telephone or any other quickest mode of communication to the Inspector of Police, highest administrative officer, fire brigade and the nearby installations. The information should include the location of the installation and the degree of emergency (anticipated, eminent or actual).

Standard Operating Procedures (SOPs) are in place for actions on receiving the bomb threat call for assessing the genuineness of the call, trying to get the exact location of the bomb and identifying the caller.

Responsibilities of the CISF Commandant / Deendayal Port Officer

- a) Advise the Emergency chief (Chairman/Dy. Chairman/Dy. Conservator/Harbour Master) and keep him apprised of the actions being taken.
- b) Immediately make elaborate preparations near the threatened area for
 - Firefighting
 - Casualty handling
 - Rescue operations
 - Search operations
- c) Prepare for partial/total evacuation if required. Emergency chief or his alternate will authorize these activities.
- d) Designate the team for bomb search. Initiate search operations with Fire and safety/security officers if time is available.

Action Plan

Two situations are possible.

- ❖ When no time limit is given.
- ❖ When bomb threat call has time limit specified.

As soon as the call is received the concerned area-in-charge will make firefighting/first aid preparations immediately.

In the first case if there is no time limit specified for bomb explosion, as soon as the Emergency chief gives a clearance the following action should be initiated.



- Emergency shutdown of the Port sections likely to be affected.
- Evacuation of the employees and visitors to safer locations.
- Bomb search taking all precautions.

When no time is specified, the concerned officers should search the area along with safety and security officers. The search should be carried out as follows:

- Search must be conducted by employees of the concerned department since they are familiar with the area and would be in a better position to notice a foreign object faster.
- Two teams could be formed to search various parts of the area. Stand quietly for some moments to listen for any clockwork device before starting the search.
- As far as practical do not cause any disturbance in the environment till the search is over.
- Do not go into dark rooms and turn on lights. Use a flashlight instead.
- If any foreign or suspicious object is located, do not move or touch it. The removal / disarming of a bomb must be left to professionals. Report the location and description of the object immediately to the emergency control centre / Security gate.
- If possible place sandbags or mattresses around the bomb. Do not cover it.
- Identify the danger area and block it off with clear zone of at least 100 m.

2.7 Procedures to be Followed In Case of Hostage Situation

RESPONSIBILITIES OF CISF COMMANDANT

- Apprise -Chairman, Deputy Chairman, Deputy Conservator, Harbor Master of contemplated action.
- Prepare threatened area for firefighting, casualty handling, search and rescue operations
- Inform Police and requisition help with regard to negotiators/snipers, etc.
- CISF to cordon off area and deny access to persons hampering operations especially media and onlookers.
- Buy time for negotiators to arrive or for formalizing proper plan of action.
- Police/CISF shall assess the situation and based on the assessment, Chairman may permit operation deemed fit to free hostages.

3.0 OFF-SITE EMERGENCY PLANNING

Off-site emergency planning is normally under the jurisdiction of the district administration. The designated official of the port is required to have co-ordination with the district administration for responsive action in off-site emergency planning.

4.0 COMPLIANCE OF INTEGRATED COASTAL ZONE MANAGEMENT PROJECT

The Detailed Project Report of the Integrated Coastal Zone Management Plan (ICZMP) for Gujarat commissioned by Gujarat Ecology Commission indicates that the plan has the following components:

- A. Coastal Resources Conservation and Management
- B. Coastal Water Monitoring



- C. Socio-Economic Development of Coastal Communities
- D. Integration of Geo-spatial Information System

Coastal Resources Conservation and Management

Under this component it is planned to restore coastal flora & fauna. The Gulf of Kutch is rich in corals as well mangroves. Some of these ecosystems have been damaged due to variety of reasons. The ICZMP for Gujarat has undertaken projects to restore some the damaged ecosystems. These include transplantation of corals and plantation of mangroves.

There are no corals in Kandla area due to highly turbid waters. However there are extensive mangrove swamps.

As part of its commitment towards protection of coastal ecosystems, DPT has undertaken an extensive mangrove plantation programme. DPT has engaged Gujarat Ecology Commission to plant mangroves in the Kandla area. Till date, DPT undertaken mangrove plantation in an area of 1400 ha of mangrove plantations had been created. In addition 350 ha of mangrove plantations have been created on DPT's land by other organisations (refer Clause 4.2.6.3 in Chapter 4 of this report). More areas are being brought under such plantations every year.

Coastal Water Monitoring

DPT engages services of accredited laboratories for carrying out regular environmental monitoring in and around the port. The scope of monitoring also includes coastal water monitoring.

Samples are collected from three locations in Kandla Creek, two locations in Nakti Creek, one location in Khori Creek and two locations in the sea at Vadinar. Samples are collected during High Tide and Low Tide both during spring tides and neap tides. Water samples are analysed for physic-chemical as well as biochemical parameters. Besides these, samples of phyto-plankton, zooplankton and benthos are collected for qualitative as well as quantitative analysis.

Marine ecological studies are also carried out through the "Coastal and Marine Ecology Division" of M/s Gujarat Institute of Desert Ecology, (GUIDE) Bhuj.

The results are submitted to Gujarat Pollution Control Board and other statutory authorities.

Socio-Economic Development of Coastal Communities

DPT has been undertaking Socio-Economic Development of communities in Kandla as well Vadinar areas under its CSR programme. The details of the works executed are given above.

Integration of Geo-spatial Information System

Coastal areas are highly dynamic and complex. Hence effective management requires increased access to technologies that can represent these dynamics, particularly to evaluate and deal appropriately with changes and its complexity. Coastal zone management requires monitoring, intervention of the processes, controls, feedback and interrelationships in order to arrive at more desirable ends. It includes shoreline classification, monitoring erosion, mapping biological resources, habitat assessment for the planning and response to natural as well as man-made disasters, changes in sea conditions over time, short term and long term land transformation etc. Geo-informatics represents the latest tools for solving spatial data-handling problems.



This aspect of the ICZMP is being implemented through Bhaskara Institute for Space Applications and Geoinformatics (BISAG). DPT shall however extend necessary technical and logistic support to BISAG for implementation of the ICZMP for the Gulf of Kutch.

5.0 MUTUAL-AID SYSTEM

At times the possibility of a major emergency (a situation out of control of facility authorities) cannot be ruled out. In such a case, the facility authorities would declare it to be a major emergency and total control would be transferred to the district level office of contingency plan committee. Necessary help would also be sought from Government sources having necessary infrastructure for dealing with disaster.