

Chapter 7

Additional Studies

7.1 Risk Assessment

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

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

MCA stands for Maximum Credible Accident or in other words, an accident with maximum damage distance, which is believed to be probable. MCA analysis for a proposed project does not include quantification of the probability of occurrence of an accident. In practice the selection of accident scenarios for MCA analysis is carried out on the basis of past accident analysis at similar projects, engineering judgement and expertise in the field of risk analysis especially in accident analysis.

7.1.1 Objectives

- ◆ Identification of vulnerable units with resources to hazard indices
- ◆ Generation of release scenarios for escape of flammable chemicals from facilities at terminals and along the pipeline route

- ◆ Estimation of damage distances for the accidental release based on different scenarios
- ◆ Estimation of probability of occurrence of hazardous event through event tree analysis
- ◆ Modeling of heat loss from buried pipeline due to leak and its dependency on various parameters
- ◆ Suggestion of risk mitigation measures for storage and pumping facilities at terminals, electric hazards and along the pipeline route
- ◆ Approach to Disaster Management Plan

7.1.2 Scope of Work

The work undertaken consists of the following stages.

- ◆ Collection of relevant data on operating conditions and selection / evaluation of accident scenarios for the storage and pumping facilities at terminals and along the pipelines
- ◆ Hazard identification through computation of Fire and Explosion Index (FEI)
- ◆ Damage distance computation based on pool fire, jet fire and flash fire scenarios
- ◆ Risk quantification based on probabilities of fire frequency from standard international database

Maximum Credible Accident (MCA) analysis is carried out to arrive at hazard distance for worst case scenario. The consequence of all the scenarios on human population is computed and hazard distances are worked out and listed for flammable and possible radiation effects. Risk mitigation measures based on MCA analysis and engineering judgment are suggested in order to improve overall system safety.

7.2 Maximum Credible Analysis (MCA)

The MCA analysis involves ordering and ranking of various sections/ units of proposed project in terms of potential vulnerability steps as given below:

- ◆ Study the process details of proposed project including hazardous material and their inventories envisaged
- ◆ Identification of potential hazardous sections and representative failure cases

- ♦ Visualization of release scenarios with recourse to consequence analysis

The details related to proposed gross root development of crude oil evacuation pipeline with associated facilities from Mangala terminal in Barmer district of Rajasthan state to Salaya terminal in Jamnagar district via Viramgam of Ahmedabad district in Gujarat state have been studied in the perspective of risk assessment. Proposed project consists of crude oil evacuation pipeline of 600 Km and associated facilities such as heating and pigging stations along the pipeline route. Storage, handling, pumping and diluent's mixing facilities will be established at Viramgam and Salaya terminals. Based on the process details of proposed project, the major process units fall in risk prone activities are storage tanks and pumps at terminals and transportation pipeline of crude oil and natural gas. Accordingly, following details regarding pipelines, storage facilities and pumps are considered for risk assessment.

Crude Oil Pipeline

Technical Particulars	Design Parameters
Diameter	24 inch
Temperature	65°C
Pressure	90 bar g
Flow Rate	150000 BOPD (max.) 30000 BOPD (min)
Material of Construction	X 65 / X 70,CS epoxy coated line with 4" PUF insulation and HDPE top sheath
Thickness of pipeline	11.1/12.7 mm
Length of pipeline	600 Km
Spur lines to IOCL Tank Farm, ESSAR and Reliance refinery	21 Km

Natural Gas Pipeline

Technical Particulars	Design Parameters
Diameter	8 inch
Temperature	36°C
Pressure	49 bar g
Flow rate	6.5 mmscfd
Material of construction	API5L-X42
Material Handling	Natural Gas
Thickness of pipeline	6.4/7.10 mm
Length of pipeline	

Crude Oil Storages

Crude Oil Storage at Mangala Terminal

Technical Particulars	Design Parameters
Capacity of tank	33325 m ³ (Nominal)
Diameter	60 m
Height	12 m
Temperature	90°C
Pressure	0.2KPa

Crude Oil Storage at Viramgam Terminal

Technical Particulars	Design Parameters
Capacity of tank	5000 m ³ (15000 bbl)
Diameter	16 m
Height	12m
Dyke area	3377 m ²
Temperature	70°-90°C
Pressure	0.2 KPa

Crude Oil Storage at Salaya Terminal

Technical Particulars	Design Parameters
Capacity of tank	50000 m ³ (150000bbl)
Diameter	51 m
Height	12 m
Dyke area	2855 m ²
Temperature	70°-90°C
Pressure	0.2 KPa

Pumps

Pump at Mangala Terminal

Technical Particulars	Design Parameters
Differential Pressure	79.5 bar g
Operating Temperature	70°-90°C
Flow rate	388.50 m ³ /hr
Material handling	Crude

Pump at Viramgam Terminal

Technical Particulars	Design Parameters
Differential Pressure	17.28 bar g
Operating Temperature	70°-90°C
Flow rate	199m ³ /hr
Material handling	

Pump at Salaya Terminal (for Blending)

Technical Particulars	Design Parameters
Differential Pressure	3.5 bar g
Operating Temperature	70°-90°C
Flow rate	497m ³ /hr
Material handling	Crude

Pump at Salaya Terminal (for Export Crude to ESSAR and Reliance)

Technical Particulars	Design Parameters
Differential Pressure	13.93
Operating Temperature	70°-90°C
Flow rate	497m ³ /hr
Material handling	Crude

Pump at Salaya Terminal (for Condensate)

Technical Particulars	Design Parameters
Differential Pressure	3.5 bar g
Operating Temperature	50°C
Flow rate	497m ³ /hr
Material handling	Condensate

Pump at Salaya Terminal (for Export Blend)

Technical Particulars	Design Parameters
Differential Pressure	16.85 bar g
Operating Temperature	35°-70°C
Flow rate	994 m ³ /hr
Material handling	Blended crude

Composition and Properties of Crude Oil

Wax content (wt %)	20 % - 38 %
Crude API	22 - 28 (Mangala ~ 28)
Viscosity (cP)	20 - 23.3 at 70°C
	22.6 - 27 at 65°C
	93.5 - 288 at 42°C
Density (kg/m ³)	65°C - 873
	50°C - 879
	30°C - 887
Heat capacity (J / kg-°C)	65°C - 2185
	50°C - 2130
	30°C - 2050
Wax Appearance Temperature (WAT) (°C)	50° - 65° (Normal operating - 65°)
Wax Dissolution Temperature (WDT) (°C)	70° (Design - 75°)
Pour point, un-treated, (°C)	40° - 45°

7.2.1 Hazard Criteria

Storage, handling and pumping of hazardous materials could contribute to the creation or escalation of accidents. The degree / level of hazards is identified by computing Fire and Explosion Index (FEI). FEI is computed by considering Material Factor (MF), General Process Hazards (GPH) and Special Process Hazard (SPH). The criteria followed for categorization of FEI hazard is given below:

FEI Range	Degree of Hazard
0 - 60	Light
61 - 96	Moderate
97 - 127	Intermediate
128 - 158	Heavy
159 & Above	Severe

The results of the fire and Explosion Indices (FEI) for proposed facilities are depicted in **Table 7.1**.

Table 7.1
Fire and Explosion Index

Sr. No.	Unit Name	Material Handled	FEI	Category
1	Crude oil pipeline	Crude oil	31.9	Light
2	Natural gas pipeline	Natural gas	120.54	Intermediate
3	Storage tank at Mangala	Crude oil	26.1	Light
4	Storage tank at Viramgam	Crude oil	23.2	Light
5	Storage tank at Salaya	Crude oil	26.1	Light
6	Pump at Mangala	Crude oil	50.75	Light
7	Pump at Viramgam	Crude oil	46.4	Light
8	Pump at Salaya (for Blending)	Crude oil	52.2	Light
9	Pump at Salaya (for export crude to ESSAR and Reliance)	Crude oil	52.2	Light
10	Pump at Salaya (for condensate)	Crude oil	52.2	Light
11	Pump at Salaya (for export blend)	Crude oil	56.55	Light

7.2.2 Consequence Analysis

Release of flammable material (crude oil / Natural gas) can cause hazard to the environment. The extent of the risk is dependent upon the nature of the release and the physical state of the material. **Fig. 7.1** provides a flowchart that can be followed to evaluate the possible consequences of a release of a flammable or toxic chemical depending on the circumstances. It is necessary to visualize the worst possible consequences and the damage caused for implementation of preventive / risk mitigation measure in detailed engineering and implementation stages.

Release of these hazardous chemicals in the atmosphere from the storage section has been studied by building probable scenarios on the basis of their properties and the effects of the scenarios are then calculated in terms of damage distances with the help of consequence analysis by plotting of the results (damage contours) on the proposed plot plan in order to visualize magnitude extent of consequence. Following accident scenarios are visualized for release of crude oil and natural gas from pipelines, crude oil storage tanks and pumps:

- ◆ 1/4", 1" and 2" leak and line rupture of crude oil and natural gas pipeline

- ♦ 10 mm, 25 mm leak and catastrophic rupture of crude oil storage tanks and pumps at Mangala, Viramgam and Salaya terminals

Damage criteria for heat loads are shown in the following **Table 7.2** and list of possible damages at various heat loads are depicted in **Table 7.3**.

Table 7.2
Damage Criteria for Heat Load, kW/m²

Exposure time Damage	t = 10 seconds		t = 30 seconds	
	With protection	Without protection	With protection	Without protection
1% Lethal injury	21.2	12.5	9.3	7.3
First degree burns	8.5	6.9	4.0	3.7

Table 7.3
List of Damages Envisaged at Various Heat Loads

Heat Load (kW/m ²)	Type of Damage
37.5	Sufficient to cause damage to process equipment
25.0	Minimum energy required to ignite wood infinitely long exposure (non-piloted)
12.5	Minimum energy required for piloted ignition of wood, melting plastic tubing
6.9	First degree burns if exposed for 10 seconds
4.0	Sufficient to cause pain to personnel if unable to reach over within 20 seconds; however, blistering of skin (1 st degree burns) is likely
1.6	Will cause no discomfort to long exposures

(Ref: Risk analysis of six potentially hazardous industrial objects in the Rijnmond area, a pilot study; D. Reidel Publishing Company; pp. 331)

7.2.3 Factors influencing the use of Physical Effect Models

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

- ♦ Determining the form in which the hazardous substance occurs for example gas, gas condensed to liquid or as a liquid in equilibrium with vapour
- ♦ Determination of the way in which the release takes place; for example intermittent or a continuous release

- ◆ Determination of the outflow volume (as a function of time) of the gas, vapour or liquid
- ◆ Dispersion of the released gas or vapour which has formed into the atmosphere

Following table indicates failure frequencies for storage tanks according to their leak size and catastrophic rupture.

Frequency of near instantaneous release of whole contents = 2×10^{-6} / year.

Frequency of lesser release = 6×10^{-5} /year Partitioned as follows:

Equivalent hole diameter (mm)	Frequency
50	4×10^{-6} /year
25	8×10^{-6} / year
13	10×10^{-6} /year
6	40×10^{-6} /year

Ref: HSE Guide assessment on installation key assumption (after Pape and Nussey, 1985)
(Courtesy of the institution of Chemical Engineers)

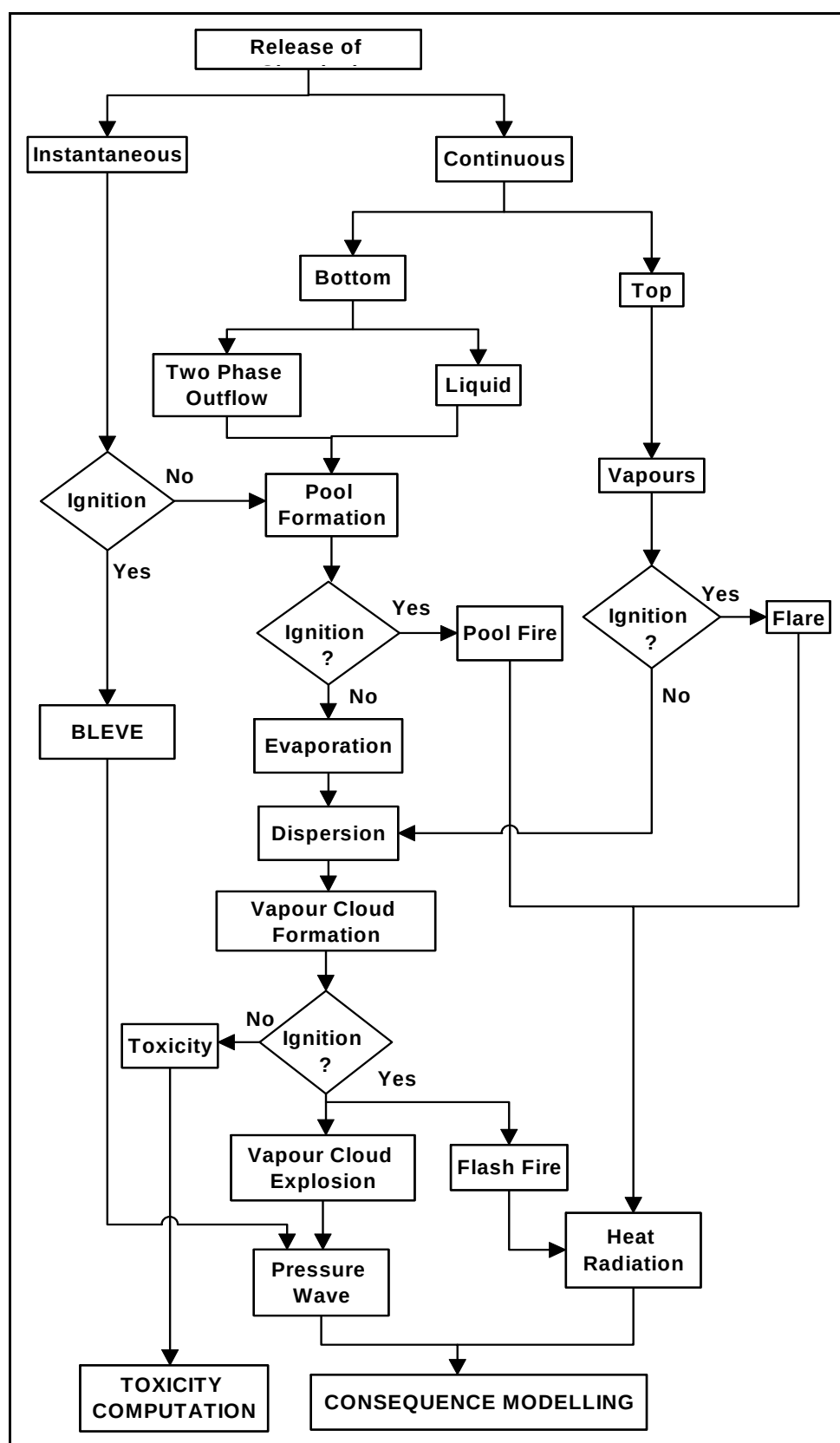


Fig. 7.1: Accidental Release of Chemicals: A Scenario

7.2.4 Likely Consequences

7.2.4.1 Burning Torch or Jet Fire

The release of crude oil and from the crude oil pipeline, storage tanks, pumps and natural gas pipeline could result in pressurized jet. This may lead to jet fire on availability of an immediate ignition which is also called as burning torch. In this model, an ellipse is assumed for the shape of a torch. The volume of the torch (flare) in this model is proportional to the mass flow.

This scenario was visualized by considering different leak sizes of ¼", 1" and 2" for various heat loads 37.5 kW/m², 12.5 kW/m² and 4 kW/m² under the weather stability conditions of 2F, 3D and 5D. The damage distances due to 2" leak in crude oil pipeline for the heat load of 4 kW/m² were found to be 112.16 m, 108.35 m and 103.34 m under weather stability conditions of 2F, 3D and 5D respectively. The computed damage distances for ¼" and 1" leak sizes are given in **Table 7.4**. Similarly, Damage distances computed for storage tanks, pumps and natural gas pipeline are shown in **Table 7.4**.

Damage contours for jet fire scenario due to leak in storage tanks at Viramgam and Salaya terminals are presented in **Fig. 7.2** and **7.3** respectively. Damage contours for pumps at Viramgam and Salaya terminals are presented in **Fig. 7.4** to **7.8**.

Table 7.4
Consequence Analysis for Jet Fire Scenario

Unit Name	Leak	Source Rate (kg/sec.)	Weather	Damage Distances (m) for Various Heat Loads		
				37.5 kW/m²	12.5 Kw/m²	4.0 kW/m²
For Crude Oil Pipeline (Underground)						
Leak in Crude Oil Pipeline Temperature = 65°C Pressure = 90 bar g	0.25"	2.36	2F	-	10.28	20.86
			3D	-	11.09	19.94
			5D	5.26	11.57	19.61
	1"	37.85	2F	-	31.56	64.66
			3D	-	33.78	62.20
			5D	14.61	35.79	59.32
	2"	151.4	2F	-	53.40	112.16
			3D	-	57.48	108.35
			5D	22.13	61.66	103.34
For Natural Gas Pipeline (Underground)						
Leak in Natural Gas Pipeline Temperature = 36°C Pressure = 49 bar g	0.25"	0.24	2F	-	-	-
			3D	-	-	3.53
			5D	-	-	5.29
	1"	3.85	2F	-	-	15.65
			3D	-	-	18.83
			5D	-	5.12	21.78
	2"	15.42	2F	-	-	32.88
			3D	-	-	37.87
			5D	-	14.12	42.37
For Storage Tanks						
Leak in Tank at Mangala Terminal Temperature = 90°C Pressure = 0.2KPa.	10 mm	0.49	2F	6.25	7.30	9.56
			3D	5.83	7.00	9.29
			5D	4.98	6.61	8.90
	25 mm	3.07	2F	12.43	15.25	19.72
			3D	11.95	14.76	19.31
			5D	11.21	13.99	18.58
Leak in tank at Viramgam Terminal Temperature = 90°C Pressure = 0.2KPa	10 mm	0.49	2F	6.25	7.30	9.56
			3D	5.83	7.00	9.29
			5D	4.98	6.61	8.90
	25 mm	3.072	2F	12.43	15.25	19.72
			3D	11.95	14.76	19.31
			5D	11.21	13.99	18.58
Leak in tank at Salaya Terminal Temperature = 90°C Pressure = 0.2KPa	10 mm	0.49	2F	6.25	7.30	9.56
			3D	5.83	7.00	9.29
			5D	4.98	6.61	8.90
	25 mm	3.072	2F	12.43	15.25	19.72
			3D	11.95	14.76	19.31

Unit Name	Leak	Source Rate (kg/sec.)	Weather	Damage Distances (m) for Various Heat Loads		
				37.5 kW/m ²	12.5 Kw/m ²	4.0 kW/m ²
			5D	11.21	13.99	18.58
For Pumps						
Leak in Pump at Mangala Terminal Temp. = 90°C Press.= 79.5 bar g	10 mm	5.42	2F	22.43	27.30	35.57
			3D	22.58	27.94	37.10
			5D	21.60	27.32	37.14
	25 mm	33.87	2F	44.62	54.51	71.42
			3D	43.29	53.76	71.75
			5D	39.60	49.88	67.53
Leak in Pump at Viramgam Terminal Temperature = 90°C Pressure = 17.28 bar g	10 mm	2.532	2F	15.52	18.95	24.68
			3D	15.60	19.37	25.71
			5D	15.51	19.66	26.70
	25 mm	15.82	2F	29.79	36.44	48.68
			3D	29.45	36.64	48.86
			5D	27.81	35.32	48.15
Leak in Pump at Salaya Terminal (For Blending) Temperature = 90°C Pressure = 3.5 bar g	10 mm	1.14	2F	9.41	11.62	15.13
			3D	9.08	11.38	15.06
			5D	8.74	11.11	14.98
	25 mm	7.12	2F	20.13	24.69	32.22
			3D	19.07	23.72	31.45
			5D	17.73	22.38	30.21
Leak in Pump at Salaya Terminal (For export crude to ESSAR and Reliance) Temperature = 90°C Pressure = 13.93 bar g	10 mm	2.27	2F	14.48	17.17	23.06
			3D	14.49	18.01	23.89
			5D	14.08	17.85	24.21
	25 mm	14.21	2F	28.12	34.40	45.01
			3D	27.86	34.67	46.21
			5D	26.04	33.05	45.03
Leak in Pump at Salaya Terminal (For Condensate) Temperature = 50°C Pressure = 3.5 bar g	10 mm	1.17	2F	6.07	7.34	9.68
			3D	5.80	7.34	9.83
			5D	5.54	7.30	9.93
	25 mm	7.32	2F	12.02	14.47	19.23
			3D	11.62	14.47	19.14
			5D	11.11	14.04	18.91
Leak in Pump at Salaya Terminal (for export blend) Temperature = 70°C Pressure = 16.85 bar g	10 mm	2.53	2F	13.94	17.04	22.18
			3D	14.06	17.47	23.18
			5D	14.24	18.06	24.50
	25 mm	15.84	2F	26.32	32.18	42.07
			3D	26.10	32.45	43.22
			5D	25.14	31.91	43.47



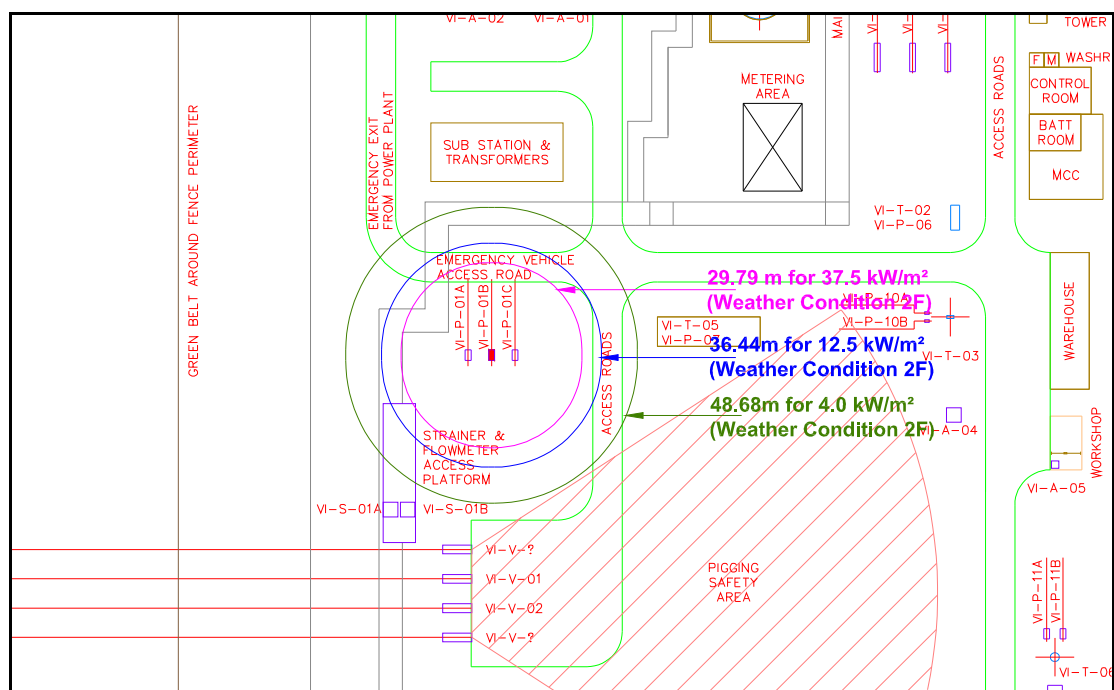


Fig. 7.4: Damage Contour for Jet Fire Scenario due to 25mm Leak in Pump at Viramgam Terminal

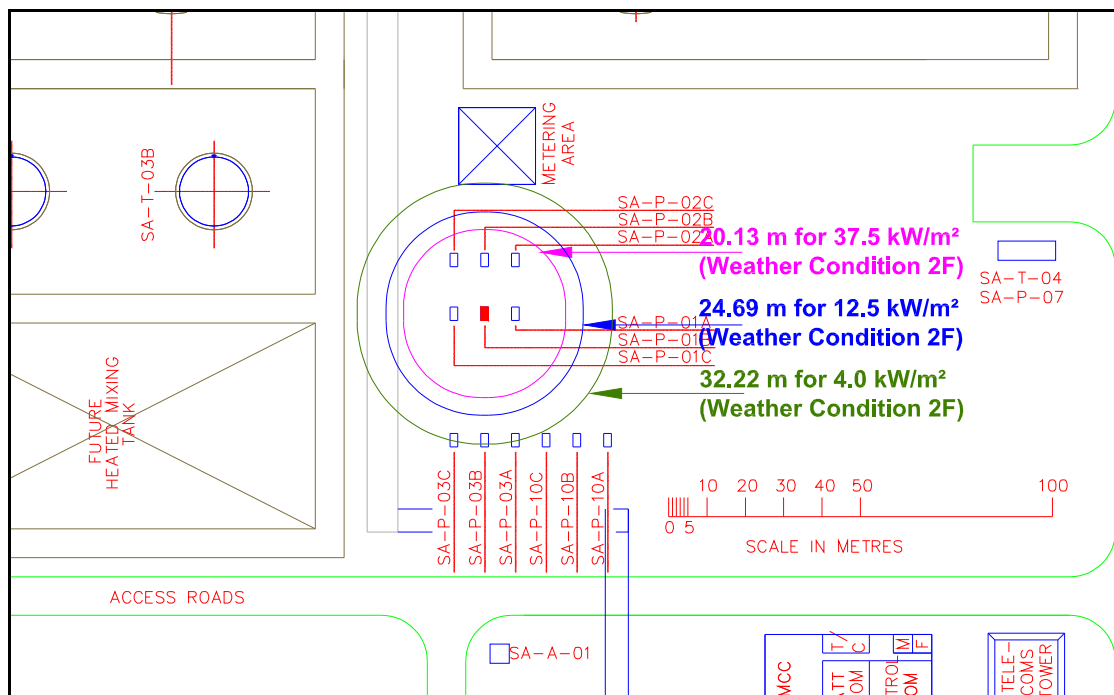


Fig. 7.5: Damage Contours for Jet Fire Scenario due to 25mm Leak in Blending Pump at Salaya Terminal

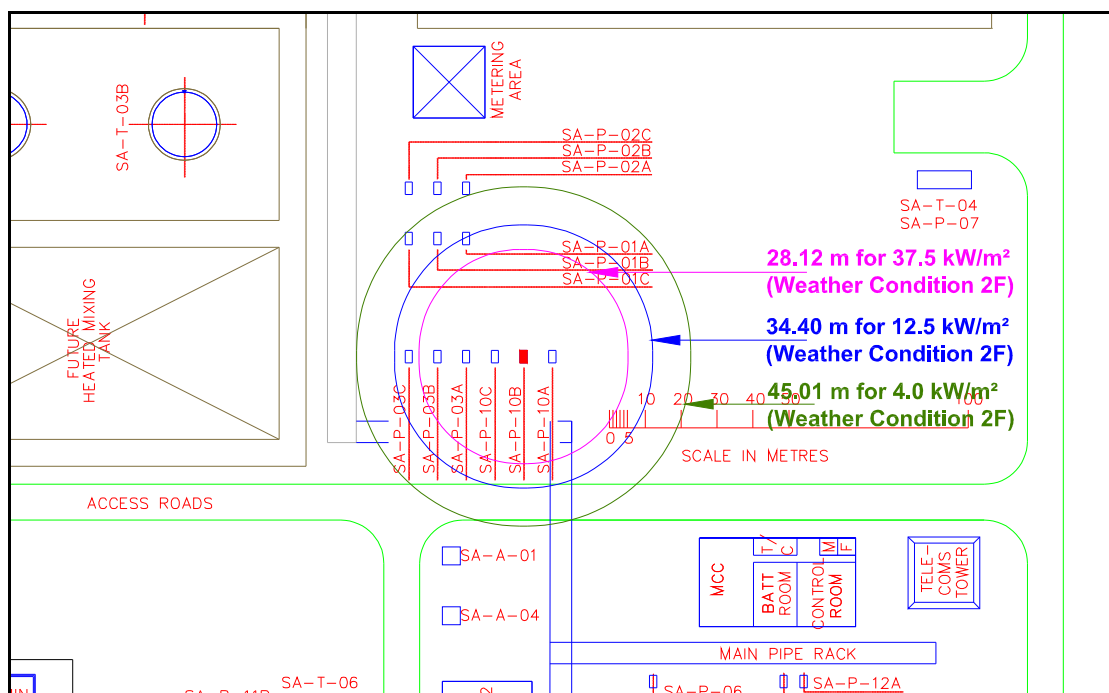


Fig. 7.6: Damage Contours for Jet Fire Scenario due to 25mm Leak in Export Crude to ESSAR Pump at Salaya Terminal

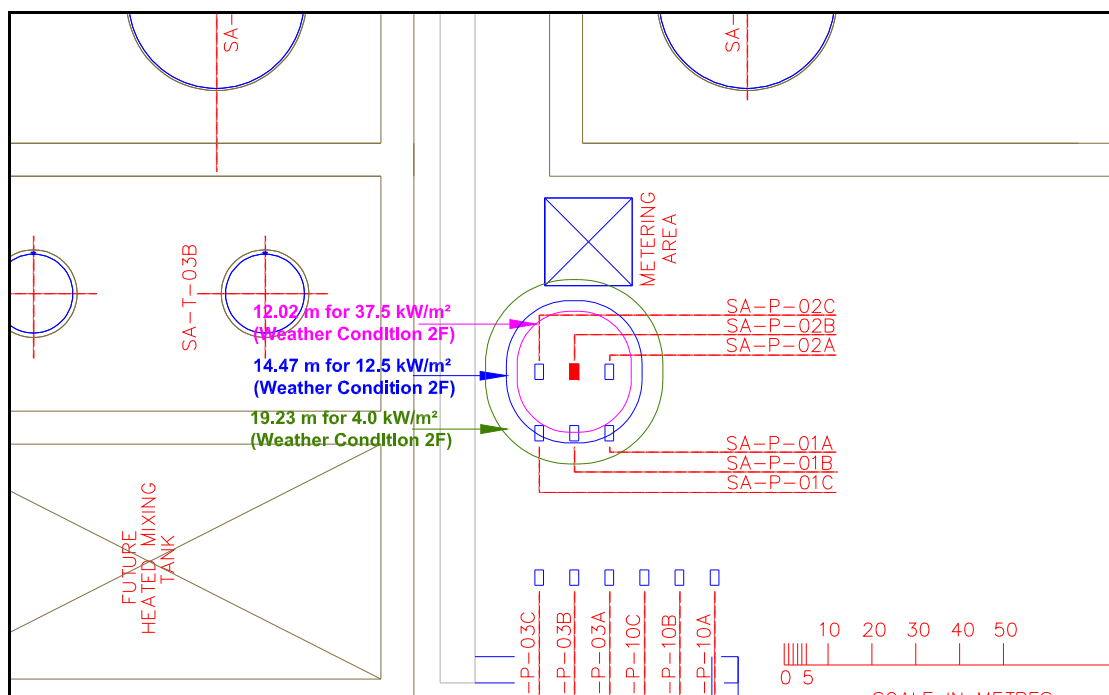


Fig. 7.7: Damage Contours for Jet Fire Scenario due to 25mm Leak in Condensate Pump at Salaya Terminal

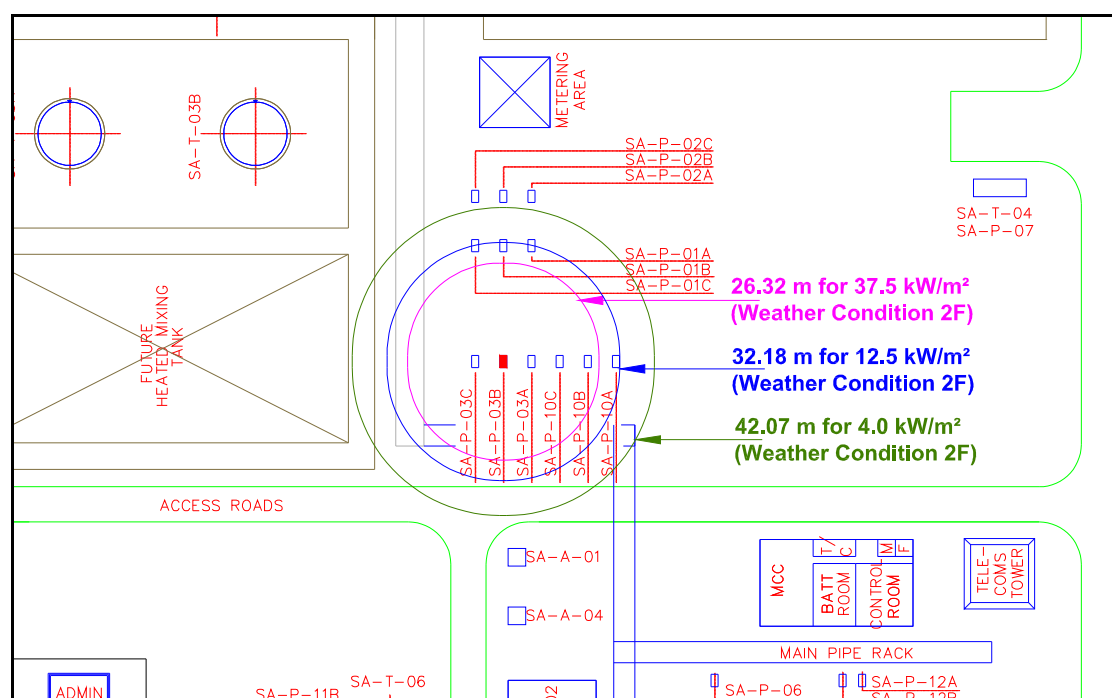


Fig. 7.8: Damage Contours for Jet Fire Scenario due to 25mm Leak in Export Blend Pump at Salaya Terminal

7.2.4.2 Pool Fire

Release of crude oil due to leak in storage tanks and pipeline may lead to formation of a pool. An availability of ignition may cause pool fire. The pool radius is related to outflow rate. Evaporation model is considered during calculations. Pool surface is considered and damage is calculated for the surroundings in terms of the heat load.

This scenario was visualized by considering different leak sizes of 10 mm and 25 mm leaks in storage tank, pumps and ¼", 1", 2" and line rupture in case of crude oil pipeline for various heat loads 37.5 kW/m², 12.5 kW/m² and 4.0 kW/m² under the weather stability conditions of 2F, 3D and 5D. The damage distances due to 2" leak in crude oil pipeline for the heat load of 4.0 kW/m² were found to be 102.57 m, 110.18 m and 119.51 m under weather condition of 2F, 3D and 5D respectively. The computed damage distances in crude oil pipeline for ¼" and 1" leak are shown in **Table 7.5**. Similarly, Damage distances computed for storage tanks and pumps are given in **Table 7.5**.

Damage contours for pool fire scenario due to leak in storage tanks are shown in **Fig. 7.9** and **7.10** for Viramgam and Salaya terminals respectively. Damage contours of pumps at Viramgam and Salaya terminals are shown in **Fig. 7.11** to **7.15**.

Table 7.5
Consequence Analysis for Pool Fire Scenario

Unit Name	Leak	Source Rate (kg/sec.)	Weather	Damage Distances (m) for Various Heat Loads		
				37.5 kW/m²	12.5 Kw/m²	4.0 kW/m²
For Crude Oil Pipeline (Underground)						
Leak in Crude Oil Pipeline Temperature = 65°C Pressure = 90 bar g	0.25"	6.1	2F	7.11	18.70	33.49
			3D	7.11	20.73	34.37
			5D	7.11	23.07	35.63
	1"	24.44	2F	-	25.45	62.58
			3D	-	25.96	67.63
			5D	-	26.69	73.48
	2"	45.69	2F	-	46.70	102.57
			3D	-	46.69	110.08
			5D	-	47.55	119.51
	Line Rupture	60.29	2F	-	61.31	128.56
			3D	-	61.28	137.45
			5D	-	62.23	149.0
For Storage Tanks						
Leak in the tank at Mangala Terminal Temperature = 90°C Pressure = 0.2KPa	10 mm	4.92	2F	9.92	21.68	34.27
			3D	10.20	23.33	34.98
			5D	11.07	25.67	36.62
	25 mm	12.40	2F	-	22.55	48.07
			3D	-	24.11	57.08
			5D	-	25.96	53.97
	Catastrophic Rupture	67.70	2F	-	69.88	142.49
			3D	-	69.52	151.75
			5D	-	70.92	164.87
Leak in the tank at Viramgam Terminal Temperature = 90°C Pressure = 0.2KPa	10 mm	4.92	2F	9.92	21.68	34.27
			3D	10.20	23.33	34.98
			5D	11.07	25.67	36.62
	25 mm	12.40	2F	-	22.55	48.07
			3D	-	24.11	51.08
			5D	-	25.96	53.97
	Catastrophic Rupture	32.78	2F	-	34.47	79.09
			3D	-	34.54	84.99
			5D	-	35.03	92.65

Unit Name	Leak	Source Rate (kg/sec.)	Weather	Damage Distances (m) for Various Heat Loads		
				37.5 kW/m²	12.5 Kw/m²	4.0 kW/m²
Leak in the tank at Salaya terminal Temperature = 90℃ Pressure = 0.2KPa	10 mm	4.92	2F	9.92	21.68	34.27
			3D	10.20	23.33	34.98
			5D	11.07	25.67	36.62
	25 mm	12.40	2F	-	22.55	48.07
			3D	-	24.11	51.08
			5D	-	25.96	53.97
	Catastrophic Rupture	30.14	2F	-	32.01	74.25
			3D	-	32.32	80.10
			5D	-	33.63	87.62
For Pumps						
Leak in Pump at Mangala Terminal Temperature = 90℃ Pressure = 79.5 bar g	10 mm	15.43	2F	-	64.49	93.20
			3D	-	83.74	114.71
			5D	-	91.97	125.25
	25 mm	39.55	2F	-	135.24	185.93
			3D	-	143.04	200.26
			5D	-	156.13	220.73
	Catastrophic Rupture	61.16	2F	-	108.79	176.68
			3D	-	119.32	196.25
			5D	-	158.19	245.95
Leak in Pump at Viramgam Terminal Temperature = 90℃ Pressure = 17.28 bar g	10 mm	10.80	2F	-	48.79	72.16
			3D	-	65.68	89.60
			5D	-	75.33	98.91
	25 mm	27.62	2F	-	65.45	105.40
			3D	-	80.80	125.81
			5D	-	85.61	136.02
	Catastrophic Rupture	43.59	2F	-	54.91	109.03
			3D	-	56.44	117.82
			5D	-	66.23	135.87
Leak in Pump at Salaya Terminal (For Blending) Temperature = 90℃ Pressure = 3.5 bar g	10 mm	7.42	2F	17.35	27.62	45.01
			3D	19.88	32.35	48.83
			5D	20.87	36.21	50.99
	25 mm	18.70	2F	-	33.15	65.11
			3D	-	35.69	70.93
			5D	-	38.17	77.27
	Catastrophic Rupture	70.67	2F	-	77.62	152.31
			3D	-	77.67	162.22
			5D	-	82.52	179.17

Unit Name	Leak	Source Rate (kg/sec.)	Weather	Damage Distances (m) for Various Heat Loads		
				37.5 kW/m ²	12.5 Kw/m ²	4.0 kW/m ²
Leak in Pump at Salaya Terminal (for export crude to ESSAR and Reliance) Temperature = 90°C Pressure = 13.93bar g	10 mm	10.28	2F	-	43.24	65.85
			3D	-	57.62	80.71
			5D	-	66.99	88.82
	25 mm	26.20	2F	-	61.17	99.85
			3D	-	77.49	120.95
			5D	-	81.23	129.88
	Catastrophic Rupture	69.74	2F	-	90.01	164.07
			3D	-	91.02	174.86
			5D	-	96.58	192.43
Leak in pump at salaya terminal (For condensate) Temperature = 50°C Pressure = 3.5bar g	10 mm	7.70	2F	16.22	26.07	44.09
			3D	17.74	29.69	46.99
			5D	18.24	33.18	48.67
	25 mm	19.36	2F	-	32.67	65.20
			3D	-	35.29	71.26
			5D	-	36.71	76.64
	Catastrophic Rupture	71.89	2F	-	78.35	153.90
			3D	-	78.66	164.17
			5D	-	83.49	181.15
Leak in pump at Salaya Terminal (for export blend) Temperature = 70°C Pressure = 16.85 bar g	10 mm	10.95	2F	-	42.59	66.22
			3D	-	56.86	81.13
			5D	-	67.17	91.45
	25 mm	27.89	2F	-	66.69	106.89
			3D	-	74.02	119.38
			5D	-	86.49	137.24
	Catastrophic Rupture	91.88	2F	-	115.87	204.33
			3D	-	117.07	217.32
			5D	-	139.04	254.16

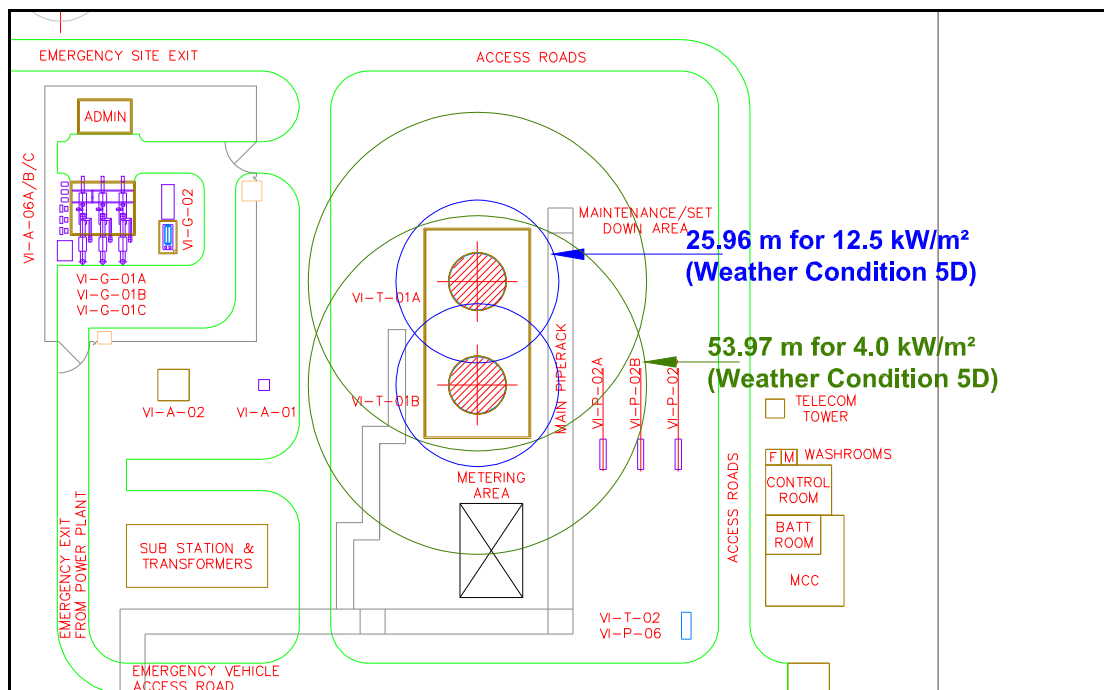


Fig. 7.9: Damage Contours for Pool Fire Scenario due to 25mm Leak in Tank at Viramgam Terminal

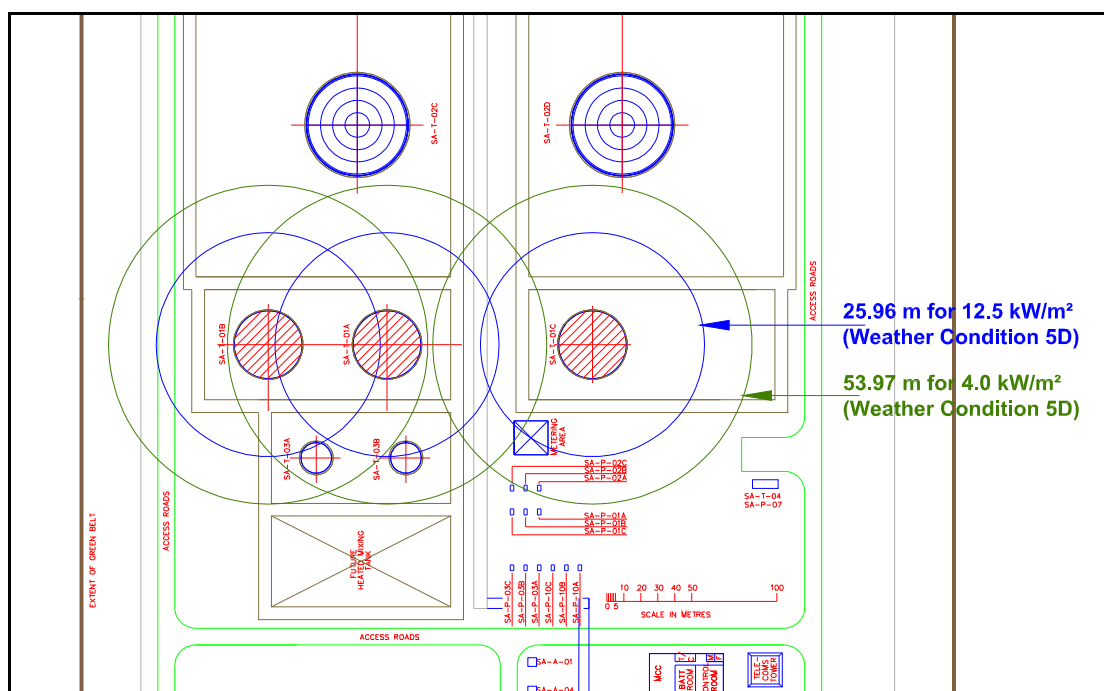


Fig. 7.10: Damage Contours for Pool Fire Scenario due to 25mm Leak in Tank at Salaya Terminal

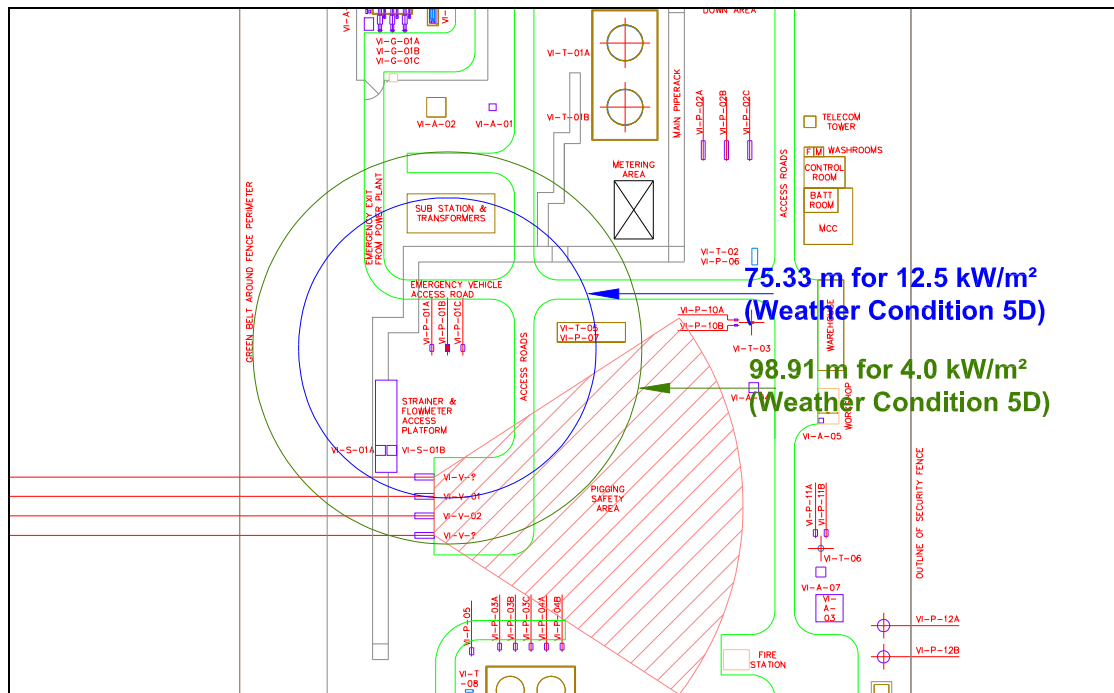


Fig. 7.11: Damage Contour for Pool Fire Scenario due to 10mm Leak in Pump at Viramgam Terminal

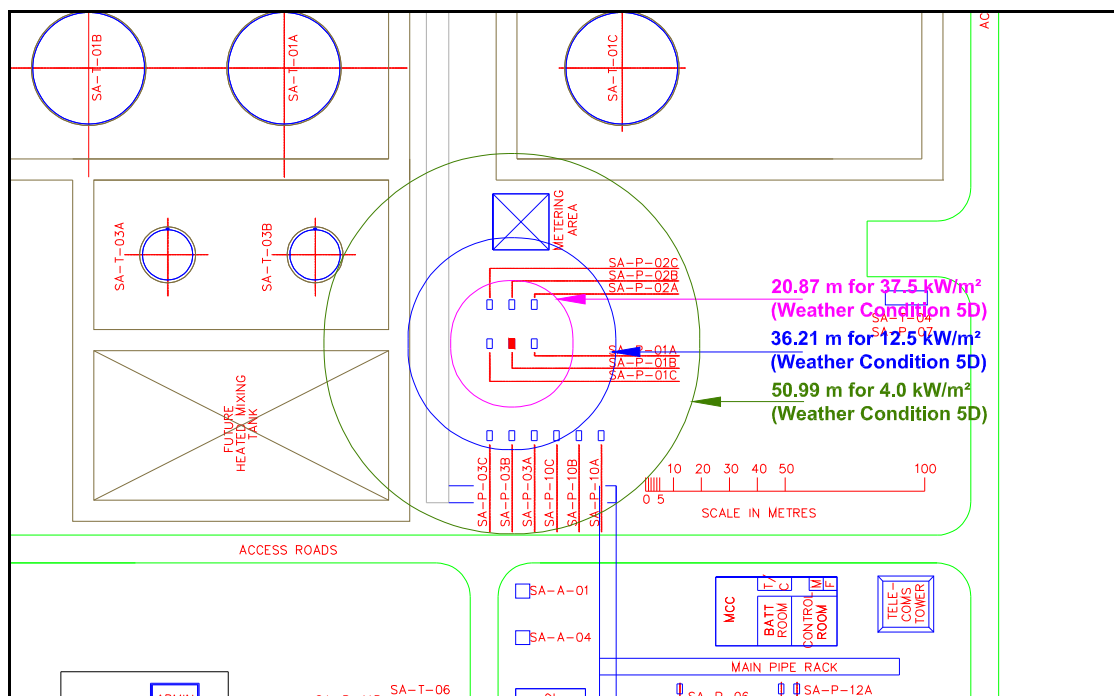


Fig. 7.12: Damage Contours for Pool Fire Scenario due to 10mm Leak in Blending Pump at Salaya Terminal

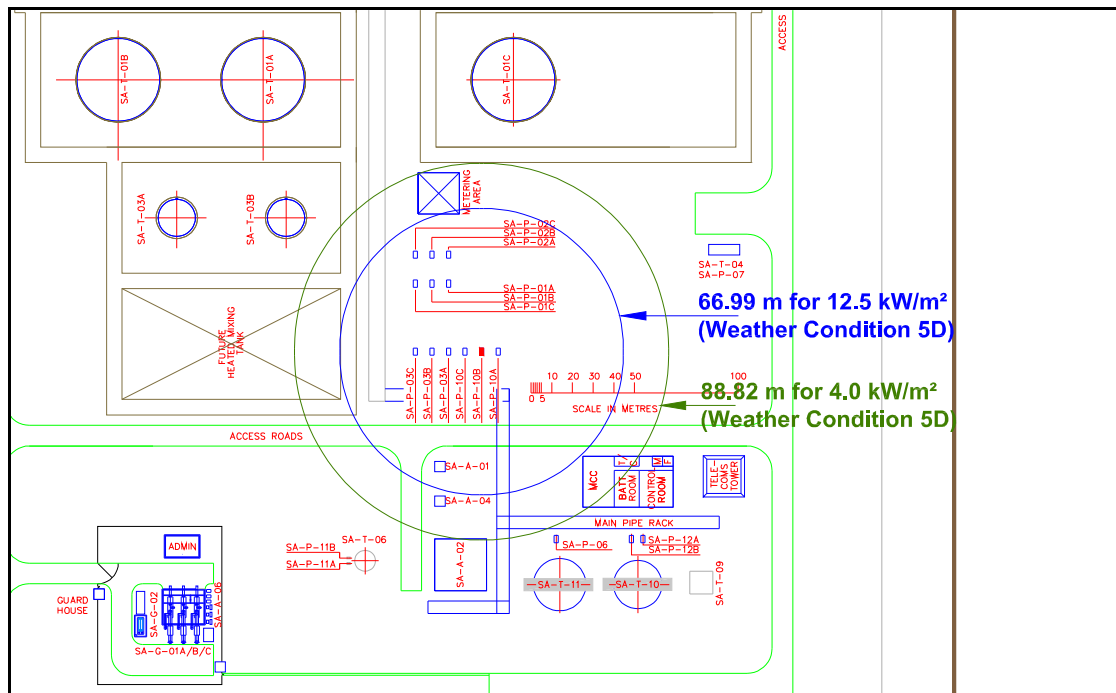


Fig. 7.13: Damage Contours for Pool Fire Scenario due to 10mm Leak in Export Crude to ESSAR Pump at Salaya Terminal

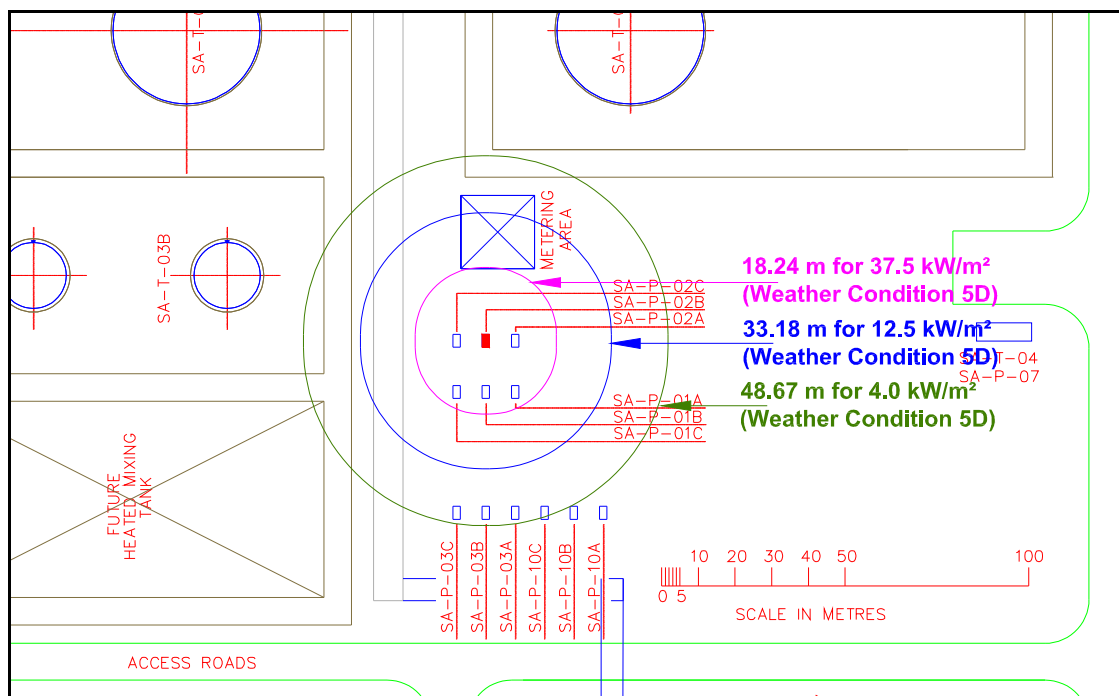


Fig. 7.14: Damage Contours for Pool Fire Scenario due to 10mm Leak in Condensate Pump at Salaya Terminal

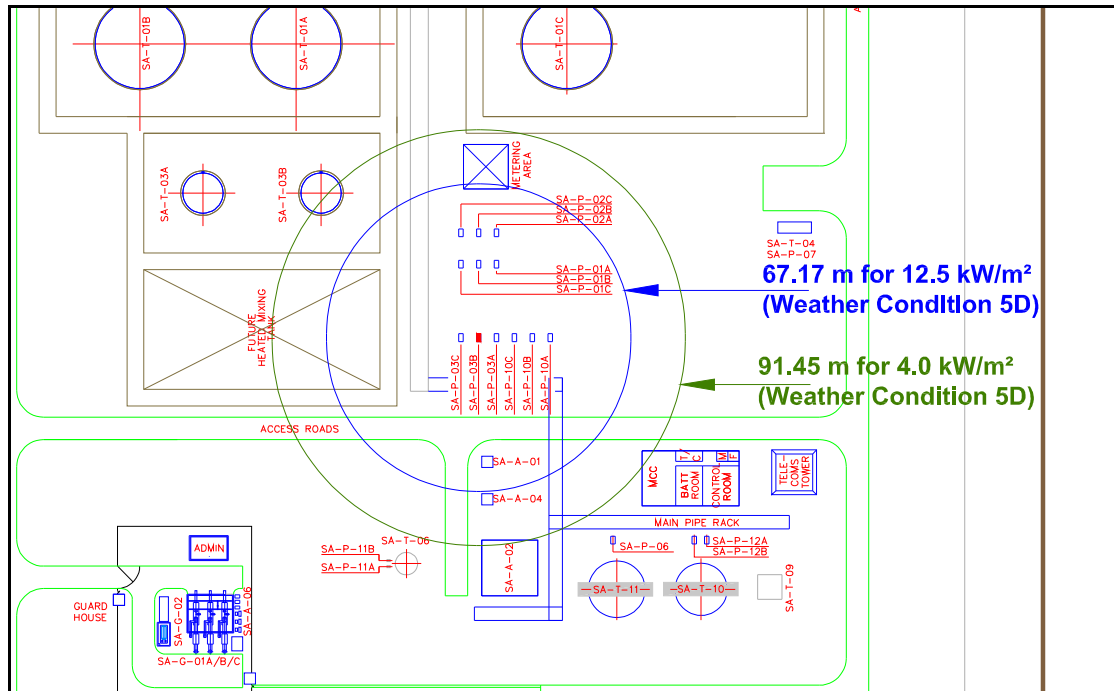


Fig. 7.15: Damage Contours for Pool Fire Scenario due to 10mm Leak in Export Blend Pump at Salaya Terminal

7.2.4.3 Flash Fire

A flash fire results from the ignition of a released flammable cloud in which there is essentially no increase in combustion rate. The ignition source could be electric spark, a hot surface, and friction between moving parts of a machine or an open fire.

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

The main dangers of flash fires are radiation and direct flame contact. The size of the flammable cloud determines the area of possible direct flame contact effects. Radiation effects on a target depend on several factors including its distance from the flames, flame height, flame emissive power, local atmospheric transitivity and cloud size.

The scenario of flash fire for natural gas pipeline was visualized by considering different leak sizes of ¼", 1" and 2" for LFL fraction of 44000 ppm under the weather stability conditions of 2F, 3D and 5D. The damage distances due to 2" leak were found to be 1.96 m, 2.00 m and 2.45 m under weather condition of 2F, 3D and 5D respectively. Similarly, the computed damage distances for ¼", 1" and line rupture are given in **Table 7.6**.

Table 7.6
Consequence Analysis for Flash Fire Scenario

Unit Name	Leak (inch)	LFL Conc. (ppm)	Weather	Damage Distances in (m) at LFL (conc.)
				For 600 sec
Leak in Natural Gas Pipeline Temperature = 36°C Pressure = 49 bar g	0.25"	44000	2F	0.19
			3D	0.22
			5D	0.31
	1"	44000	2F	0.84
			3D	0.88
			5D	1.21
	2"	44000	2F	1.96
			3D	2.00
			5D	2.45
	Line Rupture	44000	2F	5.71
			3D	6.28
			5D	6.56

7.3 Risk Evaluation

Risk is quantified in terms of probability of occurrence of hazardous event and magnitude of its consequences. The data regarding probability of occurrence of hazardous event due to failure of pipeline was collected from some international guidelines. The consequence modeling was carried out in order to assess the extent of damage by visualizing accidental release scenarios of natural gas. The credible scenarios considered are jet fire and pool fire due to leaks in the crude oil pipeline and jet fire and flash fire due to leak in the natural gas pipeline. The source strengths were computed using outflow models depending upon the physical state of the release.

The objective of this study is to identify the impact due to accidental release of crude oil and natural gas from pipelines.

Risk Assessment Methodology

The risk is quantified in terms of probability of occurrence of hazardous event and magnitude of its consequences. The international database is used to establish the probability of failure of pipelines for consequence analysis. **PHAST Professional V 6.51** is used to compute the damage distances and risk for accidental release scenarios of crude oil and natural gas pipelines. **Fig. 7.16** provides an overview of the risk assessment and risk management process.

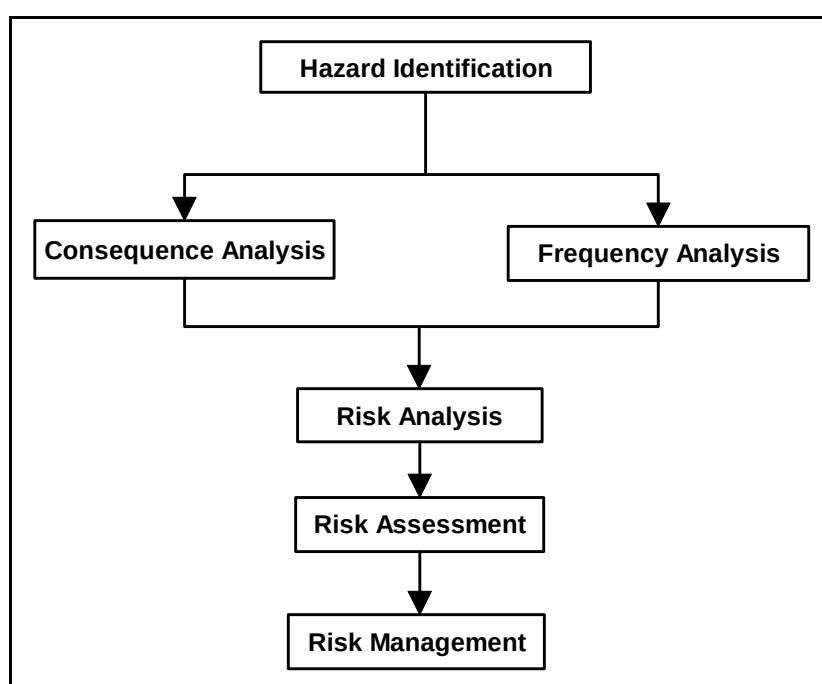


Fig. 7.16: Risk Assessment and Risk Management Process

Risk Assessment (RA) begins with Hazard Identification (HAZID). Hazard identification is necessary, as hazards that have not been identified cannot be assessed. There are many forms of hazard identification technique. Each has its particular benefits and drawbacks when applied to different risk assessment processes. For this study, hazard identification is required simply to identify those events, which have the potential to cause a significant impact on the safety of proposed development concept or on the environment. These hazards are then taken forward in the process for more detailed analysis of their potential safety and environmental risks.

Frequency Analysis and Consequence Analysis is the next main step in the risk assessment process. These activities can be undertaken in any order.

Frequency analysis involves the estimation of the likelihood of hazards occurring. This is typically done with reference to accident databases, reliability databases and leak frequency databases.

Consequence analysis involves the calculation of the various consequences of a hazard. This could include calculation of the potential mass of hydrocarbons that could leak from systems, the potential release rate in terms of release size and physical conditions.

Risk analysis involves the suitable combination of frequency and consequence analysis. Typically this is undertaken using event tree techniques for hydrocarbon events. The event trees enable consequences to be defined in terms of rule sets, which are then incorporated within event trees. Risk analysis provides numerical outputs of the various forms of risk, which are required.

Risk assessment is the process of comparing the results of the risk analysis with defined criteria. Depending on results and the criteria used, the assessment can indicate if the risks are broadly acceptable (low risks), intolerable (high risks) or somewhere in between these limits. The assessment should be used to provide guidance on managing risks achieved through the development of recommendations.

Risk management is an ongoing process of managing risks through implementation of risk reduction measures, monitoring and analyzing risk.

7.3.1 Frequency Analysis

As a common damage state of interest, fatality rates are a subset of pipeline failure rates. Very few failures result in a fatality. A rudimentary frequency based assessment will simply identify the number of fatalities or injuries per incident and use this ratio to predict future human effects. For example, even in a database with much missing detail as is typically the case in pipeline failure databases, one can extract an overall failure rate and the number of fatalities per length time (mile-year or km-year). From this, fatalities per failure ratio can be calculated. These values can then be scaled to the length and design life of the subject pipeline to obtain some very high level risk estimates on that pipeline. **Table 7.7** depicts the data of failure rates related to hole size and wall thickness.

Table 7.7
Failure Rates related to Hole Size and Wall Thickness

Sr. No.	Hole Size (mm)	Wall Thk. (mm)	Impact Factor	Corrosion Factor	External Force (Fraction)	Corrosion (Fraction)	Material Defect (Fraction)	Other (Fraction)	Failures
1	5	<6	1.3	2	-	-	-	-	2.08E-4
		6 -10	0.36	0.95	0.125	0.5	0.34	0.5	1.20E-4
		>10	0.04	0	-	-	-	-	6.05E-5
		<6	1.3	2	-	-	-	-	2.08E-4
2	25	6 -10	0.36	0.95	0.125	0.5	0.34	0.5	1.20E-4
		>10	0.04	0	-	-	-	-	6.05E-5
		<6	1.3	2	-	-	-	-	1.11e-4
3	70	6-10	0.36	0.95	0.285	0	0	0	3.08E-5
		>10	0.04	0	-	-	-	-	3.42E-6
		<6	1.3	2					1.11E-4
4	100	6 -10	0.36	0.95	0.285	0	0	0	3.08E-5
		>10	0.04	0	-	-	-	-	3.42E-6
		<6	1.3	2	-	-	-	-	7.02E-5
5	150	6 -10	0.36	0.95	0.18	0	0	0	1.94E-5
		>10	0.04	0	-	-	-	-	2.16E-6
Generic failure rates (overall = 5.50 E-4)					3.00E-4	1.0E-4	1.0E-4	5.0E-5	-

Note: Thk.- Thickness

7.3.2 Probability of Immediate Ignition and Individual Risk Assessment Criteria

For the frequency assessment, it is necessary to estimate the probability of ignition if a leak occurs. Ignition of a released material due to leak may occur either at the point of leak or at some distance from it. The cause of ignition may be the leak itself (e.g., a leak may generate static electricity) or an ignition source, which then gives a spark and ignites the leak.

The information available on probability of ignition is mostly in the form of expert estimates. **Table 7.8** and **7.9** depicts the immediate ignition probabilities used in this analysis.

Table 7.8
Ignition Probabilities – Continuous Release Auto Ignition Not Likely
(Final State Liquid)

Fluid	Probabilities of Outcome					
	Ignition	VCE	Fireball	Flash Fire	Jet Fire	Pool Fire
C ₁ -C ₂	-	-	-	-	-	-
C ₃ -C ₄	0.1	-	-	-	0.02	0.008
C ₅	0.1	-	-	-	0.02	0.08
C ₆ -C ₈	0.1	-	-	-	0.01	0.004
C ₉ -C ₁₂	0.05	-	-	-	0.01	0.004
C ₁₃ -C ₁₆	0.05	-	--	-	0.005	0.015
C ₁₇ -C ₂₅	0.02	-	-	-	0.005	0.015
C ₂₅ +0.02	-	-	-	-	-	-
H ₂	-	-	-	-	-	-
H ₂ S	-	-	-	-	-	-

Table 7.9
Ignition Probabilities – Continuous Release Auto Ignition Not Likely
(Final State Gas)

Fluid	Probabilities of Outcome					
	Ignition	VCE	Fireball	Flash Fire	Jet Fire	Pool Fire
C ₁ -C ₂	0.2	0.04	-	0.06	0.1	-
C ₃ -C ₄	0.1	0.03	-	0.02	0.05	-
C ₅	0.1	0.03	-	0.02	0.05	-
C ₆ -C ₈	0.1	0.03	-	0.02	0.05	-
C ₉ -C ₁₂	0.05	0.01	-	0.02	0.02	-
C ₁₃ -C ₁₆	-	-	-	-	-	-
C ₁₇ -C ₂₅	-	-	-	-	-	-
C ₂₅ +0.02	-	-	-	-	-	-
H ₂	0.9	0.4	-	0.4	0.1	-
H ₂ S	0.9	0.4	-	0.4	0.2	-

7.3.3 Risk Quantification

Risk is quantified in terms of probability of occurrence of fire i.e. fire frequency. The probability of occurrence of credible and worst case scenarios are used with recourse to standard databases as discussed in the previous sections of

the chapter. The consequence modeling was carried out to study the extent of damage for more likely credible scenarios such as small leaks and less likely worst-case scenario for pipelines. The damage caused due to release of flammable material from the pipeline depends on:

- ◆ Probability of failure
- ◆ Length, diameter and thickness of pipeline
- ◆ Probability that the ignition source is available

Risk results obtained by using the data from various international guidelines for various crude oil and natural gas pipelines are discussed in the report. The fire frequencies at 4 kW/m² lethality level were calculated and presented in the form of risk transects as discussed below.

Crude Oil Pipeline

Mangala – Viramgam Terminal Pipeline (24" Diameter and 340 km Length)

The leak in underground crude oil pipeline leads to jet fire and pool fire. Underground pipeline failure may cause jet fire as worst and credible scenario as discussed and presented in **Table 7.4**. Jet fire frequency per year-km is calculated by using various international data and presenting it in the form of event trees. **Fig. 7.17** shows the event tree for ¼" leak in 24" pipeline. The failure frequency for 24" diameter pipeline is 6.05×10^{-5} as given in **Table 7.7**. Then according to the event tree, its jet fire frequency due to ¼" leak will be 0.0121×10^{-5} /km-year (**Fig. 7.17**)

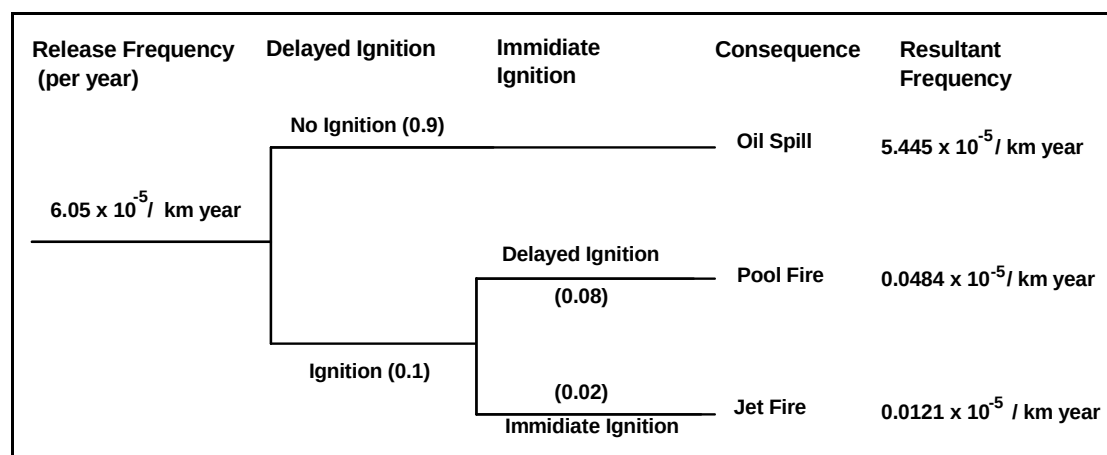


Fig. 7.17: Event Tree for Accidental Release of Crude Oil from Pipeline due to ¼" Leak

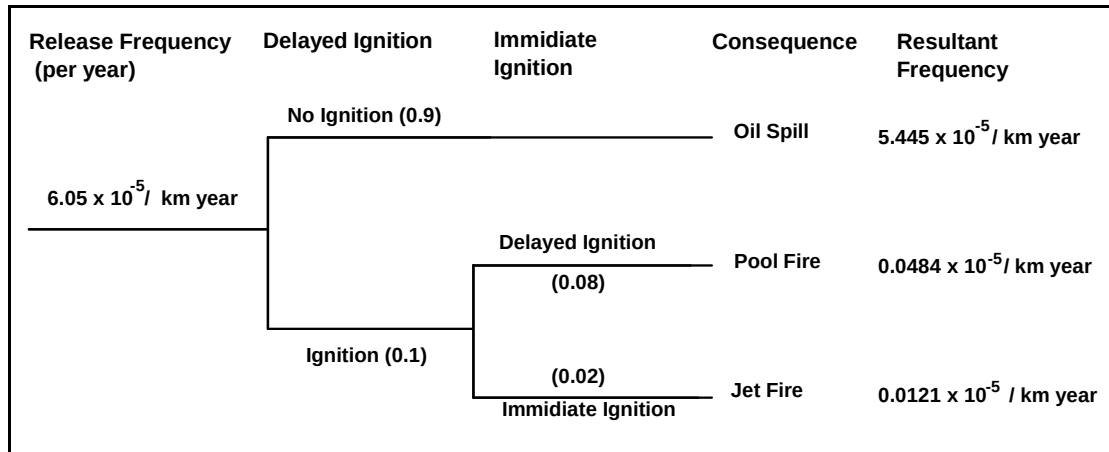


Fig. 7.18: Event Tree for Accidental Release of Crude Oil from Pipeline due to 1" Leak

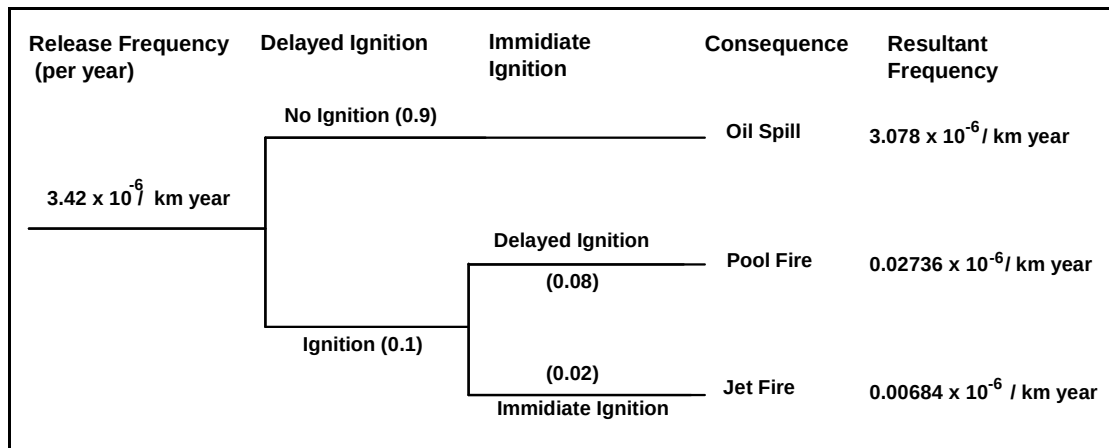


Fig. 7.19: Event Tree for Accidental Release of Crude Oil from Pipeline due to 2" Leak

Since the length of Mangala – Viramgam terminal pipeline is 340 km.

Fire frequency for length for 1/4" leak = 4.114×10^{-5} /year

Fire frequency for 1" leak = 4.114×10^{-5} /year (Fig. 7.18)

Fire frequency for 2" leak = 0.235×10^{-5} /year (Fig. 7.19)

The maximum damage distances due to vertical jet fire of oil due to 1/4", 1" and 2" pipeline for pressure 90 bar g are 20.86 m, 64.66 m and 112.16 m as presented in Table 7.4.

Therefore the fire frequencies at 20.86 m will be:

= Fire frequency for 1/4" leak + Fire frequency for 1" leak + Fire frequency for 2" leak

$$= 8.463\text{E-}05/\text{year}$$

Fire Frequencies at 64.66 m

$$= \text{Fire frequency for 1" leak} + \text{Fire frequency for 2" leak}$$

$$= 4.349 \text{ E-}5/\text{year}$$

Fire Frequencies at 112.16 m

$$= \text{Fire frequency for 2" leak}$$

$$= 0.235\text{E-}5/\text{year}$$

The fire frequency results for Mangala- Viramgam terminal pipeline are as summarized in **Table 7.10**.

Table 7.10

**Fire Frequencies at Various Distances for Various Failure Scenarios of
Mangala – Viramgam Terminal Pipeline**

Sr. No.	Scenario	Fire Frequency (Per year)	Distance (m) for 4 kW/m ²
1	¼" Leak	8.463E-5/year	20.86
2	1" Leak	4.349E-5/year	64.66
3	2" leak	0.235E-5/year	112.16

Risk transect is plotted for the values given in table above and presented in **Fig. 7.20**. It shows that fire frequency with respect to damage distance of 4 kW/m² is very low and though the pipeline is buried these values are ALARP as low as reasonably practicable.

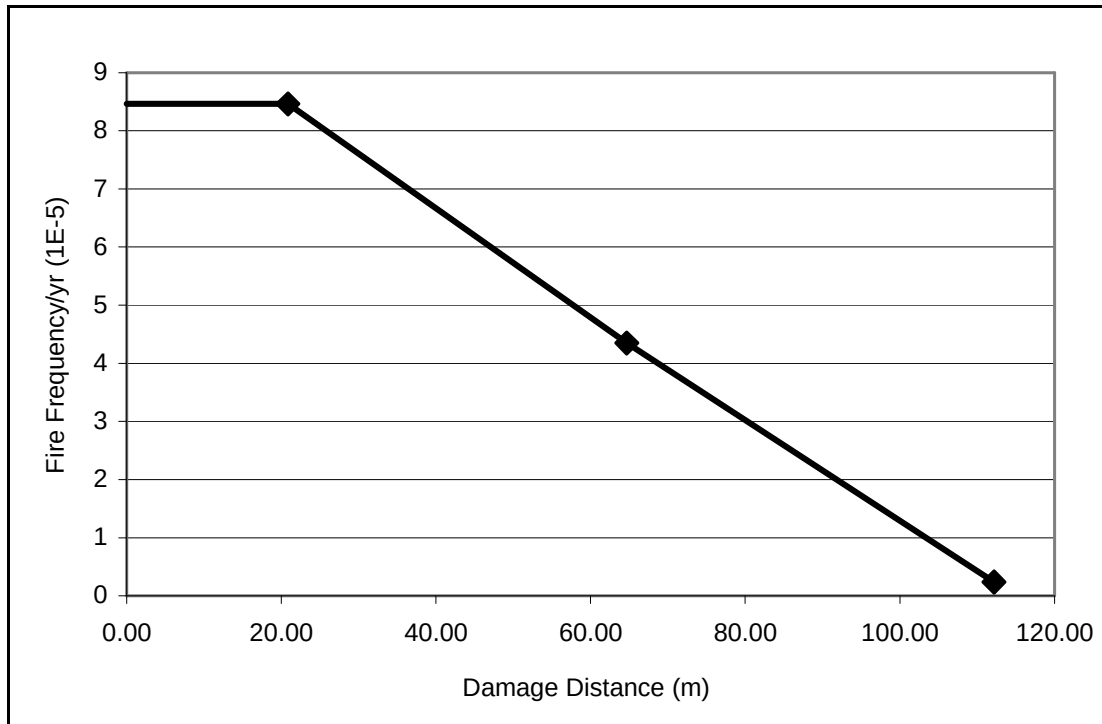


Fig. 7.20: Risk Transect Showing Jet Fire Risk at Various Distances along the Mangala – Viramgam Pipeline

Viramgam - Salaya Terminal Pipeline (24" Diameter and 260 km Length)

The leak in underground crude oil pipeline leads to jet fire and pool fire. Underground pipeline failure may cause Jet fire as worst and credible scenario as discussed and presented in **Table 7.4**. Jet fire frequency per year-km is calculated by using various international data and presenting it in the form of event trees. **Fig. 7.17** shows the event tree for ¼" leak in 24" pipeline. The failure frequency for 24" diameter pipeline is 6.05×10^{-5} as given in **Table 7.7**. Then according to the event tree, its Jet fire frequency due to ¼" leak will be 0.0121×10^{-5} /km-year (**Fig. 7.17**).

Since the length of Viramgam - Salaya terminal pipeline is 260 km.

Fire frequency for length for ¼" leak = 3.146×10^{-5} /year

Fire frequency for 1" leak = 3.146×10^{-5} /year (**Fig. 7.18**)

Fire frequency for 2" leak = 0.177×10^{-5} /year (**Fig. 7.19**)

The maximum damage distances due to vertical jet fire of oil due to ¼", 1" and 2" pipeline for pressure 90 bar g are 20.86 m, 64.66 m and 112.16 m as presented in **Table 7.4**.

Therefore the fire frequencies at 20.86 m will be

= Fire frequency for ¼" leak + Fire frequency for 1" leak + Fire frequency for 2" leak

= 6.469E-05/year

Fire frequencies at 64.66 m

= Fire frequency for 1" leak+ Fire frequency for 2" leak

= 3.323 E-5/year

Fire Frequencies at 112.16 m

= Fire frequency for 2" leak

= 0.177E-5/year

The fire frequency results for Viramgam - Salaya terminal are as summarized in **Table 7.11**.

Table 7.11

Fire Frequencies at Various Distances for Various Failure Scenarios of Viramgam - Salaya Terminal Pipeline

Sr. No.	Scenario	Fire Frequency (Per year)	Distance (m) for 4 kW/m ²
1	¼" Leak	6.469E-5/year	20.86
2	1" Leak	3.323E-5/year	64.66
3	2" leak	0.177E-5/year	112.16

Risk transect is plotted for the values given in table above and presented in **Fig. 7.21**. It shows that fire frequency with respect to damage distance of 4 kW/m² is very low and though the pipeline is buried these values are ALARP as low as reasonably practicable.

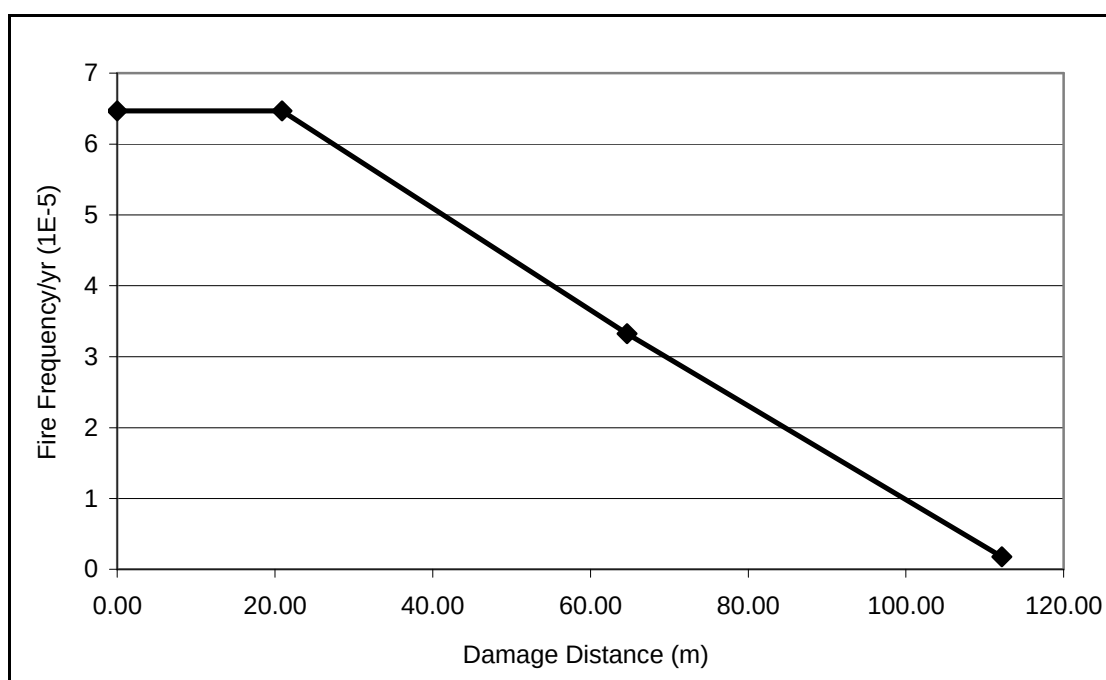


Fig. 7.21: Risk Transect Showing Jet Fire Risk at Various Distances along the Viramgam - Salaya Terminal Pipeline

Natural Gas Pipeline

Mangala – Viramgam Terminal Pipeline (8" Diameter and 340 km Length)

The leak in underground natural gas pipeline leads to jet fire and flash fire. Underground pipeline failure may cause Jet fire as worst and credible scenario as discussed and presented in **Table 7.4**. Jet fire frequency per year-km is calculated by using various international data and presenting it in the form of event trees. **Fig. 7.22** shows the event tree for ¼" leak in 10" pipeline. The failure frequency for 8" diameter pipeline is 1.20×10^{-4} as given in **Table 7.7**. Then according to the event tree, its Jet fire frequency due to ¼" leak will be 0.024×10^{-4} /km-year (**Fig. 7.22**).

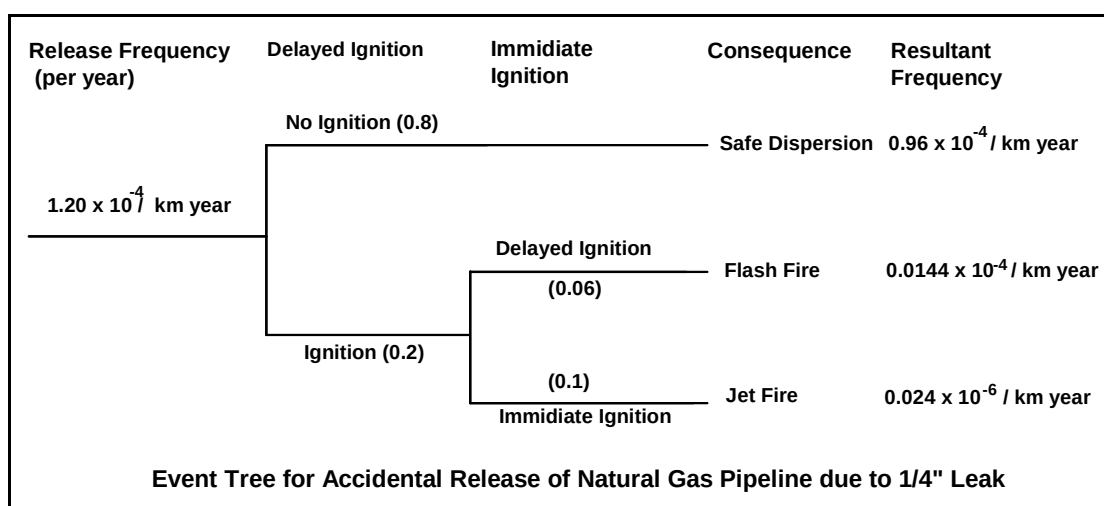


Fig. 7.22: Event Tree for Accidental Release of Natural Gas from Pipeline due to 1/4" Leak

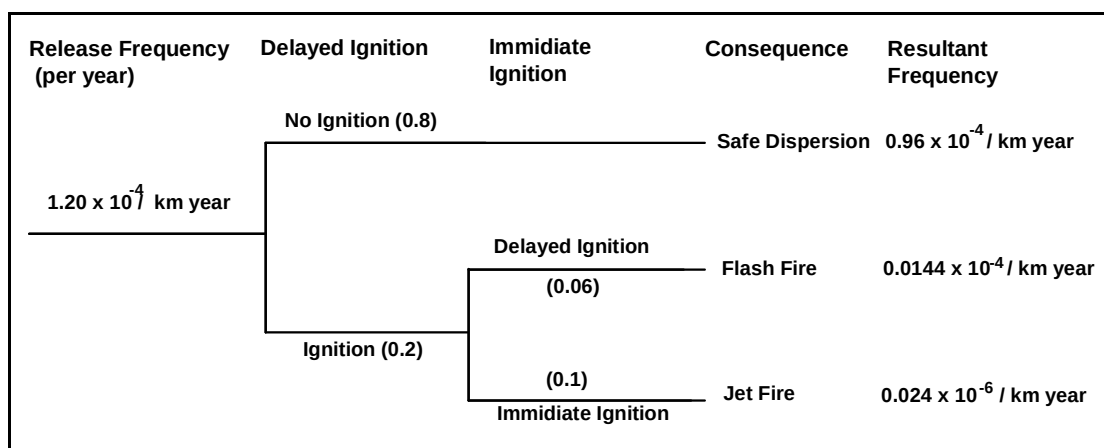


Fig. 7.23: Event Tree for Accidental Release of Natural Gas from Pipeline due to 1" Leak

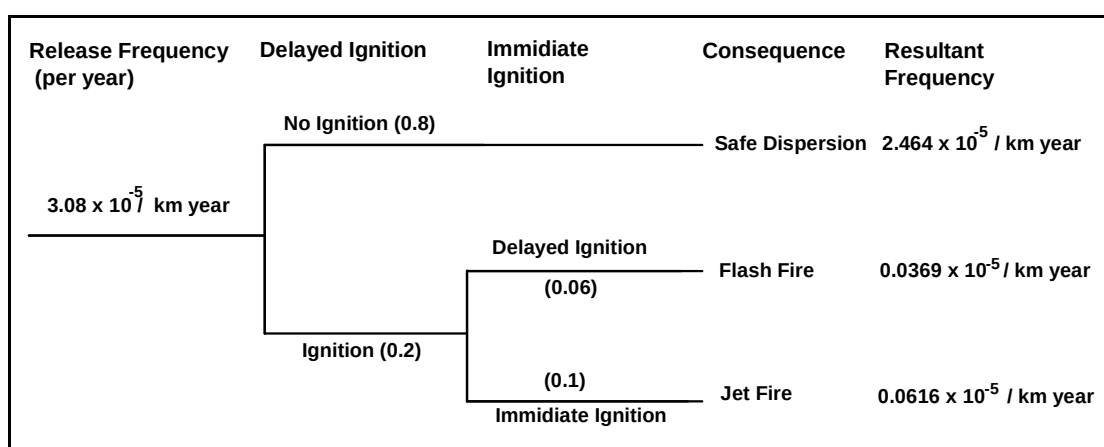


Fig. 7.24: Event Tree for Accidental Release of Natural Gas from Pipeline due to 2" Leak

Since the length of Mangala – Viramgam Terminal Pipeline is 340 km.

Fire frequency for length for ¼" leak = 8.16×10^{-4} /year.

Fire frequency for 1" leak = 8.16×10^{-4} /year (**Fig. 7.23**).

Fire frequency for 2" leak = 2.094×10^{-4} /year (**Fig. 7.24**).

The maximum damage distances due to vertical jet fire of oil due to ¼", 1", 2" pipeline for pressure 90 bar g are 5.29 m, 21.78 m and 42.37 m as presented in **Table 7.4**.

Therefore the fire frequencies at 5.29 m will be:

= Fire frequency for ¼" leak + Fire frequency for 1" leak + Fire frequency for 2" leak

= 18.41×10^{-4} /year

Fire Frequencies at 21.78 m

= Fire frequency for 1" leak + Fire frequency for 2" leak

= 10.25×10^{-4} /year

Fire Frequencies at 42.37 m

= Fire frequency for 2" leak

= 2.094×10^{-4} /year

The fire frequency results for Mangala – Viramgam Terminal are as summarized in **Table 7.12**.

Table 7.12

Fire Frequencies at Various Distances for Various Failure Scenarios of Mangala – Viramgam Terminal Pipeline

Sr. No.	Scenario	Fire Frequency (Per year)	Distance (m) for 4 kW/m ²
1	¼" Leak	18.41×10^{-4} /year	5.29
2	1" Leak	10.25×10^{-4} /year	21.78
3	2" leak	2.09×10^{-4} /year	42.37

Risk transect is plotted for the values given in table above and presented in **Fig. 7.25**. It shows that fire frequency with respect to damage distance of 4 kW/m² is very low and though the pipeline is buried these values are ALARP as low as reasonably practicable.

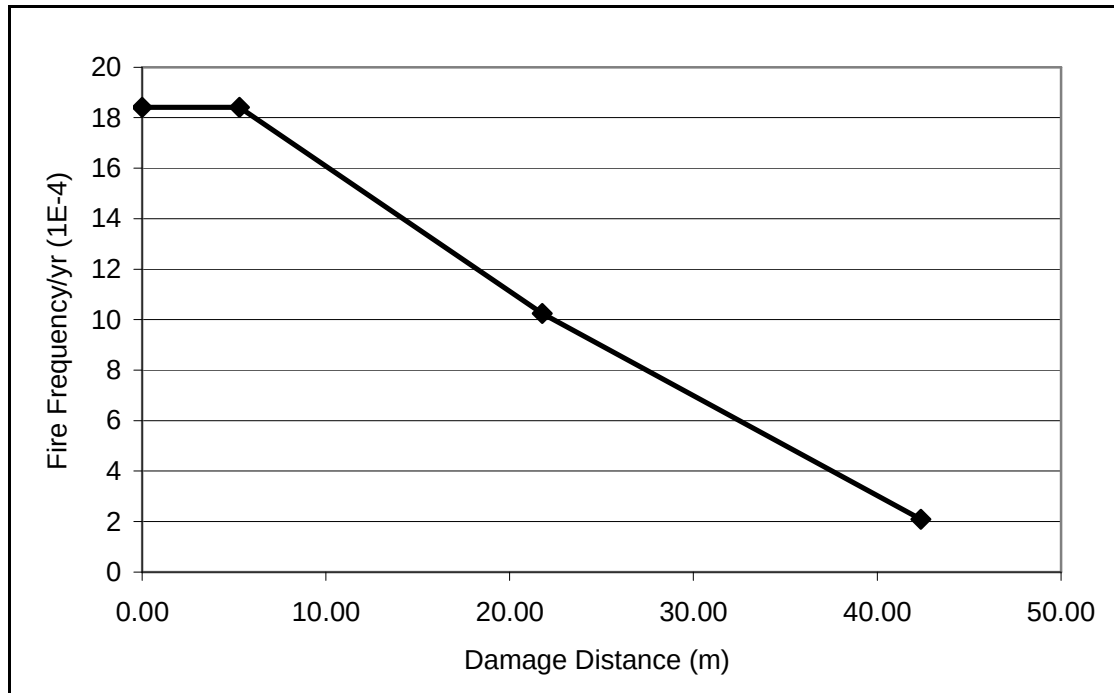


Fig. 7.25: Risk Transect Showing Jet Fire Risk at Various Distances along the Mangala – Viramgam Terminal Pipeline

Viramgam – Salaya Terminal Pipeline (8" Diameter and 260 km Length)

The leak in underground natural gas pipeline leads to jet fire and flash fire. Underground pipeline failure may cause Jet fire as worst and credible scenario as discussed and presented in **Table 7.4**. Jet fire frequency per year-km is calculated by using various international data and presenting it in the form of event trees. **Fig. 7.22** shows the event tree for ¼" leak in 10" pipeline. The failure frequency for 8" diameter pipeline is 1.20×10^{-4} as given in **Table 7.7**. Then according to the event tree, its Jet fire frequency due to ¼" leak will be 0.024×10^{-4} /km-year (**Fig. 7.22**).

Since the length of Viramgam – Salaya Terminal pipeline is 260 km.

Fire frequency for length for ¼" leak = 6.24×10^{-4} /year

Fire frequency for 1" leak = 6.24×10^{-4} /year (**Fig. 7.23**)

Fire frequency for 2" leak = 1.601×10^{-4} /year (**Fig. 7.24**)

The maximum damage distances due to vertical jet fire of oil due to ¼", 1", 2" pipeline for pressure 90 bar g are 5.29 m, 21.78 m and 42.37 m as presented in **Table 7.4**.

Therefore the fire frequencies at 5.29 m will be:

= Fire frequency for 1/4" leak+ Fire frequency for 1" leak+ Fire frequency for 2" leak.

= 14.08E-04/year

Fire Frequencies at 21.78 m

= Fire frequency for 1" leak+ Fire frequency for 2" leak

= 7.841E-4/year

Fire Frequencies at 42.37 m

= Fire frequency for 2" leak

= 1.601E-4/year

The fire frequency results for (Viramgam Terminal) – (Salaya Terminal) are as summarized in **Table 7.13**.

Table 7.13

Fire Frequencies at Various Distances for Various Failure Scenarios of Viramgam – Salaya Terminal Pipeline

Sr. No.	Scenario	Fire Frequency (Per year)	Distance (m) for 4 kW/m ²
1	¼" Leak	14.08E-4/year	5.29
2	1" Leak	7.84E-4/year	21.78
3	2" leak	1.60E-4/year	42.37

Risk transect is plotted for the values given in table above and presented in **Fig. 7.26**. It shows that fire frequency with respect to damage distance of 4 kW/m² is very low and though the pipeline is buried these values are ALARP as low as reasonably practicable.

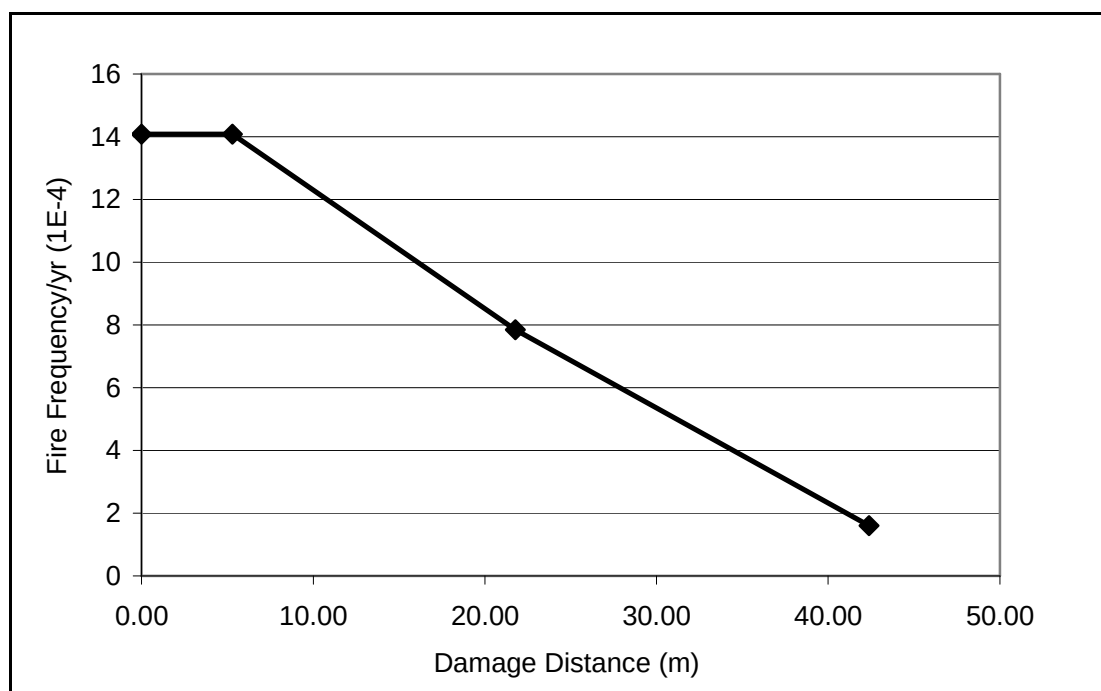


Fig. 7.26: Risk Transect Showing Jet Fire Risk at Various Distances along the Viramgam – Salaya Terminal Pipeline

7.4 Heat Modeling for Buried Heated Pipeline¹²

CEIL is proposing to establish heated pipeline with SEHT system for evacuation of crude oil from Barmer to Jamnagar. Though there will not be any heat transmission from heated pipeline to the surrounding soil as company is taking all preventive and control measures such as PUF insulation around the pipeline, underground burial of pipelines and continuous monitoring systems, the heat radiation due to failure of control measures in unforeseen situations may not be ruled out. In order to assess the heat loss and its impacts on the surrounding environment, a heat modeling exercise has been carried out.

Heat loss from buried pipeline can be determined by measuring the temperature profile on the ground surface above the pipe. The temperature measurements can be made by means of infrared (IR) thermography using equipment such as modern IR thermography cameras. TX model established in work performed in International Energy Agency (IEA) hypothesizes that the temperature distribution on the ground surface above the pipes corresponds to the heat loss from the pipes. TX factor is the integral of the surface temperature profile across the pipe. Semiempirical equation, based on TX factor, has been derived by considering

influences of the climate, especially of the wind and the changing surface temperature. This model is called the advanced TX-interpretation model ATXIM.

Heat loss from buried pipeline can be determined quantitatively by analyzing the TX profile. The TX profile is best measured using an IR thermography camera. Thermography can be applied at both night and day conditions. More refined analytical methods for heat loss determination from buried pipeline are available to trace leaking media pipes and to determine the condition of the insulation. In the quantitative heat loss analysis, it is presumed that the temperature profile on the ground surface above the pipes, measured in the direction perpendicular to the pipe alignment, is related to the pipe heat loss.

The basic idea is that TX is a function of the heat loss. TX is affected by parameters such as burial depth, thermal conductivity of ground and pipe insulation, ambient temperature, and the geometrical parameters of the pipes. By including all of these parameters in an interpretation model it is proposed that one may determine the amount of heat loss quantitatively and hence to draw conclusions about a potential damage to the protective casing or the pipe and to the surrounding soil.

The heat loss from buried pipes under steady-state conditions can be theoretically determined. The heat loss Q from a single buried pipe can be determined by the following equation⁴.

$$Q = \frac{2\pi \cdot \lambda_s \cdot \Delta T_s}{\ln(1 + 2\lambda_s / (\alpha \cdot h_f))} \quad [\text{W} / \text{m}] \quad \text{-----} (1)$$

Where,

ΔT_s = temperature difference between ground surface and pipe surface.

α = convective heat transfer coefficient between surface and air, $\text{W}/(\text{m}^2 \cdot ^\circ\text{C})$

h_f = buried depth of pipe, m

λ_s = heat conductivity of the surrounding ground (soil), $\text{W}/(\text{m} \cdot ^\circ\text{C})$

For small values of the logarithmic argument, equation (1) simplifies further to:

$$Q \approx (\pi \cdot \alpha \cdot h_f) \cdot \Delta T_s \quad \text{-----} (2)$$

The surprising result of Equation (2) is that in the first approximation there is no influence of the thermal conductivity of the soil on the heat loss and that the overall influence of the ground thermal conductivity on the temperature profile on the soil surface and hence on the TX factor might be small under steady state conditions. On the other hand, the convective heat transfer coefficient and therefore the wind conditions will play an important role for the determination of heat losses from surface conditions.

7.4.1 The TX Factor Principle

The TX factor method for quantifying the heat losses from district heating pipes is based on the temperature distribution at the ground surface above the pipes. A correlation between the temperature profile at the ground surface perpendicular to the pipes and the heat loss was described. The area below the profile is the so called TX factor and is related to the heat loss. Mathematically the TX factor is expressed as:

$$TX = \int_{-x_m}^{x_m} [T(x) - T(x)_{\min}] dx \quad \text{----- (7)}$$

Here,

x_m = Position at the ground surface across the pipes, m

$T(x)$ = Local temperature, °C

$T(x)_{\min}$ = The lowest temperature at the ground surface within x_m metres from the centre of the pipes, °C.

The measured TX factor is then used to calculate the heat loss by means of the interpretation model.

The interpretation model proposed gives

$$P_f = TX \cdot [A + B \cdot h_f + C \cdot \lambda + D \cdot (dT_m/dt) + E/x_m] + F \cdot h_f + G \cdot \lambda + H \cdot (dT_m/dt) + I/(x_m)^2 \quad \text{----- (8)}$$

Where,

P_f = Heat loss

x_m = The distance in each direction from the center of the pipes to the end of the temperature profile, m

dT_m/dt = change of mean distribution temperature during the last weeks, °C/24 hours

A to I = Constants

The constants A - I were determined by a series of simulations using a numerical model. The interpretation model was then determined from the results of these simulations using a first order multiple regression. In the present study the objective was to adjust the interpretation model such that it would more closely model the observed daily variations of TX. The result is the following proposed advanced interpretation model (ATXIM):

$$P_f = TX_{meas} \cdot [2.5 / (1.34 + 2.35 \cdot (0.8)^{<wind7>}) \cdot [-13.6 + 19.6 \cdot h_f + 4.3 \cdot \lambda + 12.8 \cdot (dT_m/dt) + 40.1/x_m] + 9.1 \cdot h_f - 6.3 \cdot \lambda + 18.8 \cdot (dT_m/dt) + 24.7/(x_m)^2] \quad (9)$$

The TX method requires very high precision in relative temperature measurements. The resolution of the infrared camera is less than 1/10 of a °C for relative temperature measurements, and that is important for this method. This means that the precision in the measurements (and thus the TX factor calculation) depends on the difference between the highest and lowest value in the temperature profile. This difference can be as low as about 0.5°C, but this method of using IR camera gives high accuracy of the measurements. Thus the IR camera method is most accurate where relatively high temperature differences exist such as for pipes with higher heat losses or for pipes buried at shallow depth. This TX model is applicable to pipes buried at depths between 0.5 and 2.0 m.

However, there are many parameters affecting the temperature distribution and hence TX which should be included in the ATXIM. Most of the theoretical work attempted to include these parameters and events in order to increase the understanding of the TX model. Rain conditions, snow, partial shadowing, and strong varying winds are disturbing influences for this model.

7.4.2 Simulation Program

The simulation program has been developed in order to get a detailed understanding of the heat transfer processes between the ground surface and the buried pipes. The program consists of the ground model and the surface model. The models are based on the finite difference method with different time intervals. **Fig. 7.27** shows the variation of the TX factor during the same day. The total

variation of TX is about $\pm 15\%$ during this period which is relatively low in spite of a strong change of irradiation during the day.

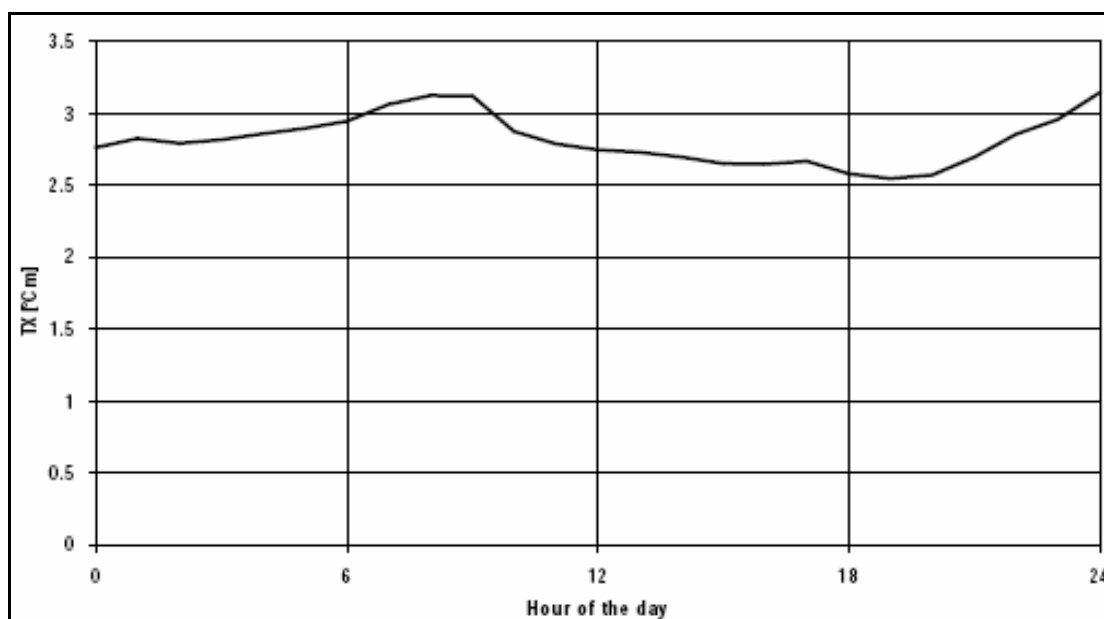


Fig. 7.27: TX Factor Variation for the Same Day

The simulation program based on hourly data was used for making long term simulations of the TX factor. The following climate data are read by the TX - simulation program:

- ◆ Global radiation on a horizontal surface
- ◆ Ambient temperature
- ◆ Wind velocity
- ◆ Infrared radiation
- ◆ Air humidity

The other major inputs that are required are the thermal properties of the soil. One disturbing factor in the simulations - as in reality - is the rain. This difficulty is due to the inaccurate determination of how much water remains on the surface during and after a rain period. The drying process could take several hours or even several days disturbing the resulting TX-factor. Because of the uncertainty in its analysis we circumvented the problem of rain by not including it in the analysis. Hence the results are valid for dry periods only.

The simulations are straightforward and can be performed on a PC. The heat loss from the pipes is decreased during the summer period and the TX factor also decreases during the summer period as expected.

7.4.3 Heat Loss during Different Seasons

The heat loss in buried pipes can be determined quantitatively by analyzing the TX profile under certain well controlled conditions. The TX profile is best measured using an IR thermography camera, of which there are a number commercially available. Thermography can be applied at both night and day conditions, but the surface of the test area must have been irradiated uniformly during the last hour, preferably longer. The TX factor can be used as a reliable measure for the heat loss in summer season.

During autumn and winter season, the TX factor has variations due to wet surfaces or freezing of the ground. During autumn season, the difficulty is regarding the determination of how much water remains on the surface during and after a rain period. The drying process could take several hours or even several days disturbing the resulting TX-factor. During winter season, fluctuations due to ground freezing are much shorter as compare to autumn season. Hence, the results for autumn and winter season will achieve with accuracy within $\pm 20\%$.

7.4.4 Effect of Soil Properties on Heat Loss

In Rajasthan state, the pipe will be buried in a well defined sand bed. The cover of the ground surface could be asphalt, concrete, sand, or grass. As long the individual layers are reasonably broad that is broader than the TX integration limits, the TX factor is not heavily affected or disturbed by different physical properties of each layer. Hence a sandbed around the pipes with a thermal conductivity differing from the surrounding soil does not severely impact the TX factor. This is shown in **Fig. 7.28** for a condition where the heat conductivity of the sand bed is one half that of the surrounding soil including the surface.

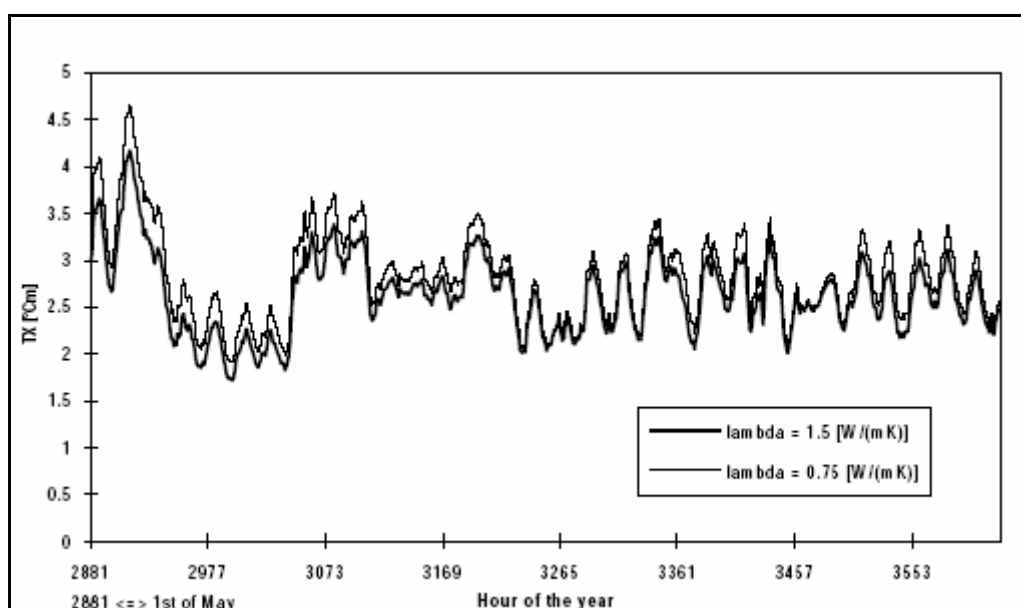


Fig. 7.28: Comparison of TX Simulation with different Heat Conductivity in the Sandbed

7.4.5 Influence of Different Physical Parameters on the TX Factor Surface Temperature

One of the parameters contributing to these fluctuations is the changing surface temperature. The surface temperature varies due to changes in the ambient temperature and the solar radiation. Its influence is relatively weak at stronger winds but relevant for winds below 1 m/s. This can be seen from **Fig. 7.29** showing the daily variation of TX and of the surface temperature for two otherwise identical hot summer days, one with and the other without wind.

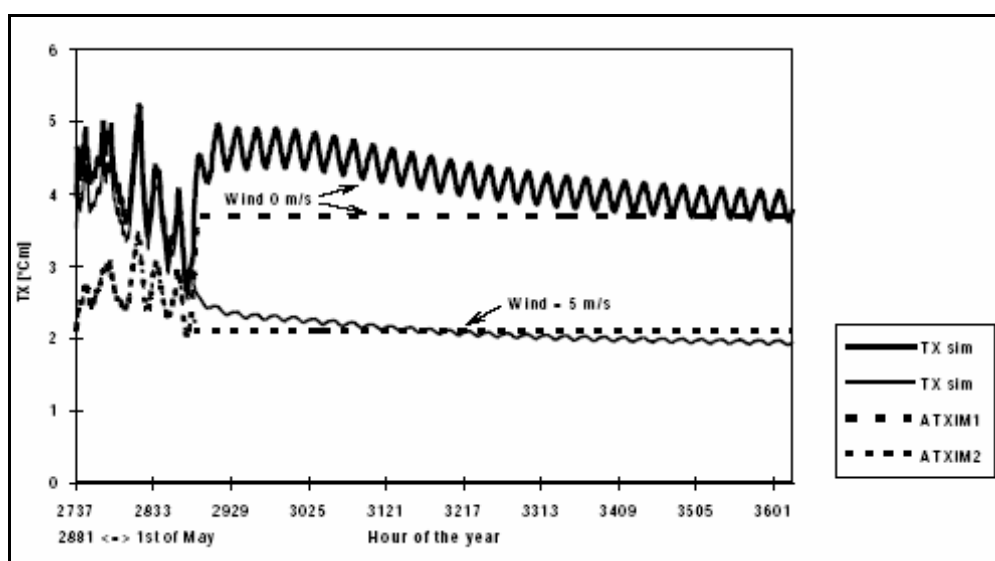


Fig. 7.29: Variation of the TX Factor and Surface Temperature for No Wind and Strong Wind Respectively for the Same Conditions of the Heat Loss of the Pipes

The Buried Depth of Pipes

It has been shown that the depth of the pipes in the ground is a very important parameter for the value of the TX factor and hence for the determination of the heat loss using this method⁴. The depth must be known accurately, and if this is not the case, it should be measured by some suitable commercially available instrument. The effect of buried depth on TX factor is shown in **Fig. 7.30**.

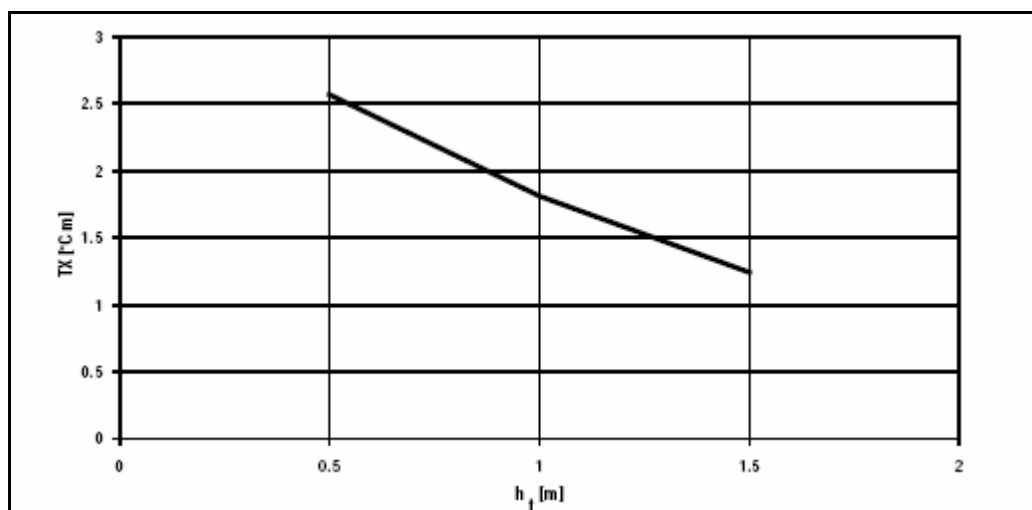


Fig. 7.30: TX 0 as a Function of the Buried Depth of Pipes h_f .

7.4.6 Variation of Soil Temperature with Ground Depth for Proposed Pipeline

Heat transmission from heated pipeline to surrounding soil will not take place due to its insulation covers and buried nature. However, heat transfer due to failure of control measures in unforeseen situations may not be ruled out. In order to evaluate the heat loss in such cases and to study its impacts on the surrounding environment, a heat modeling has been carried out for dry and wet seasons.

It has been observed that thermal conductivity of the soil above the pipe changes during different seasons. In order to assess the effect of thermal conductivity in different seasons on heat transmission, pipeline has been divided into following two sections

1. Mangala – Viramgam Pipeline
2. Viramgam – Salaya Pipeline

Following data of thermal conductivities from Ground Thermal Measurement Studies along the pipeline route for different seasons is used

Thermal Conductivity (λ_s) (W/m °c)			
Dry Season		Wet Season	
Mangala-Viramgam pipeline	Viramgam– Salaya pipeline	Mangala–Viramgam pipeline	Viramgam–Salaya pipeline
0.6	0.39	2.7	2.2

Following data and assumptions have been used in the heat loss calculations for two sections of pipelines

Heat Transfer coefficient (α)	11 W / m ² K
Pipe surface temperature	22°C
Heat Loss	150 W/m

Equation (1) has been used to compute soil temperature at various depth levels above pipe. Soil temperature and its variation with ground depth in graphical format for Mangla – Viramgam and Viramgam - Salaya pipeline sections for dry season are given in **Fig. 7.31** and **7.32** respectively. Similar results for wet season are given Fig. **7. 33** to **7. 34**.

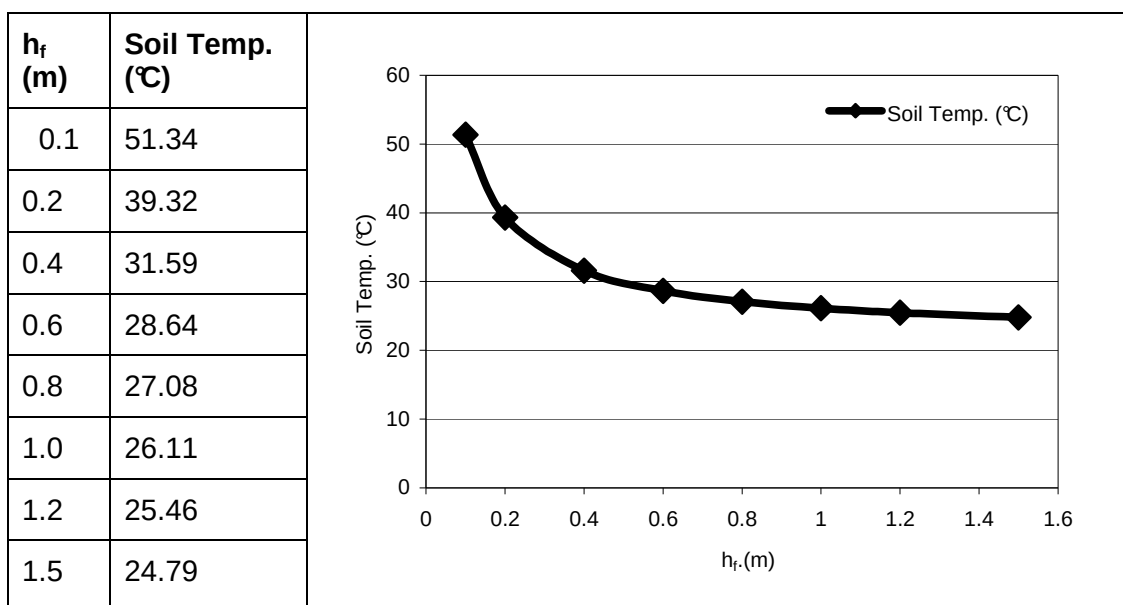


Fig. 7. 31: Dry Season - Variation of Soil Temperature with Ground Depth for Mangala – Viramgam Pipeline Section

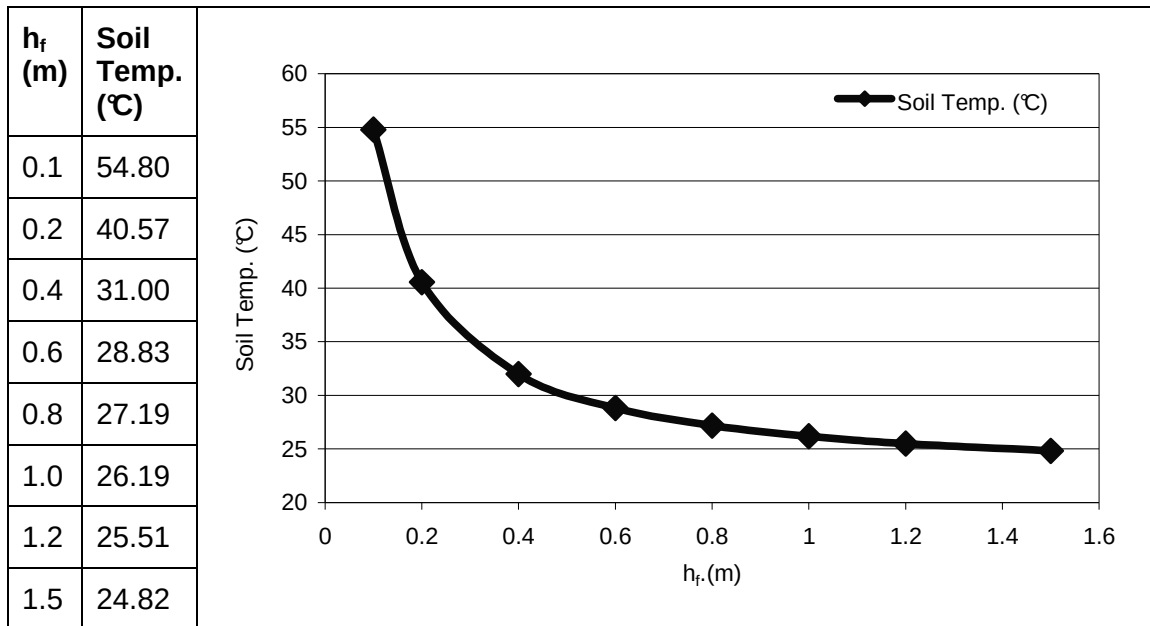


Fig. 7.32: Dry Season - Variation of Soil Temperature with Ground Depth for Viramgam – Salaya Pipeline Section

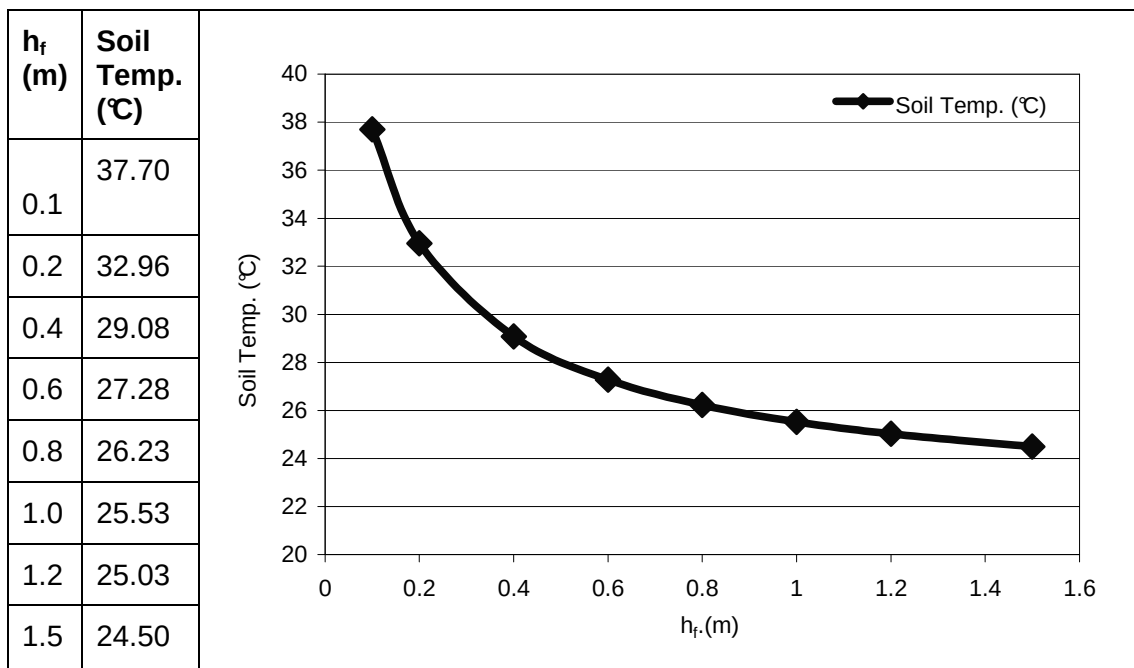


Fig. 7.33: Wet Season - Variation of Soil Temperature with Ground Depth for Mangala - Viramgam Pipeline Section

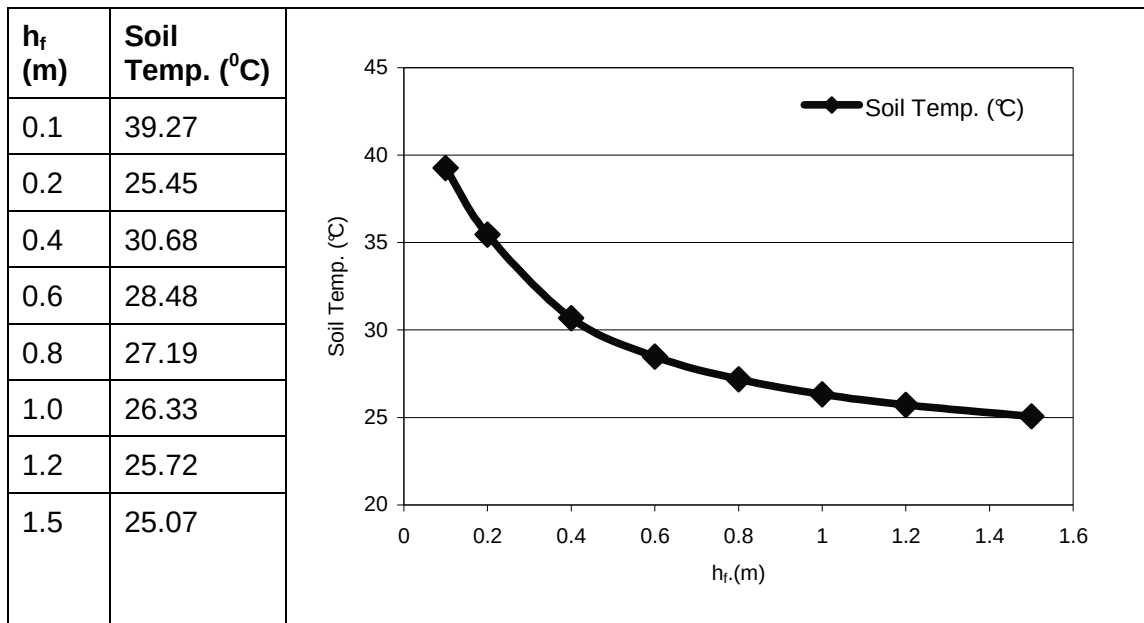


Fig. 7.34: Wet Season - Variation of Soil Temperature with Ground Depth for Viramgam – Salaya Pipeline Section

7.4.7 Conclusion of Heat Modeling

It has been observed from heat loss computations that incremental change in ground surface temperature is about 2-3 $^{\circ}\text{C}$ for buried pipeline depth of 1 to 1.5 m. It has also been seen that the variation of soil temperature from pipe surface to ground surface is in decreasing order and attains surface soil temperature. For a depth of 1 m or above, soil temperature doesn't show any significant change in its original value. As CEIL is taking all preventive measures to avoid heat loss from pipeline, even in case of worst case leak or failure of insulation system, the effect on the ground temperature will be insignificant.

7.5 Past Accident Data Analysis

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

Data analysis helps in correlating the causal factors and the corrective steps to be taken for controlling the accidents. It is, therefore, of vital importance to collect the data methodically, based on potential incidents, sections involved, causes

of failure and the preventive measures taken. This helps to face future eventualities with more preparedness.

Underground Oil Pipeline Leak, Aquasco, Maryland, April 7, 2000

On April 7, 2000, a 12-inch leak was detected in underground pipeline that supplies oil to the Potomac Electric Power Company (PEPCO) Chalk Point generating station. Approximately 140,000 gallons of fuel oil spilled into Swanson Creek, a small tributary of the Patuxent River. On the night of April 8, severe weather conditions caused oil to breach booms that had been deployed as per the U.S. Environmental Protection Agency Cleanup Order of May 1, 2000, spreading oil into the Patuxent River for approximately 17 linear miles downstream. About 40 miles of environmentally sensitive downstream creeks and shorelines were oiled as a result. The spill resulted in lost recreational use, damage to wetlands and beach shorelines, and injuries to birds and waterfowl, fish and shellfish, diamondback terrapins, and benthic communities.

Pipeline rupture near Cohasset, Minnesota, July 4, 2002,

A 34-inch-diameter steel pipeline owned and operated by Enbridge Pipelines, LLC ruptured in a marsh west of Cohasset, Minnesota at 2:12 a.m. on July 4, 2002. Approximately 6,000 barrels (252,000 gallons) of crude oil were released from the pipeline as a result of the rupture. The cost of the accident was reported the Research and Special Programs Administration Office of Pipeline Safety to be approximately \$5.6 million. No deaths or injuries resulted from the release. The National Transportation Safety Board determines that the probable cause of July 4, 2002, pipeline rupture near Cohasset, Minnesota, was inadequate loading of the for transportation that allowed a fatigue crack to initiate along the seam of the longitudinal weld during transit. After the pipe was installed, the fatigue crack grew with pressure cycle stresses until the crack reached a critical size and the pipe ruptured.

Based on this and few more previous studies, various risk mitigation measures are recommended as follows.

Oil Pipeline Explosion, Ilo-Ilo, Nigeria, May 12, 2006

Oil pipeline explosion occurred at Ilo-Ilo, a fishing village 25 miles east of Nigeria's main city of Lagos, killing 200 people on May 12, 2006. Nigeria is Africa's leading oil producer, the world's seventh-biggest exporter and fifth-biggest source of U.S. oil imports. But, most of the population lives in poverty. The pipelines often pass

through poor communities, who break them to steal the precious oil. The blast took place when villagers were scooping out fuel that was gushing out from a ruptured pipe. Nigeria has a history of pipeline disasters. At least 1000 people died in Jesse in a pipeline blast in October, 1998.

Gasoline Pipeline Explosion in Nigeria, December 26, 2006

A gasoline pipeline explosion occurred due to a leak in the northern suburbs of Lagos, Nigeria on December 26, 2006 causing deaths of hundreds of people. The explosion is believed to have been caused by vandalization in the pipeline. Reports say that thieves used a drill to punch a hole in the pipeline in order to steal gasoline, which is sold on the black market. Fuel was being pumped into the pipes to be distributed for consumer use when it exploded. The pipeline is operated by the Nigerian National Petroleum Corporation, which is owned by the State of Nigeria. Workers have stopped pumping fuel through the pipelines. Estimates suggest that 200-900 people were killed, and another 60 people received medical treatment.

7.6 Safety Management and Mitigation Measures

The awareness and first aid training programmes should be conducted to avoid the adverse impacts. The fire frequency involved due to effect of the possible crude oil and natural gas release are represented by risk transects in **Fig. 7.20** to **Fig. 7.21** and **Fig. 7.25** to **Fig. 7.26** respectively.

The rupture of the pipelines has a very low frequency. Hence, large leakage could be considered as a major loss scenario, which can result in jet fire or pool fire leading to thermal radiation effects in case of crude oil pipeline. The same can be jet fire and flash fire in case on natural gas pipeline. A Disaster Management Plan (DMP) should involve specific recommendations to the particular locations/section areas with local features incorporated in the plan.

7.6.1 Safety Management

The safety philosophy should ensure that the pipeline is built in accordance with the prudent construction practices as defined in ASME/ANSI 31.8/31.4, OISD standard 141 and 138 for design, construction, maintenance and inspection. For the storage terminals, the design and the fire fighting facilities should be according to OISD 118 - "layouts for oil and gas installations" and OISD 117- "Fire protection facilities for petroleum and Depots and terminals". Further, the Safety Management Systems will be based on the full-fledged risk assessment based on the

design systems. The operational and safety manuals should be developed based on the detail design and will be terrain specific taking all aspects of the type of soil, crossings, forests, vegetation, agricultural activities and proximity to the dwellings. A safety training Manual shall also be made for the training needs to effectively integrate the humans and equipments.

Instrumentation and monitoring should be done by state-of-the-art equipment that will provide real time data transmitted to a central control centre. This data received in the control centre will allow the pipeline operating pressures and flowing volumes to be monitored on a real time basis.

The pipeline and associated facilities should be periodically patrolled to ensure that there is no encroachment on the pipeline right of use. In addition to this method, during day to day operational and maintenance activities, employees should be aware of all activities occurring on and around the pipeline and storage facilities and report such activities to the appropriate parties.

7.6.2 Mitigation Measures

7.6.2.1 Pipeline Hazards

Pipeline External Corrosion Protection and Monitoring

Pipeline should be epoxy coated line with 4" PUF insulation and HDPE top sheath. Periodic intelligent pigging survey and pipe-to-soil potential surveys shall be conducted for pipeline health monitoring in accordance with the requirement of codes and best industry practices. Following are some common design criteria used in insulation system design for piping application

- ◆ Controlling heat loss on hot piping by PUF insulation system
- ◆ Providing personnel protection
- ◆ Limiting or retarding surface condensation
- ◆ Providing process control
- ◆ Economic optimization or energy conservation
- ◆ Providing fire protection
- ◆ Providing freeze protection
- ◆ Providing noise control

Sectionalizing Block Valves

Main line block valves should be provided as per the requirements of ANSI/ASME B 31.8/B 31.4 and OISD 141 based on population density and land use along the pipeline route. Provision should be made for safe blow down of gas contained in each section of the pipeline into the atmosphere.

Valve maintenance should be performed every six months to ensure effective operability.

Pigging Facilities

For maintenance of the pipeline, pig launching and pig-receiving facilities should be provided at the beginning and end. The launchers and receivers should be suitable for intelligent pigging.

Pigging is partly an experience-driven technique. From a wide selection of pig types, the knowledge operator must choose an appropriate model, design the pigging protocol including pig speed, distance and driving force and assess the progress during the operation. The evaluator should be satisfied that the pigging operation is indeed beneficial and effective in removing corrosive products from the line in a timely fashion.

Pipeline Testing

All welds should be radiographed and hydrostatic testing of the pipeline should be performed at a pressure up to 1.4 times the design pressure of the pipeline system based on the design code requirements. The test pressure should be held for a minimum period of 24 hours. This will ensure complete structural integrity of the pipeline.

Leak Detection System

State-of-the-art Supervisory Control and Data Acquisition (SCADA) system supported by leak detection software module, precision instrument and dedicated communication system should be installed to monitor the integrity of the pipeline. The shut down system of the pipeline will act to close the sectionalizing valves based on leak detection system and will alert the pipeline operator about the potential leaks along the pipeline route. Typically, the time required to detect / confirm a leak, raising alarm and taking action to isolate the leaking section is around 100-150 seconds. The entire pipeline system should be monitored continuously from a control station having a SCADA system. The remote control and monitoring is typically done from a centralized system on a 24/7 basis. The systems are typically computer based and

most have a back-up computer and other redundant features. The centralized SCADA system typically communicates with the field and remote devices through a dedicated communication network such as land telephone lines, satellite system, microwave towers, or directional radio frequencies with most systems having reluctant communication frequencies.

The measures that should be employed to protect security of SCADA systems include:

- ◆ Maintain integrity of communication parts through out the system
- ◆ Verification of transmitted signals on regular basis
- ◆ Inspection of status of field devices through fixed time schedule
- ◆ Regular feedback of control signals to check its reliability
- ◆ Database protection from viruses to avoid system failure
- ◆ Accessing control to the control center by defined procedure

Other Safety Aspects

- ◆ The pipeline will be physically patrolled by walk-through and aerial survey to ensure there is no encroachment on the pipeline right of way. Moreover, during day to day operational and maintenance activities, company employees should be aware of all activities occurring around the pipeline and report such activities to the appropriate authorities
- ◆ Pipeline appurtenances like valves and meters should be painted to prevent atmospheric corrosion
- ◆ Pipeline marker signs should be placed where the pipeline crosses rivers, highways and major crossings. Line of sight of markers should be maintained
- ◆ Nearby population along the pipeline route should be made aware of the safety precautions, to be taken in the event of any mishap due to pipeline.

7.6.2.2 Storage Tanks and Pumps at Terminals

General Recommendations

- ◆ Fire is one of the major hazards, which can result from leak or rupture of storage tanks. Fire prevention and relevant code enforcement is one of the major areas of responsibility for the fire service. Hence the facility should be equipped with:

- Smoke and fire detection alarm system
 - Detection system for toxic release of chlorine
 - Water supply
 - Fire hydrant and nozzle installation
 - Foam system
 - Water fog and sprinkler system
 - Mobile Fire fighting equipment
 - First aid appliances
- ◆ Periodic maintenance of all protective and safety equipment
 - ◆ Periodical training / awareness should be given to work force at the project as refresh courses handle many new emergency situation
 - ◆ Periodic mock drills should be conducted so as to check the alertness and efficiency of the DMP and corresponding records should be maintained
 - ◆ Signboard including emergency phone numbers and no smoking signs should be installed at various locations
 - ◆ Plant shall have adequate communication system
 - ◆ All major units / equipments shall be provided with smoke / fire detection and alarm system

Fire Protection System

The typical fire fighting system for the various facilities described under this project is outlined in this section. The exact details of the fire fighting systems and capabilities to be installed and developed will be finalised after the completion of detailed engineering in consultation with the concerned process and equipment vendors and fire. It is also to be understood that not all facilities described below will be applicable for every installation. The outline of the fire system proposed is described below.

Fire protection system shall be deigned in accordance with the requirements of OISD, Tariff Advisory Committee (TAC) of India, NFPA standards, design requirements and safe engineering practices and will have full capability for early detection and suppression of fire. The system will primarily consist of:

- ◆ Hydrant system
- ◆ Foam protection system
- ◆ Deluge sprinkler system
- ◆ Portable fire extinguisher
- ◆ Fire detection and alarm system

Hydrant System: The system will essentially consists of firewater storage, pumping, system pressurisation and all inter connected pipe work and auxiliary fire fighting appliances. The water storage and pumping capacity and other features of this system will be finalised considering TAC recommendations.

Adequate number of engine driven / electric motor driven fire water pumps will be provided. The pumps will be started automatically in the event of drop in header pressure. The actuation will be through pressure switches, the setting of which will be staggered to achieve sequential starting of the pumps to meet the system demand. When power supply is available, the electric motor driven pump will start first and in case of further pressure drop the engine driven pump will start. However when electric power is not available, the engine driven pump will cut-in depending on the system demand. The pumping capacity would meet the simultaneous water demand for foam protection of one oil tank, and supplementary foam hose stream in the oil dyke area, which is the maximum water demand in a single occurrence of fire. The pumping capacity should also meet the guidelines of TAC for this size of plant, considering ordinary hazard occupancy.

The fire water system will be kept pressurised by the hydro-pneumatic tank, which will take care of small leakages from the fire water system. A jockey pump, sized as per the TAC guidelines will, automatically replenish the water level in the hydro-pneumatic tank at periodic intervals. Air required for pressurising the hydro-pneumatic tank will be supplied by an electric motor driven compressor.

The outdoor hydrant system will be provided all over the plant for exterior protection. The hydrant mains will be laid underground. Hose houses, complete with all accessories, will be provided at suitable intervals. The overall plant will be divided in several fire zones, where the fire fighting action can be pursued effectively. The pressurised main will also be connected to Sprinkler/ emulsifier System for protection of transformers and Fuel Oil storage tanks.

Foam protection system: Fuel oil storage tanks and the surrounding dyke areas will be protected with low expansion foam system, using fluoro-protein. The storage tanks will be provided with sub-surface foam injection system and the dyke area will be provided with supplementary foam hose stream for combating spill fires. The foam protection system will be designed as per the requirements of NFPA, OISD and TAC. A central foam preparation unit consisting of at least foam storage tank, proportionating devices etc. shall be provided, to supply foam solution to the foam protection system. Pressurised water for foam system will be tapped from the outdoor main hydrant.

Sprinkler system: Automatic deluge sprinkler system will be provided for the protection of power transformer. An array of spray nozzles will be provided all around the protected area. The nozzles will be connected to the automatic deluge valve. A set of heat or smoke detectors, located in the area will sense the fire. Deluge valve will automatically open once two independent detectors sense fire.

Manually initiated water spray system will be provided for exposure protection of oil storage tanks, so that when one tank is on fire, the other tank can be cooled to guard against exposure heating. Pressurized water supply to all sprinkler systems will be tapped from the outdoor hydrant main.

Portable Fire Extinguishers: Besides, fire hydrant arrangement, portable fire extinguishers of suitable categories will be placed at control rooms, electrical switchgear room and various utility buildings for immediate use in the event of fire. Three different kinds of extinguishers i.e. foam, CO₂ and multipurpose dry chemical (MPDC) will be provided. Each type of extinguisher has its own characteristic to fight a particular class of fire. The size and type of extinguishers will be decided as per recommendations of NFPA and relevant Indian Standard and will be placed in convenient accessible locations.

Storage Tanks

- ◆ Protective systems with high reliability and availability should be designed to ensure that its physical conditions are maintained
- ◆ Impurities should be controlled to obviate abnormal corrosion
- ◆ Dyke should be provided for all storage tanks

- ◆ These measures should be backed up by relief systems such that the combination of vessel design, protection, quality control and relief eliminates the possibility of complete vessel failure
- ◆ Wind socks should be installed at suitable height and with proper visibilities to check the wind direction at the time of accident
- ◆ Co-ordination with local authorities such as fire, police, ambulance, district administration and nearby industries should be ensured to manage / control meet any eventuality
- ◆ Necked flame, welding, etc shall not be permitted in storage area
- ◆ To prevent the hazard of static electricity, the fill and recirculation lines to the storage tanks shall discharged below the liquid level.

Control Rooms

- ◆ Control room shall be located at a distance at sufficient distance from operating areas
- ◆ The building shall be located upwind of the process storage and handling facilities.
- ◆ All control room should be blast proof and shock proof
- ◆ Critical switches and alarm should be always kept in line
- ◆ Minimum number of doors shall be provided in the control room while at the same time the number of doors shall be adequate for safe exit
- ◆ Smoke detection system shall be provided for control rooms at appropriate locations
- ◆ Halon / Its proven Equivalent fire extinguisher shall be used for control rooms and computer rooms
- ◆ To resist fire spread through ducts, dampers shall be installed in ducts

Pumps

- ◆ To prevent accidental spills at pump stations leak containment is provided; valves and pump stations will be kept to a minimum in most sensitive pipeline segments
- ◆ Pump stations will be electronically equipped to detect leaks and leak containment will be provided

- ◆ Pump stations will be enclosed in buildings to minimize noise

7.6.2.3 Electricity Hazard

- ◆ All electrical equipments shall be provided with proper earthing. Earthed electrode shall periodically tested and maintained
- ◆ Emergency lighting shall be available at all critical locations including the operator's room to carry out safe shut down of the plant, ready identification of fire fighting facilities such as fire water pumps and fire alarm stations.
- ◆ All electrical equipments shall be free from carbon dust, oil deposits, and grease.
- ◆ Cable routing shall be planned away from heat sources, gas, water, oil, drain piping and air conditioning ducts.
- ◆ Use of approved insulated tools, rubber mats, shockproof gloves and boots, tester, fuse tongs, discharge rod, safety belt, hand lamp, wooden or insulated ladder and not wearing metal ring and chain.
- ◆ Flame and shock detectors and central fire annunciation system for fire safety should be provided.
- ◆ Temperature sensitive alarm and protective relays to make alert and disconnect equipment before overheating
- ◆ Prevent higher humidity and temperature near electric insulations.
- ◆ Danger from excess current due to overload or short circuit should be prevented by providing fuses, circuit breakers, thermal protection
- ◆ Use only carbon dioxide, halon or dry chemical fire extinguishers for electrical fires
- ◆ All tanks, vessels and pipelines containing flammable liquid or gases should be separately earthed. Jumpering of pipelines at flange joints necessary
- ◆ While pumping flammable liquids in tanks, the inlet pipe should discharge at the bottom of the tank. At this time it is advisable to maintain an inert gas blanketing. Flow velocity should be restricted
- ◆ Liquid spillages and dust deposits should be removed as early as possible

7.6.2.4 Generators

Cooling System

- ◆ Radiator fins must be inspected on a monthly basis and cleared of all dirt and debris. The generator must be off prior to inspecting by shining a light through the front of the radiator. If the light doesn't shine through the fins, the blockage clearing should be done carefully.
- ◆ Antifreeze levels should be checked on a weekly basis.
- ◆ Block heaters should be plugged in year-round, as they reduce wear on the generator's engine.
- ◆ Inspect hoses and the water pump for signs of wear, bulges, cracking, and leaks. Check the hose clamps for tightness.

Battery and Charging Systems

- ◆ The charging gauge (or indicator light) should read OK on the battery charger.
- ◆ The battery and charger connections should be tight and cleaning any corrosion off the terminals should be done regularly. The battery charger must be turned off before working on the battery or the starter.

Engine

- ◆ Inspect the engine for leaks and wear.
- ◆ Check engine belts for wear, cracking, splitting, or looseness.
- ◆ Check oil level regularly. The engine oil and oil filter should be changed annually, or every 100 to 250 hours, depending on the environment in which the unit is located.
- ◆ Check the air filter every 100 hours of operation, more frequently in dustier environments, and change the filter at least once per year. The filter canister should not contain dirt or other debris.

Power Generating Units

- ◆ Hydrocarbon detectors are recommended in power plant
- ◆ Surrounding population (including all strata of society) should be made aware of the safety precautions, to be taken in the event of any mishap in the plant
- ◆ Critical switches and alarms should always remain online
- ◆ The equipments should be hydraulically tested to a pressure of at least 1.5 times the design pressure before putting into operation

- ◆ The pipeline / equipments / storage loading unloading lines should be monitored continuously for identifying leakages and have control systems which should be capable of closing down transmission of oil and gas automatically, if ever required
- ◆ Every storage tank, including its roof and all metal connections, should be electrically continuous and be effectively earthed as per OISD Std. 108
- ◆ Hydrocarbon detectors may be installed in the tank farms with remote alarms in control stations as per OISD Std. 108
- ◆ Fire water requirements should be decided as per guidelines given in OISD Std. 116
- ◆ Fire proofing materials and systems should be applied as per OISD Std. 164

7.6.2.5 Degradation of Crude Oil in Contaminated Soil

Sea oil contamination poses a threat on marine life and the death of hundreds of marine organisms. Soil contamination on the other hand is slow and lethal. It acts over a long period of time by poisoning food crops and water supplies.

Oil contamination in soil results in an imbalance in the carbon-nitrogen ratio at the spill site, because crude oil is essentially a mixture of carbon and hydrogen. This causes a nitrogen deficiency in oil soaked soil, which retards the growth of bacteria and the utilization of carbon sources. Furthermore, large concentrations of biodegradable organics in the top layer deplete oxygen reserves in the soil and slow down the rates of oxygen diffusion into deeper layers.

Soil contamination can be cured by several ways. Many methods have been used for the degradation of crude oil. Some of these methods include Land farming, surface heating, bio-remediation, disposal in landfills etc.

Oil Spill Response Plan

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

- ◆ Nature of the substrate,
- ◆ Slope of the terrain,

- ◆ Amount of product, and
- ◆ Time available to implement the response action.

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

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

- ◆ On-site Spills
- ◆ Off-site Spills

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

Response Strategies – On-Site Spills

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

Dikes, Berms or Retaining Walls

Dikes, berms, and retaining walls are normally used in areas with the potential for large spills, such as single or multiple above ground storage and processing tanks. To evaluate the adequacy of a spill containment dike, the following criteria has to be reviewed: capacity, material of construction and compatibility with tank contents, integrity, and strength.

The slopes of earth dikes should not be steeper than 1 foot vertical to 1½ feet horizontal. On average, dikes are not to exceed an interior height of six feet.

A reinforced concrete retaining wall is used when space is not available for a dike. Retaining walls are usually constructed of either reinforced concrete blocks or reinforced poured concrete.

Curbing

Curbs are a very effective means of secondary containment around drum storage areas, product dispensing areas, bulk loading and unloading areas, and

pump equipment areas. Curbing can be used where only small spills are expected. Curbing can also be used to direct spills to drains or catchment systems.

Culverting, Gutters or Other Drainage Systems

Secondary containment, such as dikes, is not always feasible; drainage trenches, culverts, sewers, swales, or gutters that direct a spill to a retention pond or catchment basin are acceptable alternatives. Drainage from undiked areas should, if possible, flow into retention areas designed to retain spills or return the material to activity property.

Sorbents and Drip Pans

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

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

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

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

Spill Diversion Ponds or Retention Ponds

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

Response Strategies – Off-Site Spills

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

Strategies

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

Points to Remember

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

Methods

A decision guide for choosing containment methods is provided in **Fig. 7.35**. The terrestrial containment techniques are summarized below

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

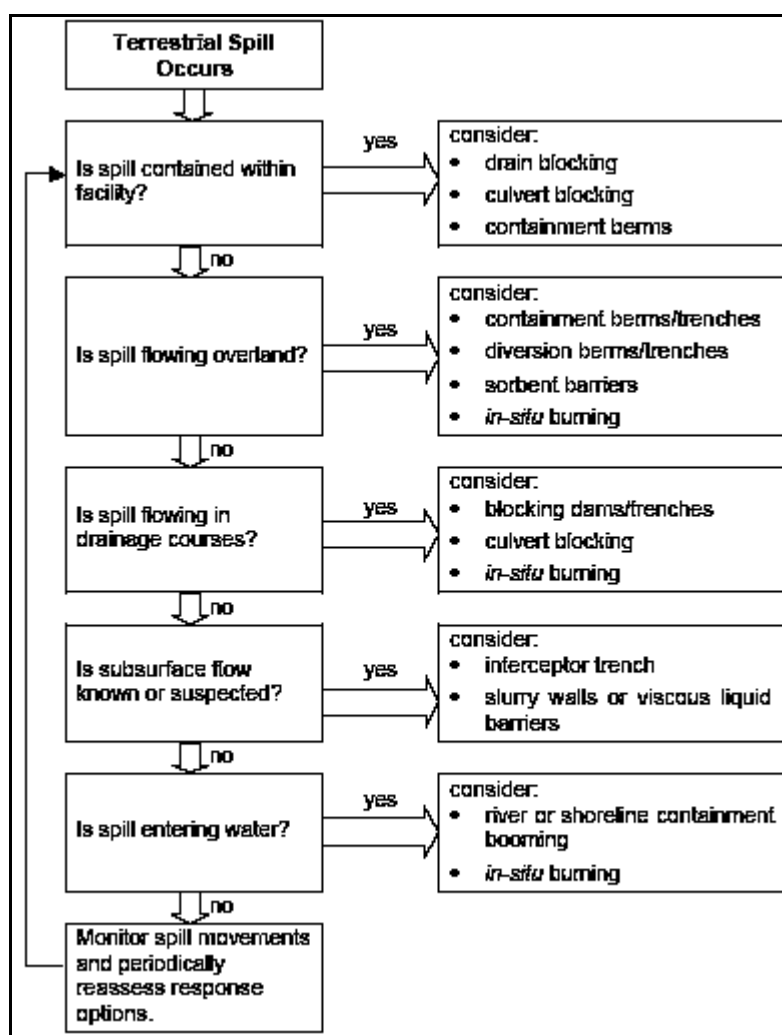


Fig. 7.35: Decision Tree

7.7 Approach to Disaster Management Plan (DMP)

Chemicals occupy an important segment of our economy and are also the source of large benefits to the society. In recent years, there has been a rapid increase in the number, variety and complexity of the chemicals being used in the industry and in our daily life. However, many of these chemicals are toxic, highly reactive, explosive or inflammable or have a combination of these characteristics and all these are classed as hazardous chemicals. Such chemicals are potential hazardous not only to the human beings, flora and fauna but also to all forms of property and our environment as a whole. Thus, extreme care is essential in handling such chemicals in any form and at all stages of manufacture, processing, treatment, package, storage, transportation, use, collection, destruction, conversion or sale.

Several agencies of the Government, both at the Central and State levels, such as the Directorate of Explosives, the Inspectorate of Factories and Port and Transport Authorities are entrusted with the responsibility of ensuring safe handling and management of hazardous chemicals under Acts and Rules made for the purpose. In spite of these measures, the possibility of accidents can not be ruled out. Human errors and mechanical, electrical, instrumental or system failures have, on occasions, led to severe disasters. Apart from those which occurred at Bhopal. Mexico and other parts of the world in the last few decades have made people all over the world concerned with the dangers of chemical accidents. Occurrence of such accidents makes it essential that the Central and State Governments as well as the local authorities are fully prepared to mitigate the sufferings and meet the eventualities resulting from any unfortunate occurrence of chemical accidents in our country.

7.7.1 Objectives of Disaster Management Plan (DMP)

The purpose of DMP is to give an approach to detail organizational responsibilities, actions, reporting requirements and support resources available to ensure effective and timely management of emergencies associated to production and operations in the site. The overall objectives of DMP are:

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

- ♦ To provide guidance to help stakeholders take appropriate action to prevent accidents involving hazardous substances and to mitigate adverse effects of accidents that do nevertheless occur. **Fig. 7.36** shows effect of loss of containment from the process

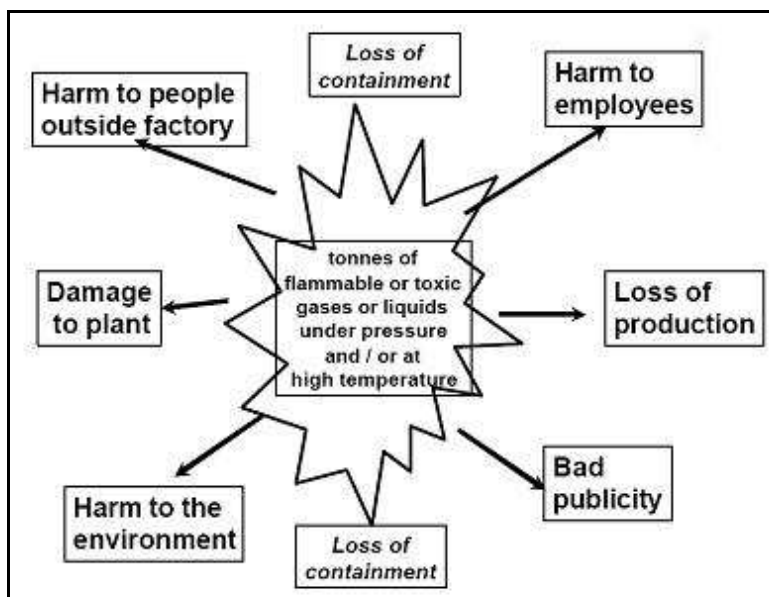


Fig. 7.36: Focus on Loss of Containment from the Process

Disaster Scenarios

Various scenarios that are anticipated to cause major emergencies inside the industries are fire, explosion, toxic release and natural calamities like cyclone, flood and earthquake. All these scenarios are discussed in brief in the following text.

Fire

Fire is also a serious hazard and is normally regarded as having a disaster potential less than explosion or toxic release that can be controlled at the incipient stage. Certain examples are tank fire, pool fire, jet fire, flash fire, pump fire, flange fire, duct fire and cable tray fire. A fire involving a storage tank is serious and would require several days of fire fighting.

Explosion

Explosion is a major hazard and the violence of explosion depends on the rate at which energy is released. Explosion can bring in certain effects like blast wave, thermal effects, missile effects, ground shock and injury to personnel. The explosion types considered in this plan for the purpose of Maximum Credible

Accident (MCA) Analysis include Unconfined Vapor Cloud Explosion (UVCE) and Boiling Liquid Expanding Vapor Explosion (BLEVE) blast effect.

Toxic Release

Release of toxic chemicals in the form of gases and vapors can pose major hazards if proper care is not taken. Such hazards presented by a toxic release depend on the duration of exposure and on the chemical itself. It ranges from a sudden brief exposure at high concentration to a prolonged exposure at lower concentration over a working lifetime.

Cyclone

As one of the terminals is located in the coastal areas, the possibility of cyclone striking the area cannot be ruled out. However, all the equipment and installations are designed to withstand a wind speed of 180 km/h. Receiving advance information from the local meteorological department can activate the strategic actions during a cyclone. While establishing the strategic actions during such scenarios, factors such as poor communication, loss of utilities, disrupted logistics and life-threatening rescue facilities are considered.

Earthquake

An earthquake can pose a major threat to the pipeline and associated facilities, property, life and environment. Some of the effects of an earthquake are ground shaking, ground lateral displacement, and ground uplift, ground settlement, soil liquefaction and fires. Though the earthquake is not a regular phenomenon in this region, the possibility of its occurrence cannot be ruled out.

Flood

The chance of flooding due to seasonal monsoons is rare by virtue of its location from dams and rivers. However, with the advance information from the local meteorological department on flood warning, specific actions to be carried out on those occasions are considered in this plan. Some of the effects likely during flood are water entering the plants / processing units, danger to life of persons / property and outbreak of epidemics / other contagious diseases.

Disaster Management Plan: Key Elements

Following are the key elements of Disaster Management Plan:

- ◆ Basis of the plan
- ◆ Accident / emergency response planning procedures

- ◆ On-site Disaster Management Plan
- ◆ Off-site Disaster Management Plan

7.7.2 Basis of the Plan

Identification and assessment of hazards is crucial for on-site emergency planning and it is therefore necessary to identify what emergencies could arise in production of various products and their storage. Hazard analysis or consequence analysis gives the following results.

- ◆ Hazards from spread of fire or release of flammable chemicals from storage, production units and transportation facilities
- ◆ Hazards due to formation of pressure waves due to vapor cloud explosion of flammable gases

7.7.3 Emergency Planning and Response Procedures

Emergency rarely occurs therefore activities during emergencies; require coordination of higher order than for planned activities carried out according to fixed time schedule or on a routine day-to-day basis. To effectively coordinate emergency response activities, an organizational approach to planning is required. The important areas of emergency planning are Organization and Responsibilities, Procedures, Communication, Transport, Resource requirements and Control Center. Offsite emergency requires additional planning over and above those considered under onsite plans, which should be properly integrated to ensure better coordination.

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

7.7.4 On-site Disaster Management Plan

Purpose

- ◆ To protect persons and property of storage terminals in case of all kinds of accidents, dangerous occurrences emergencies and disasters happening in or affecting plant at any time
- ◆ To informed people and surroundings about above happening if it is likely to adversely affect them
- ◆ To inform authorities including helping agencies (doctors, hospitals, fire, police transport etc.) in advance, and also at the time of actual happening

- ◆ To identify, assess, foresee and work out various kinds of possible hazards, their places, potential and damaging capacity and area in case of above happenings. Review, revise, redesign, replace or reconstruct the process, plant, vessels and control measures if so assessed.

During an emergency in order to handle disaster / emergency situations, an organizational chart entrusting responsibility to various plant personnel showing their specific roles during emergency should be available as shown in **Fig. 7.37**. The composition of the management team is given below:

Plant manager, Section In-charge, Site Controller, Incident Controller, Personnel, Administrative Manager, Communication Officer, Fire and Security Officer, Transport Coordinator, Medical Coordinator, Media Representatives, Communication Coordinator

Before Crisis

- ◆ Prepare a plan of the storage, handling and pumping stations premises and surrounding showing therein the areas of various hazards like fire, explosion ,toxic releases etc, and also location of assembly points ,fire station or equipments room, telephone room, first aid or ambulance room ,emergency control room, main gate ,emergency gates ,normal wind direction , north direction, outside fire station ,hospital and other services .Mention their distances from proposed activities.
- ◆ The fire protection equipment shall be kept in good operating condition at all time and fire fighting system should be periodically tested for people functioning logged for record and corrective action.
- ◆ The fire fighting training shall be provided to all officers, truck drivers and other employees who are likely to be present in installation
- ◆ There should be regular mock fire drills once a month record of such drills shall be maintained
- ◆ Every employee or authorized person working in the production shall be familiarized with the fire alarm signal and shall know the location of fire alarm point nearest to place of work
- ◆ Assign key personnel and alternate responsible for site safety
- ◆ Describe risk associated with each operation conducted.

During Crisis

- ◆ Monitor the behavior of entrant for any effects that suggests they should be evacuated
- ◆ Evacuate the space if any hazard that could danger the entrant is detected
- ◆ Perform no other duties that may interfere with their primary responsibilities
- ◆ Notify the attendant if they experience any warning signs or symptoms of exposures or detect a dangerous condition
- ◆ Exit the permit space when instructed by attendant
- ◆ Reporting Procedure
- ◆ In the event of fire from accidental release of flammable gas or liquid, a person seeing the incident will follow the laid down procedure in the plant and report as follows:
 - Will dial the nearest telephone
 - Will state his name and exact location of emergency
 - Will contact affected officers on duty
 - People reporting the accident will remain near the location to guide emergency crew arriving at the scene
- ◆ In case fire emergency person should activate the nearest available push button type instrument which will automatically sound an alarm in fire control room indicating the location of fire.

After Crisis

- ◆ Report injuries or blood or body fluid exposures to the appropriate supervisor immediately
- ◆ Assembly points:
 - Assembly points shall be set up farthest from the location of likely hazardous events, where pre-designed persons from the works, contractors and visitors would assemble in case of emergency. Up-to-date list of pre-designed employees shift wise must be available at these points so that roll call could be taken. Pre-designated persons would take charge of these points and mark presence as the people come into it.

- ◆ Wash wounds and skin sites that have been in contact with blood with soap and water.
- ◆ Workers should be seen as soon as possible by a health professional.
- ◆ Provide information to the relevant public authority and community including other closely located facilities regarding the nature of hazard and emergency procedure in event of major accident.
- ◆ Record and discuss the lessons learned and the analysis of major accidents and misses with employees and employee representative.

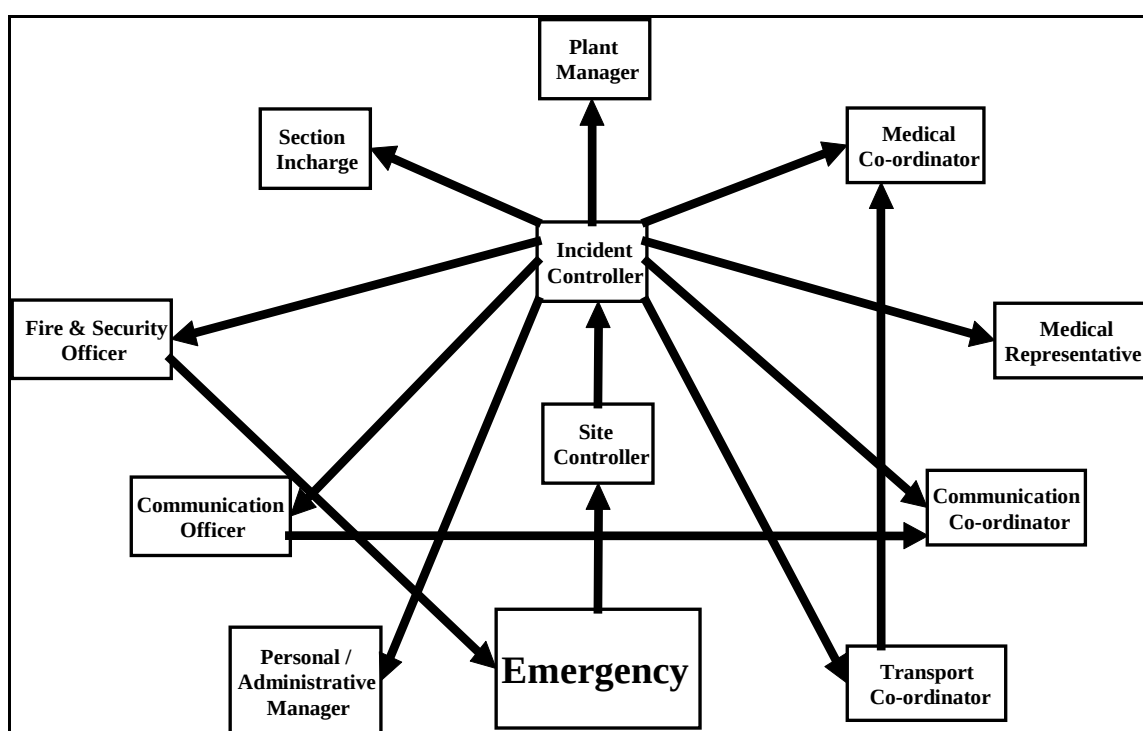


Fig. 7.37: Onsite DMP - Disaster Control/Management System

7.7.5 Disaster Management / Emergency Preparedness Program: Off-site

Emergency is a sudden unexpected event, which can cause serious damage to personnel life, property and environment as a whole, which necessitate to evolve Off-site Emergency Plan to combat any such eventuality. In Offsite disaster management Plan many agencies are involved like Revenue, Public Health, Fire Services, Police, Civil Defense, Home Guards, Medical Services and other Voluntary organization. Thus handling of such emergencies requires an organized multidisciplinary approach.

If it becomes necessary to evacuate people, then this can be done in orderly way. The different agencies involved in evacuation of people are Civil Administration (both state and central), non Govt. organizations, factory Inspectorate and Police authorities.

Fire

Effects of fire on population will be mainly due to thermal radiation. In such cases, houses situated to the proximity of disaster need to be evacuated, although a severe smoke hazard due to fire is to be reviewed periodically.

Explosion

An explosion will give a very little time to warn population and areas affected may be much longer than that in case of fire. The effects of explosion on population will be mainly due to shock waves, flying splinters, collapse of structures and exposure to thermal radiation.

Off-site (Notifying External Agencies)

Depending on the type and severity of emergency, the communication controller must notify the appropriate external agencies. The major emergencies should be notified to:

- ◆ District Collector
- ◆ Law enforcement departments
- ◆ Local governments and other response teams
- ◆ Fire departments and other response teams
- ◆ Hospital and emergency medical services
- ◆ Ambulance services
- ◆ Local environmental agencies
- ◆ Utility companies, such as water, sewer, public works, telephone, and electricity
- ◆ Contractors for heavy and special machinery and supply of nitrogen / dry air for purging the pipeline
- ◆ Suppliers of emergency equipment
- ◆ Neighboring industries, which can provide additional emergency response personnel and material

- ◆ The broadcasting media

The notice shall include the following information:

- ◆ The name and address of the site where the release, has occurred
- ◆ The name, position, and telephone number of the caller
- ◆ The location of the point of the release; a description of the source, cause and type of release; the quantity and concentration of the material released; and whether the release is of a continuous nature
- ◆ Any known or anticipate acute or chronic health risks associated with the emergency and, where appropriate, advice regarding medical attention necessary for exposed individuals
- ◆ Proper precautions to be taken as a result of the release, including evacuation
- ◆ The name(s) and telephone number(s) of the person (s) to be contacted for further information
- ◆ Weather conditions, including wind direction and speed, and expected off-site effects, if any

Neighboring industries or activities can often provide additional resources, in terms of expertise, personnel, material and equipment. As far the case of other local external agencies, such possible co-operation can be more effective only if predetermined plans for intervention have been established.

Purpose

- ◆ To save lives and injuries and to prevent or reduce property losses
- ◆ To provide for quick resumption of normal situation or operation
- ◆ To make explicit the inter related be suggested if necessary
- ◆ To make explicit inter related set of actions to be undertaken in the event of an industrial accident posing hazards to the community
- ◆ To inform people and surrounding about emergency and disaster if it is likely to adversely affect machinery will be established for this purpose to guide the people in proper way

- ◆ To plan for rescue and recuperation of casualties and injuries. To plan for relief and rehabilitation
- ◆ To plan for prevention of harms, total loss and recurrence of disaster. It will be ensured that absolute safety and security is achieved within the shortest time

Before Crisis

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

- ◆ People in vicinity of hazardous installation, and others who are potentially affected in the event of an accident, should be aware of the risks of accidents, know where to obtain information concerning the installation, and understand what to do in the event of an accident
- ◆ Non-governmental Organizations (NGO's) (Such as environmental, humanitarian and consumer group) should motivate their constituents and others, to be involved in risk reduction and accident prevention efforts. They should help to identify specific concerns and priorities regarding risk reduction and prevention, preparedness and response activities
- ◆ NGO's should facilitate efforts to inform the public and should provide technical assistance to help the public analyze and understand information that is made available
- ◆ Public authorities (at all levels) and management of hazardous installation should established emergency planning activities/ program's for accidents involving the hazardous substance
- ◆ All parties who will be involved in emergency planning process. In this respect public health authorities, including experts from information centers should be involved in relevant aspects of offsite emergency planning
- ◆ Emergency warning alert system alert system should be in place to warn the potentially affected public, or there is an imminent threat of an accident
- ◆ The system chosen should be effective and provide timely warning. Suitable warning system could include or a combination of for e.g.: sirens, automatic telephone message, and mobile public address system

During Crisis

- ◆ Central Control Committee: As the off-site plan is to be prepared by the government a central control committee shall be formed under the chairmanship of area head. Other officers from police, fire, factory, medical, engineering, social welfare, publicity, railway, transport and requisite departments shall be incorporated as members. Some experts will also be included for guidance. The functions of committee should be:
 - To work as main co-coordinating body constituted of necessary district heads and other authorities with overall command, coordination, guidance, supervision, policy and doing all necessary things to control disaster in shortest times
 - To prepare, review, alter or cancel this plan and to keep it a complete document with all details
 - To take advice and assistance from experts in fields to make plan more successful
 - To set in motion all machineries to this plan in event of disaster causing or likely to cause severe damage to public, property or environment
 - The incident control committee, traffic control committee and press publicity committee will first be informed, as they are needed first
- ◆ Medical Help, Ambulance and Hospital Committee: This committee consisted of doctors for medical help to the injured persons because of disaster. Injuries may be of many types. As such doctors are rarely available we have to mobilize and utilize all available doctors in the area. Functions and duties of the committee include:
 - To give medical help to all injured as early as possible.
 - Civil surgeon is the secretary who will organize his team.
 - On receiving information to rush to spot he will immediately inform his team and will proceed with all necessary equipments.
 - First aid and possible treatment shall be provided at the spot or at some convenient place and patients may be requested to shift to hospitals for further treatment

- All efforts shall be made on war basis to save maximum lives and to treat maximum injuries.
- Continuity of the treatment shall be maintained till the disaster is controlled.
- ♦ Traffic Control, Law and Order: The committee is headed by District Superintendent of Police. Functions and duties of this committee should be:
 - To control traffic towards and near disaster , to maintain law and order
 - To evacuate the places badly affected or likely to be affected
 - To shift the evacuated people to safe assembly points
 - To rehabilitate them after disaster is over.
 - Necessary vehicles, wireless sets and instruments for quick communications shall be maintained and used as per need

After Crisis

- ♦ At the time of disaster, many people may badly be affected. Injured people shall be treated by medical help, ambulance and hospital committee but those not injured but displaced kept at assembly points, dead whose relative or property is lost, houses collapsed and in need of any kind of help shall be treated by this welfare and restoration committee. Functions and duties of this committee are:
 - To find out persons in need of human help owing to disastrous effect. They may give first aid if medical team is not available
 - They will serve the evacuated people kept at assembly points. They will arrange for their food, water, shelter, clothing, sanitation, and guidelines to reach any needful places
 - They will look for removal and disposal of dead bodies, for help of sick, weak, children and needy persons for their essential requirements
 - The team will also work for restoration of detached people, lost articles, essential commodities etc.
 - The team will also look after the restoration of government articles

- The team will also ensure that the original activities, services and systems are resumed again as they were functioning before the disaster
- ◆ Police
 - The police should assist in controlling of the accident site, organizing evacuation and removing of any seriously injured people to hospitals
- ◆ Fire Brigade
 - The fire brigade shall organize to put out fires other than gas fires and provide assistance as required.
- ◆ Hospitals and Doctors
 - Hospitals and doctors must be ready to treat any injuries.
- ◆ Media
 - The media should have ready and continuous access to designated officials with relevant information, as well as to other sources in order to provide essential and accurate information to public throughout the emergency and to help avoid confusion
 - Efforts should be made to check the clarity and reliability of information as it becomes available, and before it is communicated to public
 - Public health authorities should be consulted when issuing statements to the media concerning health aspects of chemical accidents
 - Members of the media should facilitate response efforts by providing means for informing the public with credible information about accidents involving hazardous substances
- ◆ Non-governmental organizations (NGO)
 - NGO's could provide a valuable source of expertise and information to support emergency response efforts. Members of NGOs could assist response personnel by performing specified tasks, as planned during the emergency planning process. Such

tasks could include providing humanitarian, psychological and social assistance to members of community and response personnel. Various organizations involved during emergencies are shown in **Fig. 7.38**.

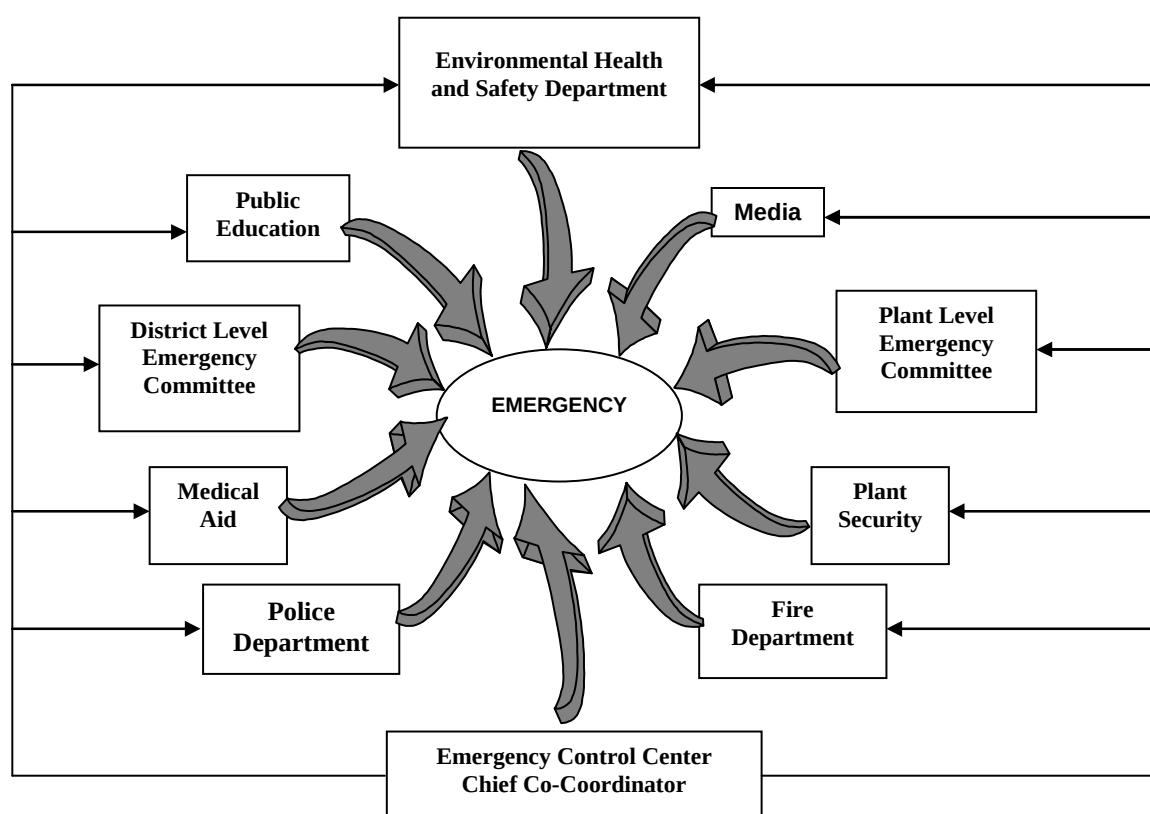


Fig. 7.38: Various Organizations Involved During Emergency

7.7.6 Emergency Preparedness Plan and Response for Pipeline

- ◆ Industry should continue to share its experience with respect to the use of safety management systems for pipelines, and improve the efficiency of individual elements / techniques of these systems
- ◆ General principles applicable to emergency planning for hazardous installations also apply to pipelines, it may be necessary to make further efforts
- ◆ Emergency planning for pipelines may be complicated because of some of their characteristics including the fact that pipelines are normally unmanned; the length and location of pipelines; the need to be able to shut off or

depressurized the flow of material, and the need to ensure access by emergency response personnel

- ◆ Pipeline location will be clearly marked at fence lines and road crossings to minimize risk of third party damage
- ◆ Industry responsible for pipelines should review and necessary, develop and implement systems to reduce third party interference as this is a major cause of accident
 - This should be done in co-operation with public authorities in all regions
 - Systems for reducing third party interference involve ensuring that proper information is circulated among interested parties concerning the location of pipeline in a given area. In, addition it is important to facilitate communication between the pipeline operator and third parties
 - In order to facilitate learning from experience, industry responsible for pipelines (as well as public authorities and other stakeholders) should improve sharing of information on improving safety of pipelines and on accidents / near-miss case histories
 - This should include concerning pipelines that reach the end of their intended useful or design life. Options for dealing with pipeline that are no longer in use include removal, outright abandonment, or abandonment with additional actions. Care should be taken to properly assess the associated risks to each option, on a case-by-case basis recognizing that the best solution in a given situation may be a combination of methods
 - Information should also be pooled and shared on the extent of the pipeline systems, on the amount of materials they convey, and on statistical analysis of the use of pipelines to transport hazardous substances
 - Information should be collected and made available concerning the relationship between failure and the characteristic of the pipeline, in order to better understand the nature and causes of accidents (e.g., relating to age, size, location, and construction of the pipeline)

- ◆ Public education is often an integral part of damage prevention program. Pipeline route maps could be supplied and informal training given to groups to alert them. The quality of the public education program can be assessed by evaluating components
- ◆ An appropriate level of public education is to be mail outs, advertisements, and speaking engagements for urban areas, and mail outs with annual landowner / tenant visits for rural areas. The program generates these standards by simply identifying the population density value and assigning points accordingly.

7.8 Public Consultation

“Public consultation” refers to the process by which the concerns of local affected persons and others who have plausible stake in the environmental impacts of the project are ascertained with a view to taking into account all the material concerns in the project design as appropriate.

Public consultation is a part of CEIL’s business process and has been outlined in CEIL’s CSR policy. The policy stresses on importance of respecting local cultural factors and emphasizes on contributing to socio-economic development in regions where it undertakes business activities. CEIL has developed mechanisms for public consultation and responding to concerns in all the assets where it has had its presence for a substantial period of time like Rajasthan, Andhra Pradesh and Gujarat. Various initiatives are taken for improving local socio-economic, education and community health conditions. In this project too CEIL has already initiated consultation process by conducting public hearings at the Viramgam and Salaya. CEIL has also conducted social baseline study and stakeholder assessment for the whole stretch of proposed pipeline including the proposed terminal locations.

7.8.1 Public Hearing for Salaya and Viramgam Terminals

As per the MoEF approved TOR, for the proposed oil evacuation pipeline project public hearing was to be carried out for the two terminals that is Viramgam and Salaya. The process for public hearing was initiated by making an application to the Gujarat Pollution Control Board enclosing prescribed number of copies of EIA report prepared in accordance with approved TOR from MoEF, Executive Summary in English and Gujarati and CDs containing electronic versions of EIA report and Executive Summary. The application to GPCB was submitted on 15th September 2007 vide letter no. HSE/HPB/09/MS/21. The Gujarat Pollution Control Board issued notifications mentioning the date, time and venues for the public hearing. The public hearing for Slaya terminal was scheduled for 20th November from 10.30 AM at Rajput Samajni Wadi, Nana Lakhiya, District Jamnagar. Advertisements were published in local as well as national dailies inviting public and stakeholders to raise concerns and seek clarifications in writing

as well verbal during public hearing. Notice for public hearing for Salaya was published in 'Times of India' in English and 'Gujarat Samachar' in Gujarati on 18th October 2007. The public hearing for Viramgam terminal was scheduled for 24th November from 11.00 AM at Lohana Mahajan Samaj Wadi, Station Road, Viramgam, District Ahmedabad. It was published in 'Times of India' in English and in 'Sandesh' in Gujarati on 18th October, 07. The advertisements have been presented as figure 7.39.

Copies of EIA report, Executive Summary and CDs containing electronic versions of the documents were sent to the officials mentioned in Table 7.14 with a covering letter. The copies at the offices were sent one month prior to the public hearing to enable public and other stakeholders to raise their concerns and forward their suggestions in writing. No concerns were received from stakeholders for the Salaya terminal however there was one letter received from an NGO, 'Paryavaran Mitra' for the Viramgam terminal. A copy of the letter and CEIL's response has been Annexed along with the signed proceedings.

Table 7.14 – Officials to Whom Copies of Documents Were Sent

Salaya	Viramgam
1. District Collector, Jamnagar	1. District Collector, Ahmedabad
2. District Development Officer, Jamnagar	2. District Development Officer, Ahmedabad
3. District Industry Centre, Jamnagar	3. District Industry Centre, Ahmedabad
4. Chief Conservator of Forests, MoEF, Regional Office, Bhopal	4. Chief Conservator of Forests, MoEF, Regional Office, Bhopal
5. GPCB Regional Office, Jamnagar	5. GPCB Regional Office, Ahmedabad

Figure 7.39 – Public Hearing Advertisements

THE TIMES OF INDIA, AHMEDABAD ** THURSDAY, OCTOBER 18, 2007	
 GUJARAT POLLUTION CONTROL BOARD Paryavaran Bhavan, Sector 10 A, Gandhinagar 382 010 Tel : 079 - 23222096 Fax : 079 - 23222784 www.gpcb.gov.in PUBLIC NOTICE It is hereby informed that as per the Ministry of Environment and Forests, Government of India, New Delhi vide its Notification no. S.O. 1533 dated September 14, 2006. Public Hearing has been fixed for the following project covered under Category A, M/s Cairn Energy India Pty. Ltd. for their proposal of Oil Evacuation Pipeline with Associated facilities from Mangala Terminal Barmer dist. Rajasthan to Salaya Terminal in Jamnagar District via Viramgam, Ahmedabad dist in Gujarat as mentioned in their request application. Other concerned persons having plausible stake in the environmental aspects are requested to send their response in writing to the concerned regulatory authorities. Such interested persons are requested to send their comments to the regulatory authorities as under: Central Government in MoEF (Ministry of Environment and Forests, GOI, CGO Complex, Lodi Road, New Delhi 110003) as the said matter falls under Category A of schedule of aforesaid Notification. It may be noted that, a copy of the draft Environment Impact Assessment report and the Summary Environment Impact Assessment Report is sent to the following authorities or offices to make available the draft EIA Report for inspection to the public during normal office hours, till the Public Hearing is over. 1. The District Collector Office, Ahmedabad 2. District Development Office, Ahmedabad 3. District Industry Centre, Ahmedabad 4. The Chief Conservator of Forests, Ministry of Environment & Forests, Regional Office (West Zone), Kendriya Paryavaran Bhavan, E-5, Arera Colony, Link Road 3, Ravisankar Colony, Bhopal 462 016 5. Regional Office : GPCB, 40, Shrimali Society, Neptune House - 2, Near Navrangpura Railway crossing, Navrangpura, Ahmedabad 380009 The District Magistrate or his or her representative not below the rank of an Additional District Magistrate shall supervise and preside over the entire public hearing process. The Public Hearing is schedule to be held on 24/11/2007 at 11.00 hrs at Lohana Mahajan Samajni Wadi, Station Road, Viramgam, Dist : Ahmedabad. Place : Gandhinagar Sanjiv Tyagi Date : 08/10/2007 Member Secretary, GPCB	 GUJARAT POLLUTION CONTROL BOARD Paryavaran Bhavan, Sector 10 A, Gandhinagar 382 010 Tel : 079 - 23222096 Fax : 079 - 23222784 www.gpcb.gov.in PUBLIC NOTICE It is hereby informed that as per the Ministry of Environment and Forests, Government of India, New Delhi vide its Notification no. S.O. 1533 dated September 14, 2006. Public Hearing has been fixed for the following project covered under Category A, M/s Cairn Energy India Pty. Ltd. for their proposal of Oil Evacuation Pipeline with Associated facilities from Mangala Terminal Barmer dist. Rajasthan to Salaya Terminal in Jamnagar District via Viramgam, Ahmedabad dist in Gujarat as mentioned in their request application. Other concerned persons having plausible stake in the environmental aspects are requested to send their response in writing to the concerned regulatory authorities. Such interested persons are requested to send their comments to the regulatory authorities as under: Central Government in MoEF (Ministry of Environment and Forests, GOI, CGO Complex, Lodi Road, New Delhi 110003) as the said matter falls under Category A of schedule of aforesaid Notification. It may be noted that, a copy of the draft Environment Impact Assessment report and the Summary Environment Impact Assessment Report is sent to the following authorities or offices to make available the draft EIA Report for inspection to the public during normal office hours, till the Public Hearing is over. 1. The District Collector Office, Jamnagar 2. District Development Office, Jamnagar 3. District Industry Centre, Jamnagar 4. The Chief Conservator of Forests, Ministry of Environment & Forests, Regional Office (West Zone), Kendriya Paryavaran Bhavan, E-5, Arera Colony, Link Road 3, Ravisankar Colony, Bhopal 462 016 5. Regional Office : GPCB, Sardar Patel Commercial Complex, Rameshwamagar, Kasturba Gandhi Vikas Gruh Marg, Bedi Banadr road, Jamnagar - 368 008. The District Magistrate or his or her representative not below the rank of an Additional District Magistrate shall supervise and preside over the entire public hearing process. The Public Hearing is schedule to be held on 20/11/2007 at 10.30 hrs at Rajput Samaj Wadi, Nana lakhiya, Tal. : Lalpur, Dist. : Jamnagar Place : Gandhinagar Sanjiv Tyagi Date : 10/10/2007 Member Secretary, GPCB

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ગુજરાત પ્રદૂષણ નિયંત્રણ બોર્ડ
પર્યાવરણ ભવન, સેક્ટર ૧૦ અ, ગાંધીનગર ૩૮૨૦૧૦
ફોન : ૦૭૯ ૨૩૨૨૨૦૬૬ ફેક્સ : ૦૭૯ ૨૩૨૨૨૭૮૪ www.gpcb.gov.in

જાહેર સૂચના

ભારત સરકારના પર્યાવરણ અને વન મંત્રાલય, નવી દિલ્હીના જાહેરનામા ક્રમાંક એસ.ઓ. ૧૫૩૩ તારીખ ૧૪-૯-૨૦૦૬ અન્વયે લોક અભિપ્રાય મેળવવાની પ્રક્રિયાના ભાગરૂપે લાગતાવળગતા સ્થાનિક અસરગ્રસ્ત લોકોનું ધ્યાન દોરીને આથી જણાવવાનું કે, મેસર્સ કેર્ન એનર્જી ઈન્ડિયા લી. દ્વારા કુદ ઓઈલ વહન કરવા માટેની પાઈપલાઈનની સાથેના ટર્મિનલ કેસીલીટી ઉભી કરવા બાબતે ગામ : બારમેર, રાજસ્થાન થી લઈને જામનગર સલાયા વાયા વિરમગામ, જિલ્લો : અમદાવાદ ખાતે કેટેગરી 'એ', માટે તેઓની અરજી અને મળી છે.

આ અંગે રસ ધરાવતી વ્યક્તિઓ પણ તેઓની ટીક-ટીપ્પણી નીચે દર્શાવ્યા મુજબ સંબંધિત નિયંત્રણ ઓથોરિટીને મોકલવા વિનંતી છે.

ભારત સરકાર દ્વારા સી.જી.ઓ. કોમ્પ્લેક્સ, લોધી રોડ, નવી દિલ્હી ૧૧૦૦૦૩ ખાતે કાર્યરત એમ.ઓ.ઈ.એફ. ના ટૂંકા નામથી જાણીતી પર્યાવરણ અને વન મંત્રાલયને ઉપરોક્ત જાહેરનામાની અનુસૂચિની કેટેગરી, 'એ' માં આવરી લેવાયેલ પરિયોજના માટે નિયંત્રણ ઓથોરિટી તરીકે જાહેર કરેલ છે.

અને ઉલ્લેખનીય છે કે, ઈઆઈએ (એન્વિરોન્મેન્ટ ઈમ્પ્રોવેમેન્ટ એસેસમેન્ટ) અહેવાલના મુસદ્દાની પ્રત તથા એન્વિરોન્મેન્ટ ઈમ્પ્રોવેમેન્ટ એસેસમેન્ટનો સંબંધિત અહેવાલની પ્રતને નીચે દર્શાવેલ ઓથોરિટી / કાર્યાલયો ખાતે કચેરી કામકાજના દિવસો દરમિયાન નિહાળી શકાશે.

૧. જિલ્લા કલેક્ટરશ્રીની કચેરી, અમદાવાદ.
૨. જિલ્લા વિકાસ અધિકારીની કચેરી, અમદાવાદ.
૩. જિલ્લા ઉદ્યોગ કેન્દ્ર, અમદાવાદ.
૪. મુખ્ય વન સંરક્ષકશ્રી, પર્યાવરણ અને વન મંત્રાલય, ભારત સરકારની પ્રાદેશિક કચેરી (પશ્ચિમ ઝોન), કેન્દ્રીય પર્યાવરણ ભવન, ઈ-૫, અરેરા કોલોની, લીન્ડ રોડ - ૩, રવીશંકર કોલોની, ભોપાલ ૪૬૨૦૧૬
૫. પ્રાદેશિક કચેરી, જાપીસીબી, ગુજરાત પ્રદૂષણ નિયંત્રણ બોર્ડ
૪૦, શ્રીમાળી સોસાયટી, નેપ્થ્યુન હાઉસ - ૨, નવરંગપુરા રેલ્વે કોસીંગ પાસે, નવરંગપુરા, અમદાવાદ ૩૮૦ ૦૦૮.

જિલ્લા કલેક્ટરશ્રી, (જિલ્લા મેજિસ્ટ્રેટ) કે તેઓના / તેણીના પ્રતિનિધિ, કે જેનો હોદ્દો અધિક જિલ્લા મેજિસ્ટ્રેટથી ઊંચેનો ન હોય, તેવી વ્યક્તિ સદર લોકસુનાવણીની કામગીરીનું દેખરેખ અને સંચાલન કરશે. લોકસુનાવણીની તારીખ ૨૪-૧૧-૨૦૦૭ના ૧૧.૦૦ કલાકે લોકાણ મહાજન સમાજ વાડી, સ્ટેશન રોડ, વિરમગામ, જિ. અમદાવાદ ખાતે યોજવામાં આવી છે.

સ્થળ : ગાંધીનગર સંજીવ ત્યાગી
તા. : ૦૮/૧૦/૨૦૦૭ સત્ય સચિવ

(રાજકોટ આવૃત્તિ) ગુજરાત સમાચાર ૧૧

ગુજરાત પ્રદૂષણ નિયંત્રણ બોર્ડ
પર્યાવરણ ભવન, સેક્ટર ૧૦ અ, ગાંધીનગર ૩૮૨૦૧૦
ફોન : ૦૭૯ ૨૩૨૨૨૦૬૬ ફેક્સ : ૦૭૯ ૨૩૨૨૨૭૮૪ www.gpcb.gov.in

જાહેર સૂચના

ભારત સરકારના પર્યાવરણ અને વન મંત્રાલય, નવી દિલ્હીના જાહેરનામા ક્રમાંક એસ.ઓ. ૧૫૩૩ તારીખ ૧૪-૯-૨૦૦૬ અન્વયે લોક અભિપ્રાય મેળવવાની પ્રક્રિયાના ભાગરૂપે લાગતાવળગતા સ્થાનિક અસરગ્રસ્ત લોકોનું ધ્યાન દોરીને આથી જણાવવાનું કે, મેસર્સ કેર્ન એનર્જી ઈન્ડિયા લી. દ્વારા કુદ ઓઈલ વહન કરવા માટેની પાઈપલાઈનની સાથેના ટર્મિનલ કેસીલીટી ઉભી કરવા બાબતે ગામ : બારમેર, રાજસ્થાન થી લઈને જામનગર સલાયા વાયા વિરમગામ, જિલ્લો : અમદાવાદ ખાતે કેટેગરી 'એ', માટે તેઓની અરજી અને મળી છે.

આ અંગે રસ ધરાવતી વ્યક્તિઓ પણ તેઓની ટીક-ટીપ્પણી નીચે દર્શાવ્યા મુજબ સંબંધિત નિયંત્રણ ઓથોરિટીને મોકલવા વિનંતી છે.

ભારત સરકાર દ્વારા સી.જી.ઓ. કોમ્પ્લેક્સ, લોધી રોડ, નવી દિલ્હી ૧૧૦૦૦૩ ખાતે કાર્યરત એમ.ઓ.ઈ.એફ. ના ટૂંકા નામથી જાણીતી પર્યાવરણ અને વન મંત્રાલયને ઉપરોક્ત જાહેરનામાની અનુસૂચિની કેટેગરી 'એ' માં આવરી લેવાયેલ પરિયોજના માટે નિયંત્રણ ઓથોરિટી તરીકે જાહેર કરેલ છે.

અને ઉલ્લેખનીય છે કે, ઈઆઈએ (એન્વિરોન્મેન્ટ ઈમ્પ્રોવેમેન્ટ એસેસમેન્ટ) અહેવાલના મુસદ્દાની પ્રત તથા એન્વિરોન્મેન્ટ ઈમ્પ્રોવેમેન્ટ એસેસમેન્ટનો સંબંધિત અહેવાલની પ્રતને નીચે દર્શાવેલ ઓથોરિટી / કાર્યાલયો ખાતે કચેરી કામકાજના દિવસો દરમિયાન નિહાળી શકાશે.

૧. જિલ્લા કલેક્ટરશ્રીની કચેરી, જામનગર.
૨. જિલ્લા વિકાસ અધિકારીની કચેરી, જામનગર.
૩. જિલ્લા ઉદ્યોગ કેન્દ્ર, જામનગર.
૪. મુખ્ય વન સંરક્ષકશ્રી, પર્યાવરણ અને વન મંત્રાલય, ભારત સરકારની પ્રાદેશિક કચેરી (પશ્ચિમ ઝોન), કેન્દ્રીય પર્યાવરણ ભવન, ઈ-૫, અરેરા કોલોની, લીન્ડ રોડ - ૩, રવીશંકર કોલોની, ભોપાલ ૪૬૨૦૧૬
૫. પ્રાદેશિક કચેરી, જાપીસીબી, ગુજરાત પ્રદૂષણ નિયંત્રણ બોર્ડ
સરદાર પટેલ વાણિજ્ય સંકુલ, રામેશ્વરનગર, કસ્તુરબા ગાંધી વિકાસ ગૃહ ખર્ગ, બેડી બંદર માર્ગ, જામનગર - ૩૬૮ ૦૦૮.

જિલ્લા કલેક્ટરશ્રી, (જિલ્લા મેજિસ્ટ્રેટ) કે તેઓના / તેણીના પ્રતિનિધિ, કે જેનો હોદ્દો અધિક જિલ્લા મેજિસ્ટ્રેટથી ઊંચેનો ન હોય, તેવી વ્યક્તિ સદર લોકસુનાવણીની કામગીરીનું દેખરેખ અને સંચાલન કરશે. લોકસુનાવણીની તારીખ ૨૦-૧૧-૨૦૦૭ના ૧૦.૦૩ કલાકે રાજપૂત સમાજ વાડી, નાના લાખીયા, તા. લાલપુર, જિ. જામનગર ખાતે યોજવામાં આવી છે.

સ્થળ : ગાંધીનગર સંજીવ ત્યાગી
તા. : ૧૦/૧૦/૨૦૦૭ સત્ય સચિવ

7.8.2 Public Hearing Proceedings:

On 20th November the public hearing for Salaya terminal was held at Rajput Samajni Wadi, Nana Lakhiya, District Jamnagar. It was conducted by the GPCB Regional Officer, Jamnagar under the chairmanship of Additional District Magistrate & Additional District Collector, Jamnagar. The Regional officer initiated the proceedings by briefing the gathering on proposed project and requested the public to raise any concerns and put forth suggestions they had. The ADM requested CEIL officials to make a presentation on the project and environmental issues and their mitigations measures proposed from the

project. CEIL officials made presentations on overall project, proposed terminal at Salaya, anticipated environmental impacts & their mitigation measures. This was followed by queries & suggestions raised by public and response by CEIL officials. The proceeding was recorded by typing the minutes in English and Gujarati as well as in video and audio formats. The typed proceedings were later signed by the ADM & ADC and RO GPCB, Jamnagar. A copy of the signed proceedings, attendance sheet, issues raised with their responses have been included as Annexure V in this report. The queries raised during the public hearing and responses by CEIL for the Salaya and Viramgam terminals have been discussed in the following tables.

Table 7.15 – Issues and Responses for Salaya Terminal

Issue	Response	EIA report reference
• Would there be any chances of air pollution from this project?	• This project is related to only storage in the tanks and pumping thereafter which has no air pollution potential. The 10 MW power plant proposed would be operated only through natural gas, which is an eco-friendly fuel, and necessary care would be taken for combating any air pollution thereof.	Section: 4.2.1
• The company should procure land from the farmers directly giving appropriate compensation.	• The land acquisition will be done directly from the owners and not through Govt. land acquisition procedure, which will give appropriate and full compensation to the land owners	Section: 1.3, 4.2.4
• That company should maintain cordial and long term relationship with the villagers	• Company will totally be committed for maintaining cordial and long term relationship and company will form a committee with the district administration and local panchayat to	Section: 4.4.6

	consider community programmes.	
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Table 7.16 – Issues and Responses for Viramgam Terminal

Issue	Response	EIA report reference
Provide the details of the pipeline route in Ahmedabad district and locations of the power plants.	The requested information on pipeline route is available in the EIA report on page no. 3.178 and the same was shown. In Ahmedabad district two SEHMS stations with 1 MW power generator each and one 8MW power plant at Viramgam Terminal will be installed.	Section: 3.6.5, Table: 3.6.1; Section: 2.8, Table: 2.1 to 2.3
Which fuel will be used in the proposed power plant?	Natural gas will be the primary fuel while the emergency backup fuel will be Low Sulphur Diesel.	Section: 2.6.2
The location of the 35 Hectares of land for the proposed oil storage terminal.	Considering the technical requirements and availability of land the same will be finalised within 5 KM radius around Viramgam.	Section: 2.3
What type of heating system will be provided along the pipeline to ensure flow of crude oil?	Skin Effect Heat Management System will be used to ensure the temperature of oil in the pipeline and thus the flow.	Section: 2.6.2.3
What are the provisions made for the tree plantation to compensate the trees removed in the proposed project?	Appropriate green belt development will be undertaken within the terminal.	Section: 4.1, 4.4.2, 4.4.3, 4.4.5
Source of water during operational stage?	Estimated water requirement during the operational phase is approximately 5 M ³ per day. This being a very small quantity the same will be sourced through local civic bodies or government authorised agencies	Section: 4.2.3

How many power plants are proposed in the entire project?	8 MW at Viramgam terminal, 10 MW at Salaya terminal and 32 nos. of 1MW each along the entire route of the pipeline will be installed	Section: 2.1
Impacts from the proposed 1 MW power plants.	This has been covered in details in the EIA report (Chapter – 4)	Section: 4.2.1
How many local unskilled people will be employed during the construction stage?	During the construction phase priority will be given to the local unskilled labour force.	Section: 8.4
What are the precautions taken for levelling the land to bring it to near original condition after the pipeline laying is completed?	The pipeline contractor will obtain certificate from affected land owner, about satisfactory completion of work.	Section: 4.2.4
At what depth from the ground level the pipeline will be installed?	The top of the pipeline will be minimum 1 meter below the ground level.	Section: 2.6.5.1

Figure 7.40 – Photographs of Public Hearing - Salaya





Figure 7.41 – Photographs of Public Hearing - Viramgam



