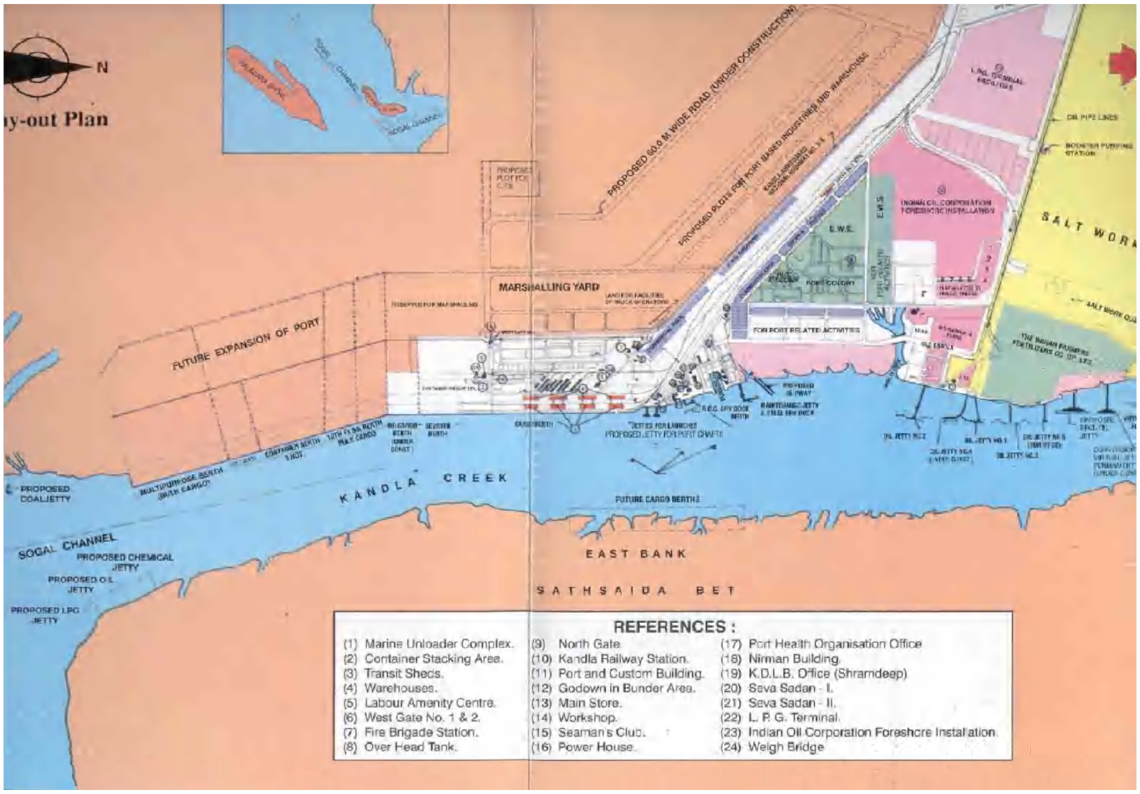
Private & Confidential

Disaster Management Plan

For



Kandla Port Trust

(ISO 9001:2008 Certified Port)

Post Box No: 50,

Gandhidham (Kutch) – 370201

(Upgraded – July 2016)

Disaster Management Plan

(Upgraded)

for

Kandla Port Trust

Post Box No: 50

Gandhidham (Kutch) – 370201

TAB
LE

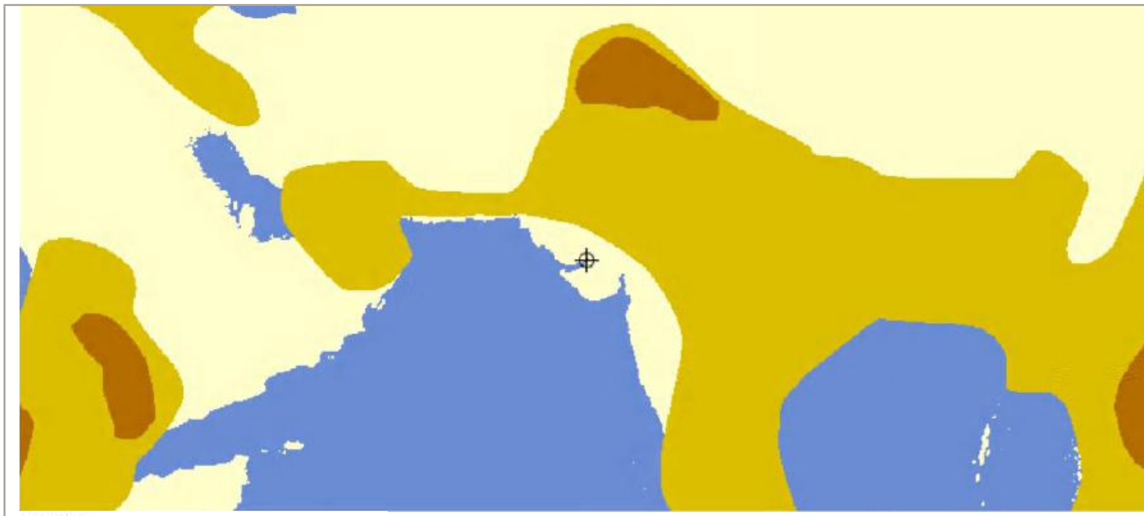
OF CONTENTS

1 P

Contents

As per Munich Re World Map for Natural hazards, Gandhidham region is in Zone – I which means on an average there are 2 - 6 lightning strikes per km[2] area per year which signifies moderate risk exposure.

Thus risk exposure can be considered as moderate.



1 PREFACE

The Disaster Management Plan (DMP) for Kandla Port has been developed to provide procedures for the implementation and continual development of the Internal Action Plan.

The Internal Action Plan is an interactive document which will be continuously refined and updated every year.

This plan has been formulated to fulfil the requirements of the relevant standards and guidelines set forth by the National Diaster Plan 2016.

It should be noted that the findings and recommendations of the study are based on the data provided and discussions held during the site visit with the port personnel at the time of the site visit on 18th& 19th August 2010 and updated in the Month of July 2016.

National Disaster Management Plan, 2016. A publication of the National Disaster Management Authority, Government of India. May 2016, New Delhi

Documents provided by Kandla Port Trust for reference are:-

1. Kandla Port Trust – Internal action plan up dated July 2016.
2. DMP – Kandla Port Trust – Originally Prepared by Tata AIG Risk Management in the year 1999. Updated by A R Jadeja, Signal Supdt. KPT
3. Copies of DMP of chemical / POL Terminals on Kandla Port Property.

a) JRE tank terminal (P) Ltd.

b) CRL

c) BPCL

d) United storage and tank terminals Ltd – Liquid Terminal

e) United storage and tank terminals Ltd – Liquefied Gas Storage and handling terminals.

f) Indo Nippon chemical Company Ltd.

g) Rishi Kiran Logistics (P) Ltd,

h) INEOS ABS (India) Ltd

i) Friends oil and chemical terminals (P) Ltd

j) Indian oil (LPG)

k) Indian Oil

l) IOC Marketing Division

m) HPCL

n) Friends salt works and allied industries

o) IFFCO

4. Layout Map of Kandla Port Trust – DRG. NO: KPH/09

5. Layout of Fire fighting line at Kandla Port Trust

6. Layout of proposed oil pipe line at oil jetty Kandla Port Trust

We have exercised all reasonable skill, care and diligence in carrying out the study. This report / document is not deemed to be any undertaking, warranty or certificate.

2 INTRODUCTION

The important aspect in emergency management is to prevent by Technical & Organizational measures, the unintentional escape of hazardous materials out of the facility and minimize accidents and losses.

Emergency planning also demonstrates the organizations commitment to the safety of employees and public and increases the organizations safety awareness.

The format and contents of the Disaster Management Plan (DMP) have been developed taking into consideration the guidelines of National Disaster Management Authority& Plan, and other accepted industry good practice principles formulated as a result of lessons learned in actual emergencies requiring extensive emergency response.

This master document is to be studied in advance and used for training purpose also. This master document will be upgraded once in every three years by reviewed annually.

2.1 Objectives of DMP

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

- ③ Rapid control and containment of the hazardous situation.
- ③ Minimizing the risk and impact of event / accident.
- ③ Effective rehabilitation of the affected persons and preventing of damage to property.

In order to effectively achieve the objectives of the emergency planning, the critical elements that form the backbone of the DMP are

- ③ Reliable and early detection of an emergency and careful planning.
- ③ The command co – ordination and response organization structure along with efficient trained personnel.
- ③ The availability of resources for handling emergencies.
- ③ Appropriate emergency response actions.
- ③ Effective notification and communication facilities ③Regular review and updating of the DMP ③Proper training of the concerned personnel.

FOREWORD

"The document On-site Disaster Management Plan is prepared with the objective of defining the functions and responsibilities of all concerned managerial, operational and supporting services department personnel with respect to detection and effective implementation of action plan. The ultimate goal is the effective containment of the emergency situation by proper mitigative action at the place of occurrence, cautioning people in adjoining affected locations, prompt rescue and medical aid to affected persons and communication to civil authorities for rushing in help from outside. All concerned are hereby requested to carefully study and thoroughly familiarize themselves with it in order to ensure its effectiveness in times of emergency"

Date: ----/-----/2016

Chairman

Kandla Port Trust

2.2 Responsibility

Responsibility for establishing and maintaining a state of emergency preparedness belongs to the DC. He is responsible for maintaining distribution control of the plan, and for ensuring that the plan and applicable implementing procedures are reviewed annually. The Fire Safety In charge is responsible for the training of personnel to ensure that adequate emergency response capabilities are maintained in accordance with the plan. He is also responsible for ensuring the adequacy of the conduct of drills, as outlined in the On-site Disaster Management Plan. All employees of various departments are responsible for carrying out their responsibilities, as defined in this Plan.

3 FACILITY DESCRIPTION PORT PROFILE

3.1 Introduction

3.1.1 Unique Location

The Major Port of Kandla situated about 90 km off the mouth of Gulf of Kachchh in the Kandla Creek at Latitude 23 degree 1minute North and Longitude 70 degree 13 minutes east, is the lone Major Port on the Gujarat coast line along the West Coast of the country. Amongst the 12 Major Ports in the country, Kandla occupies an enviable position, both in terms of international maritime trade tonnage handled and financial stability and self-sufficiency attained year after year. A gateway to the north-western part of India consisting of a vast hinterland of 1 million sq. km stretched throughout 9 states from Gujarat to Jammu & Kashmir, the Port has a unique location advantage. The Port's hinterland is well connected with infrastructural network of broad gauge and railway system as well as State and National Highways

3.1.2 The Evolution

January 20, 1952, Pandit Jawaharlal Nehru, the then Prime Minister of India, laid the foundation stone at Kandla for the new port on the western coast of India. It was declared as a Major Port on April 8, 1955 by Late Lal Bahadur Shastri, the then Union Minister for Transport. The Kandla Port Trust was constituted in 1964 under the Major Port Trusts Act, 1963. Since then, this Major Port of Kandla has come a long way in becoming the 'Port of the New Millennium'.

3.1.3 The Strengths to Anchor On

Excellent infrastructural facilities, well-connectivity with the rest of the country by road and rail networks, all-round services provided with efficiency and transparency, lowest port tariff and the envious cost-effectiveness are the major strengths of Kandla Port.

3.1.4 Vision

"To be Asia's Supreme Global Logistic Hub"

3.1.5 Mission

To transform the Port of Kandla into a most globally competitive logistics hub with international excellence leaving imprints in the international maritime arena by exploring its fathomless growth potentialities.

HAZARD RISK VULERNABILITIES

3.2Business Horizon

As the portal to the West and North India and due to its unique location advantage, a vast hinterland of 1 million sq. km can be assured for from Kandla.

The hinterland of the Kandla Port consists of the states of J &K, Punjab, Himachal Pradesh, Haryana, Rajasthan, Delhi, Gujarat and parts of Madhya Pradesh, Uttaranchal and Uttar Pradesh.

Kandla Port is the gateway port for the vast granaries of Punjab and Haryana and the rich industrial belt of West and North India.

3.2.1 Advantage of Kandla Port

- ISO 9001 – 2008 Certified Port.
- All weather port – 365 days, 24 hours.
- Protected and safe harbor.
- 12 berths stretching 2.55 km in a straight line
- Facilities for liquid cargo, POL products, chemicals and edible oil.
- Storage facility for LPG to the tune of 30,000 cu.m.
- Port with highest liquid storage capacity in the country.
- Excellent road and rail connectivity.
- High capacity cranes for dry cargo.
- Transparent and notified tariff.
- 12.5 meter draught.
- Security by CISF.

3.3 Port Logistics

3.3.1 Navigation Facilities

- Round-the-clock navigation.
- Permissible draught 12.5 meters.

Ships with 240 meters length overall and 65,000 DWT are accommodated presently.

- Safe, protected and vast anchorage at outer harbour for waiting and lighter age purpose.
    - 22 lighted navigational buoys with solar lights, as per IALA system, are provided in the navigational channel.
- Light house as an aid for night navigation.
- Fully equipped signal station operational round-the-clock. Four lighted shore beacons.

3.3.2 Flotilla

6 Harbor tugs of various sizes.

Four high speed pilot launches.

One state of the art fully computerized survey aunch
FRP mooring launches.
Four general service launches.

One heave up barge for maintenance of navigational aids.

Two pilot and oil cum debris recovery vessels, one at Kandla and one at Vadinar.

3.4 Strategic & Climatic Advantage

- All-weather port.
- Tropical and dry climatic conditions to handle any type of cargo throughout the year.
- Temperature varying from 25 degree Celsius to 44 degree Celsius.
- Scanty rainfall facilitates round-the-year operations.
- Uninterrupted and smooth port operations on 365 days a year.
- No adverse wave effect, being a protected and sheltered harbour situated in the Creek.
- The only Indian Major Port nearest to the Middle East and Europe.

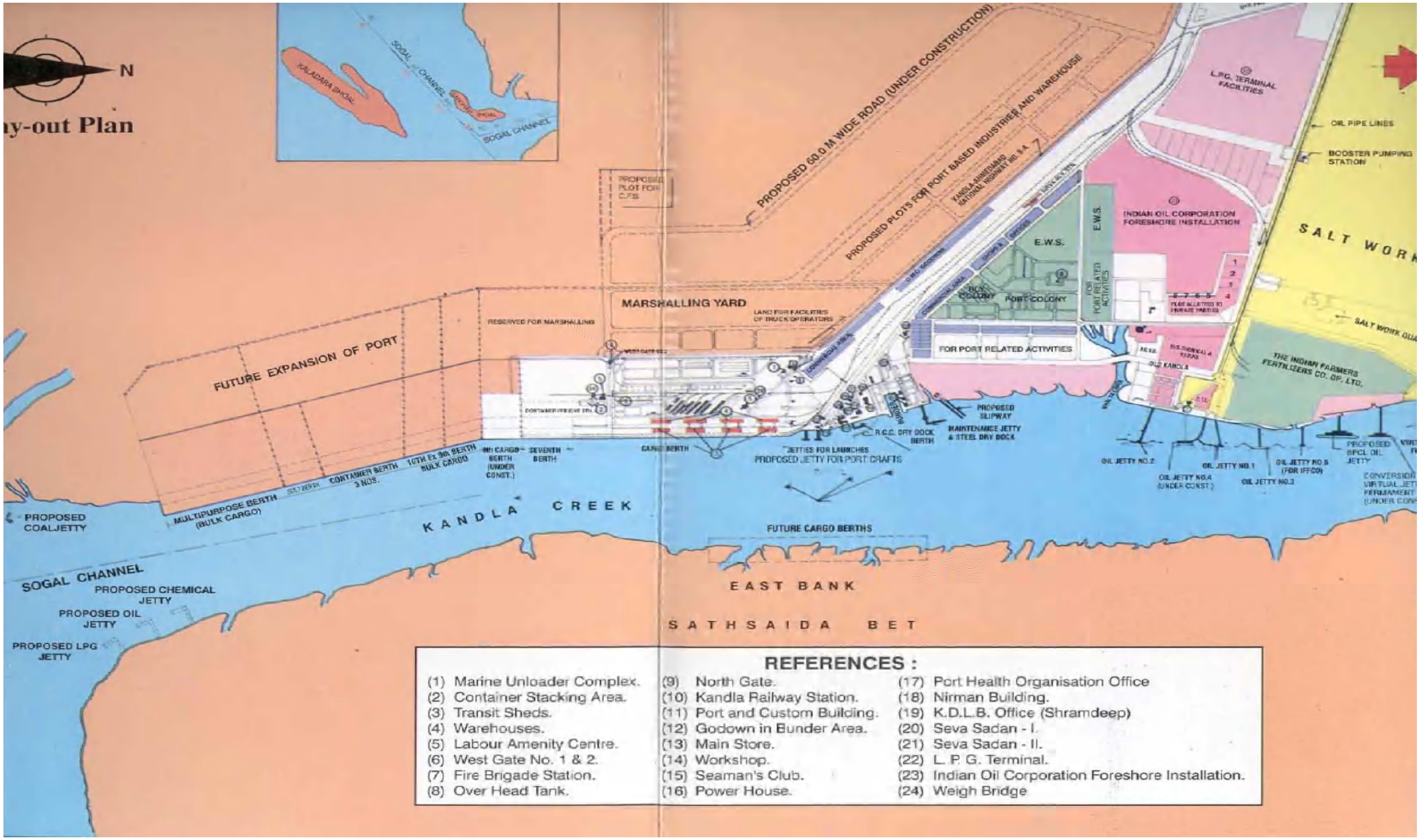
3.5 Port Location

- Latitude: $23^{o}01''$N
- Longitude: $70^{o}13''$E

Kandla Port is situated in the Kandla Creek and is 90km from the mouth of the Gulf of Kutch.

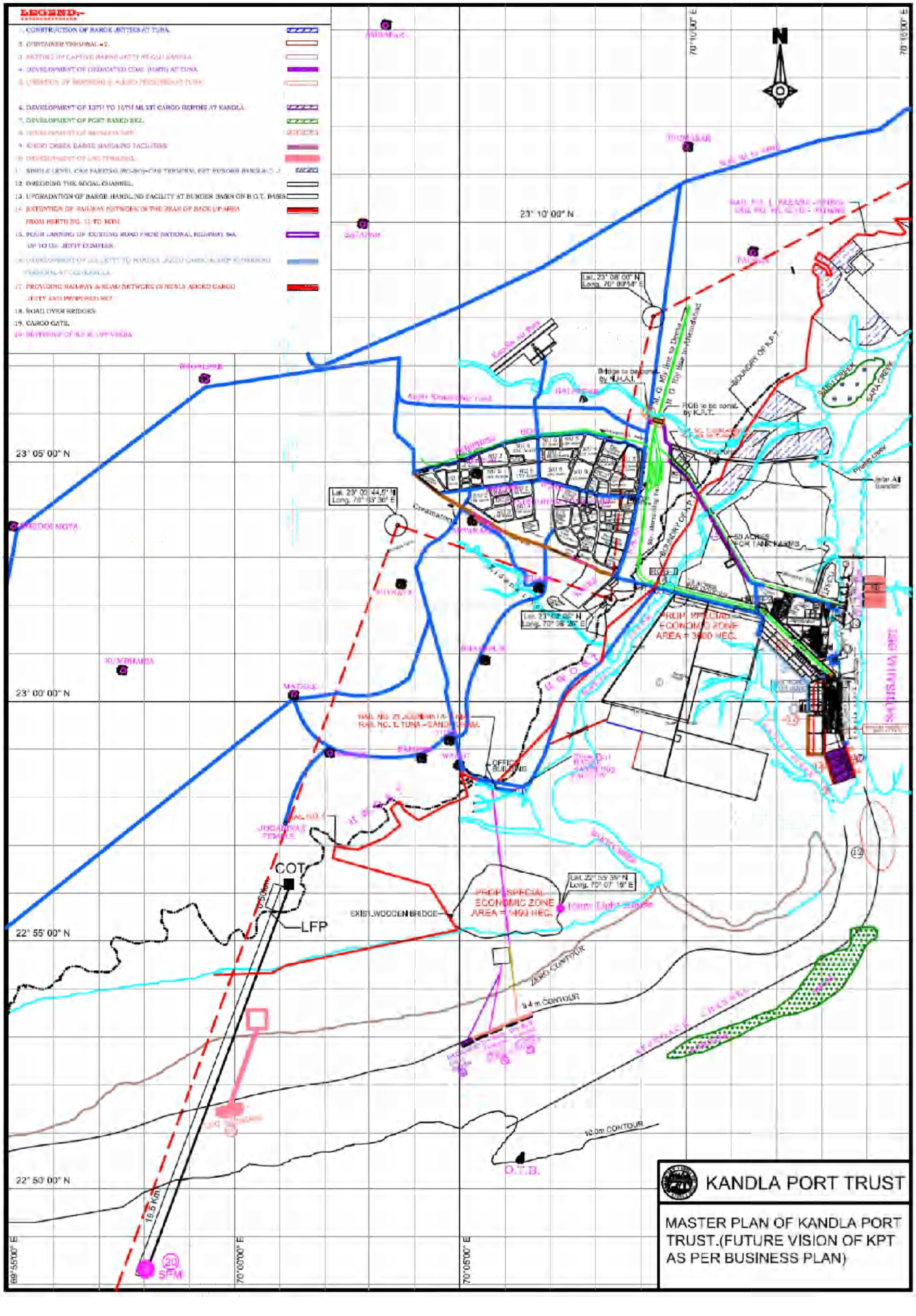
3.5.1 Location - Latitude : 23^{o} 1' N, Longitude : 70^{o} 13' E

Figure 1 – Over view of Kandla Port Trust



Q

3.6 Future Vision of KPT as per Business Plan



LEGEND:-
1. CONSTRUCTION OF BARGE JETTIES AT TUNA.
4. DEVELOPMENT OF DEDICATED COAL BERTH AT TUNA.
6. DEVELOPMENT OF 13TH TO 16TH MULTI CARGO BERTHS AT KANDLA.
7. DEVELOPMENT OF PORT BASED SEZ.
12. DREDGING THE SOGAL CHANNEL.
13. UPGRADATION OF BARGE HANDLING FACILITY AT BUNDER BASIN ON B.O.T. BASIS
14. EXTENTION OF RAILWAY NETWORK IN THE REAR OF BACK UP AREA FROM BERTH NO. 11 TO 16TH
15. FOUR LANNING OF EXISTING ROAD FROM NATIONAL HIGHWAY 8A UP TO OIL JETTY COMPLEX.
17. PROVIDING RAILWAY & ROAD NETWORK IN NEWLY ADDED CARGO JETTY AND PROPOSED SEZ
18. ROAD OVER BRIDGES
19. CARGO GATE.
70°10'00" E
70°15'00" E
N
23° 10' 00" N
23° 05' 00" N
23° 00' 00" N
22° 55' 00" N
22° 50' 00" N
69°55'00" E
70°00'00" E
70°05'00" E
Lat. 23° 08' 00" N Long. 70° 09'14" E
Lat. 23° 03' 44.5" N Long. 70° 03' 30" E
Lat. 22° 55' 39" N Long. 70° 07' 16" E
Bridge to be const. by N.H.A.I.
ROB to be const. by K.P.T.
BOUNDARY OF K.P.T.
50 ACRES FOR TANK FARMS
PROP. SPECIAL ECONOMIC ZONE AREA = 3600 HEC.
PROP. SPECIAL ECONOMIC ZONE AREA = 1450 HEC.
OFFICE BUILDING
EXIST.WOODEN BRIDGE
COT
LFP
19.5 Km
SPM
ZERO CONTOUR
9.4 m CONTOUR
10.0m CONTOUR
O.T.B.
KANDLA PORT TRUST
MASTER PLAN OF KANDLA PORT TRUST.(FUTURE VISION OF KPT AS PER BUSINESS PLAN)

3.7 Steel Floating Dry Dock

The existing steel floating dry dock caters to the need of Port crafts as well as outside organizations and has capacity to accommodate vessels of following parameters.

- LOA maximum up to 95 meters.
- Breadth maximum up to 20 meters.
- Draught maximum up to 4.5 meters.
- Lift displacement maximum up to 2700 tones.

3.8 Infrastructure Advantages at Kandla Port

- 14 dry cargo berths are available, with quay length of 2532 meter.
- Six oil jetties.
- Total custom bonded port area inside the custom fencing is 253 hectares.
- THREE cargo moorings in the inner harbor area for stream handling.

3.8.1 Chemical & Liquid handling Complex

- Total storage capacity : 21.89 Lakh KL
    - Private sector storage terminals – 9.81 Lakh KL.
    - Public sector and cooperative undertaking – 12.08 Lakh KL.

- Loading arms for simultaneous loading and unloading.
- Near zero waiting period for vessels.
- Capacity utilization at international levels ensuring demurrage free handling.
- Excellent discharge rates and faster turnaround.
- Lowest vessel related charges and wharfage charges.
- Suitable for A, B, C. LG, NH, EO classes of liquid and chemicals.

Chemical storage tank farms in the vicinity of liquid jetties.

Tanks for storage of all categories of liquid cargoes like chemicals LPG, cryogenic cargoes, ammonia, acids, petroleum products, edible oils. Etc.

- Efficient handling ensuring minimum losses.
-
- Sophisticated pipeline network (including stainless steel pipes) Sufficient parking space inside and outside the storage facilities.

3.9 Road Network

- Four lane National Highway No: 8-A extended right up to the Ports main gate.
- Fully developed road network, both in and around the Port area to facilitate faster movement of cargo.

○Inside Cargo Jetty Area – 30 km. ○Outside Cargo Jetty Area – 31 km. ○Railway Inside Cargo Jetty Area – 13 km.

3.10Storage Facilities

Kandla Port offers excellent and vast dry cargo storage facilities inside the custom bonded area for storage of import and export cargoes.

The existing storage facilities at the dry cargo jetty area are:

Sr No	Description	No	Area (Sq M)	Capacity in (Tones)
01	Warehouses	33	1.68 Lakhs	4.47 Lakh
02	Open storage space	67	13.10 Lakhs	32.27 Lakh

3.10.1 Private Sector Liquid Storage Facilities

Sr No	Name of the Terminal Operator	No of Tanks	Capacity in (KL)

01	CRL (Chemicals & Resins Ltd)	112	247000
02	FSWAI (Friend Salt Works & Allied Industries)	132	271650
03	Kesar Enterprise	44	90081
04	N P Patel Pvt Ltd	09	38497
05	FOCT (Friend Oil & Chemicals Terminal	21	39263
06	USTTL – Liquid Terminal	22	63038
07	Agencies & Cargo Care Limited	27	50000
08	J K Synthetics	14	25176
09	IMC Limited	04	25288
10	J R Enterprises	15	25320
11	Indo Nippon Chemicals Ltd	10	17200
12	Liberty Investment	06	16016
13	Bayer ABS Ltd	11	13310
14	Deepak Estate Agency	09	13212
15	Tejmalbhai & Company	08	12577
16	Avean International Care Ltd	11	12160
17	USTTL Gas Terminal	04	5720
18	Parker Agrochem Export Ltd	06	15000
	Total Capacity	465	980508

3.10.2 Public Sector Liquid Storage Facilities

Sr No	Name of the Terminal Operator	No of Tanks	Capacity in (KL)
01	Indian Oil Corporation	38	575838
02	Bharat Petroleum Corporation	21	230000

03	Hindustan Petroleum Corporation	28	204000
04	IOC – LPG	02	30000
05	IFFCO	11	110000
06	NDDB	09	58530
	Total Capacity	109	1208360

3.11Container Handling Facilities Being upgraded

Being upgraded , by ULA , will be updated soon

3.12Port Equipments

3.12.1 Wharf Cranes

- 12 wharf cranes of the following capacities:
  - Two of 12 tones.
  - Four of 16 tones.
  - Six of 25 tones.
- The rated capacity of the 16 ton crane is 400 tones / hour.
- The rated capacity of the 25 ton crane is 400 tones / hour.

3.12.2 Weighbridges

- Nine weighbridges inside the port, which includes:
  - Two Weighbridge of 40 MT capacities.
  - One Weighbridge of 50 MT capacity
  - Two Weighbridge of 60 MT capacity
  - Two Weighbridge of 80 MT capacity
  - Three Weighbridge of 100 MT capacities.

3.12.3 Other Support Equipment

- Easy availability of other support loading equipments such as Forklifts, Tractor - Trailers, Pay-loaders of various capacities.

- Private handling, equipments like Mobile Cranes, Top lifters, pay-loaders, Forklifts, Heavy-duty Trailers etc. available on hire at competitive rates.

3.13 Berths at Kandla Port

3.13.1 Details of Draught

Sr No	Name of Berth	Draught (in Meters)	DWT (In Metric Tons)
1	Cargo Berth No.1	9.80	45000
2	Cargo Berth No.2	9.80	45000
3	Cargo Berth No.3	9.80	45000
4	Cargo Berth No.4	9.80	45000
5	Cargo Berth No.5	9.10	35000
6	Cargo Berth No.6	9.10	35000
7	Cargo Berth No.7	12.00	55000
8	Cargo Berth No.8	12.00	55000
9	Cargo Berth No.9	12.00	55000
10	Cargo Berth No.10	12.00	55000

11	Cargo Berth No.11	12.50	65000
12	Cargo Berth No.12	12.50	65000
13	Cargo Berth No.13	13.0	75000
14	Cargo Berth No.15	13.0	75000
15	Oil Jetty No. 1 (Nehru Jetty)	10.0	40000
16	Oil Jetty No. 2 (Shastri Jetty)	09.00	52000
17	Oil Jetty No. 3 (Indira Jetty)	09.80	40000
18	Oil Jetty No. 4 (Rajiv Jetty)	10.70	56000
19	Oil Jetty No. 5 (IFFCO)	10.10	45000
18	Oil Jetty No. 6 (IOCL)	10.10	45000

3.13.2 Details of Berths

No of Berth	No of Bollard		No of Panels	Length of Each Panel	Length of Berth (m)	Draught (in Meters)	DWT (In Metric Tons)
1	1 to 8	08	08	22.866	182.93	9.80	45000
2	8 to 16	08	08	22.866	182.93	9.80	45000
3	17 to 24	08	08	22.866	182.93	9.80	45000
4	25 to 32	08	08	22.866	182.93	9.80	45000
5	33 to 41	09	09	22.866	205.79	9.10	35000
6	42 to 50	09	09	22.866	205.79	9.10	35000

7	51 to 58	08	08	(30.440 x 7) + 22.56 + (3.00)	238.64	12.00	55000
8	59 to 68	10	06	(45.72 x 3) + 30.44 + 27.44 + (18.00)	213.04	12.00	55000
9	69 to 76	08	05	(45.72 x 3) + 25.72 + (18.05)	182.93	12.00	55000
10	77 to 85	09	05	(59.10 x 2) + (43.20 x 2) + (4.81)	209.41	12.00	55000
11	86 to 98	13	05	(59.00 x 4) + (45.00)	281.00	12.50	65000
12	-----	---	---		264.00	12.50	65000
13						13.0	75000
15						13.0	75000

3.13.3 Details of Existing Godown

Sr No	Godown No	Size of Godown (in M)	Area in Sq Meters	Capacity in (Tons)
1	Godown – 1 (WH-A)	152.44 x 36.59	5578	9817
2	Godown – 2 (WH-B)	152.44 x 36.59	5578	10500
3	Godown – 3 (W.H -C)	152.44 x 36.59	5578	10500
4	Godown – 4 (W.H.D)	152.44 x 36.59	5578	10500
5	Godown – 6 (C.F.S. - II)	90.00 x 36.00	3240	12400
6	Godown – 7 (C.F.S. – I)	90.00 x 36.00	3240	12400

7	Godown – 8 (F.B.S.S)	236.00 x 30.00	7080	13300
8	Godown – 9 (Bagging Plant)	287.00 x 19.20	5510	10400
9	Godown – 10	132.00 x 22.50	2970	11400
10	Godown – 11	186.00 x 22.50	4185	7900
11	Godown – 12	170.00 x 22.50	3825	7200
12	Godown – 13	162.00 x 22.50	3645	6900
13	Godown – 14	192.00 x 22.50	4320	8100
14	Godown – 15	162.00 x 22.50	3645	6900
15	Godown – 16	192.00 x 22.50	4320	9100
16	Godown – 17	174.00 x 22.50	3915	15000
17	Godown – 18	138.00 x 45.00	6210	23800
18	Godown – 19	192.00 x 22.50	4320	8100
19	Godown – 20	192.00 x 22.50	4320	8100
20	Godown – 21	192.00 x 22.50	4320	8100
21	Godown – 22	192.00 x 22.50	4320	8100
22	Godown – 23	174.00 x 22.50	3915	7400
23	Godown – 24	156.00 x 45.00	7020	26900
24	Godown – 25	132.00 x 22.50	2970	5600
25	Godown – 26	99.06 x 36.55	3621	13900
26	Godown – 27		1943	6995
27	Godown – 28	173.88 x 30.50	5503	19092
28	Godown – 29	137.55 x 50.00	6888	24797
29	Godown – 30	126.00 x 49.00	6174	22226
30	Godown – 31	140.00 x 50.00	7000	25200
31	Godown – 32	307.45 x 40.00	12298	44273
32	Godown – 33	133.00 x 40.00	5320	19152

	Total Available Presently	158349	434052

3.14 Various Private Terminal Storages at Kandla & the chemicals POL products handled.

3.14.1 Bharat Petroleum Corporation Ltd

- Motor Spirit (MS)
- HSD – High Speed Diesel
- SKO – Superior Kerosene Oil
- Ethanol (Ethyl Alcohol)
- Naphtha
- LDO – Light Diesel Oil

3.14.2 CRL

- Benzene
- Toluene
- Aniline
- Butanol (Butyl Alchol)
- H Phenol
- CTC – Carbon Tetra Chloride
- Caster Oil
- CPS
- Phenol
- De Alcohol (Denatured Alcohol)

- IPA – Iso Propyl Alcohol
- Butyl Acetate
- MEK (Methyl Ethyl Ketone)
- Methyl Alcohol / Methanol
- Hexane
- Vinyl Acetate
- MIBK
- BAM
- Propylene
- Cyclo Hexane
- Caustic Soda (Sodium Hydroxide)
- Acetic Acid
- Nonene
- EDC (Ethylene Di Chloride)

3.14.3 United Storage & Tank Terminals Ltd

- LPG – Liquefied Gas Storage & Handling terminal
- 1:3 Butadiene
- Crude C 4 Mix
- Butane – 1

3.14.4 Indo Nippon Chemicals Co Ltd

- ISO Butanol
- A – Olefin
- Waksol (Parafin)
- VAM – Vinyl Acetate Monomer
- MDC – (Methyle Metacrylate)
- Toluene

Naphtha

IPA

3.14.5 Rishi Kiran Logistics (P) Ltd

- Butyl Cellsolve
- Chloroform
- DO Wanol
- HNP
- N – Parafin
- Methanol
- Polyether Polyol

Papi 27 Polymeric

Tri chloric ethylene Vinyl chloride monomer.

3.14.6 Ineos ABS (India) Ltd

Chemicals Stored

- Styrene
- ACN
- Chloroform

Parafin

Chemicals Proposed

- Methyl Ethyl Ketone (MEK)

Benzene

Methanol

HNP

Acetone

Butyl Acrylate

Butanol

1 – Butanol

CTC (Carbon Tetra Chloride)

Cyclo Hexonol

Cyclo Hexanone

Cumene

Di Octylphthalate

Ethanol – IPA (Mix)

Ethanol

Ethyl Hexonol

Ethyl Benzene

Hexane

Heptane

Iso Propanol

P – Xylene

Propylene Trimer

C – 9 – Hydrocarbons

Toluene

Vinyl Acetate

Mixed xylene

N – Tetra Decane

Polvoal

3.14.7 Friends Oil & Chemical Terminal (P) Ltd

- Furnace Oil
- Styrene
- C – Palm Oil
- Mix – HSD & Naphtha

CPO (NEG) – Crude Palm Oil

Acrylate Bam

Butyle Glycol

Mosstanoll

Butyl Glycol

Cubutol

Methyl Methacr

ISO Nanano

CDSBO

3.14.8 Indian Oil (LPG)

- LPG

3.14.9 Indian Oil

- Motor Spirit (MS)
- High Speed Diesel (HSD)
- SKO (Superior Kerosene Oil)

LAN

3.14.10 Hindustan Petroleum Company Limited

- Furnace Oil (FO)
- High Speed Diesel (HSD)
- Light Diesel Oil (LDO)
- SKO (Superior Kerosene Oil)

Motor Spirit (MS)

3.14.11 Friends Salt Works & Allied Industries

- Naptha
- Toluene
- N – Proanol
- HNP
- Mixed Parafin
- Solvent – CS
- Iso Prophyl Alcohol (IPA)
- Methenol
- N – Parafin C9 – C
- M – xylene
- High Speed Diesel (HSD)
- Mosstanol
- Methylene Chloride
- Ethyl Acetate
- Vinyl Acetate
- HA – 100
- MEK
- Acetone
- Crude Benzene
- Heavy Aromatics

Butyl Acrylate

Shell Sarasol – 4

Carbon Tetra Chloride (CTC)

HA – 170

MBK

De Natured Spirit

Nonene

Condensate

Caradol SC- 56 – 0

N – Parafin

- Butyl Acetate
- LAB
- Naptha
- Hexane
- ISO – Decyl Alcohol
- Sodium Hydroxide (Caustic Soda)
- Methyl Met
- Butyl Arylate
- MIBK
- DHSO – But
- Crude PEG
- CPKO Crude PNEG

3.14.12 IFFCO

- Anhydrous Liquid Ammonia
- Phosphoric Acid
- Potosh
- Urea
- Hydrochloric Acid
- Sulphuric Acid
- LSHS Furnace Oil

3.14.13 IOC (Marketing)

No list of chemicals is provided

3.14.14 JRE Tank Terminal (P) Ltd (Liquid Storage Terminal)

No list of chemicals is provided

3.14.15 United Storage & Tank Terminals Ltd (Liquid Terminal)

No list of chemicals is provided

3.15 Offshore Oil Terminal (OOT) Vadinar

KPT had commissioned off shore oil terminal facilities at Vadinar in 1978, jointly with Indian Oil Corporation, by providing single bouy mooring (SBM) system having capacity of 54 MMTPA, which was the first of its kind in India. A significant quantum of infrastructural up gradation has since been effected and excellent maritime infrastructure created for the 32 MMTPA Essar Oil Refinery at Vadinar.

- A draught of up to 33 meters at SBMs and lighterage point operations (LPO) Three SBMs available.
- Handling VLCCs of 300000 DWT and more.
- Providing crude oil for the refineries of Koyali (Gujarat), Mathura (Uttar Pradesh), Panipat (Haryana) and Essar Refinery, Jamnagar (Gujarat)
- 2nd SBM was commissioned in the year 1998.
- 3rd SBM at Vadinar is for importing crude for the oil refinery of Essar Oil.
- Simultaneous handling of three VLCCs possible at the SBMs.
- Vast crude tankage facility.
- Two 35 tone and two 50 tone state of art BP SRP pull back tugs are available for smooth and simultaneous shipping operations on the SBMs and product jetty.
- One oil and debris recovery tug for oil pollution control has been acquired and stationed at Vadinar.
- Excellent infrastructure and tranquil waters facilitate transshipment operations even during the monsoon.

4 IDENTIFICATION OF EMERGENCIES

4.1 Overall Methodology

In order to undertake this study TELOS has used ALOHA (Aerial Locations of Hazardous Atmospheres) a computer program designed especially for use by people responding to chemical releases, as well as for emergency planning and training. ALOHA models key hazards — toxicity, flammability, thermal radiation (heat), and overpressure (explosion blast force) — related to chemical releases that result in toxic gas dispersions, fires, and /or explosions.

4.1.1 Dispersion Modeling

ALOHA air dispersion model is intended to be used to estimate the areas near a short-duration chemical release where key hazards—toxicity, flammability, thermal radiation, or overpressure—may exceed user-specified Levels of Concern (LOCs).

(Note: If the released chemical is not flammable, toxicity is the only air dispersion hazard modeled in ALOHA.)

ALOHA is not intended for use with radioactive chemical releases, nor is ALOHA intended to be used for permitting of stack gas or modeling chronic, low-level ("fugitive") emissions. Other models are designed to address larger scale and/or air quality issues (Turner and Bender 1986). Since most first responders do not have dispersion modeling backgrounds, ALOHA has been designed to require input data that are either easily obtained or estimated at the scene of an accident. ALOHA's on-screen help can assist you in choosing inputs.

4.1.1.1What is Dispersion

Dispersion is a term used by modelers to include advection (moving) and diffusion (spreading). A dispersing vapor cloud will generally move (advent) in a downwind direction and spread (diffuse) in a crosswind and vertical direction (crosswind is the direction perpendicular to the wind). A cloud of gas that is denser or heavier than air (called a heavy gas) can also spread upwind to a small extent.

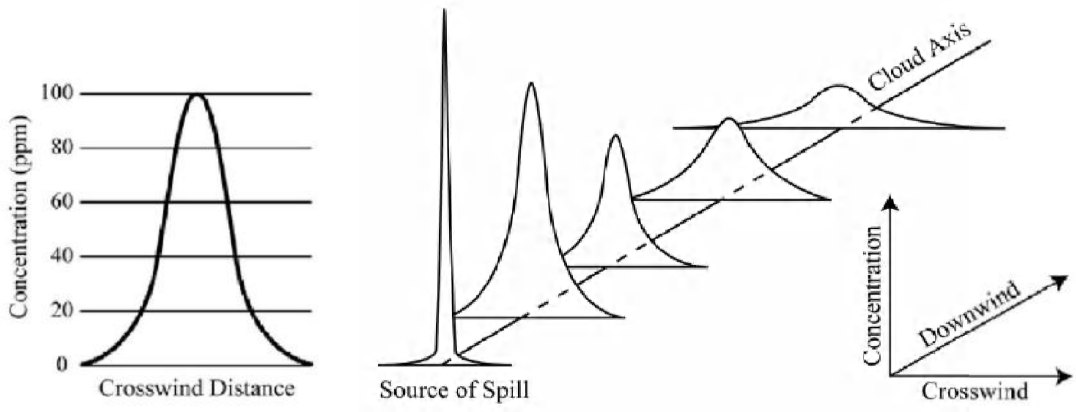
ALOHA can model the dispersion of a cloud of pollutant gas in the atmosphere and display a diagram that shows an overhead view of the regions, or threat zones, in which it predicts that key hazard levels (LOCs) will be exceeded. This diagram is called a threat zone plot. To obtain a threat zone estimate, you must first choose at least one LOC. (ALOHA will suggest default LOCs, and you may keep those or choose up to three other LOCs.) For toxic gas dispersion scenarios, an LOC is a threshold concentration of the gas at ground level—usually the concentration above which a hazard is believed to exist. The type of LOC will depend on the scenario. For each LOC you choose, ALOHA estimates a threat zone where the hazard is predicted to exceed that LOC at some time after a release begins. These zones are displayed on a single threat zone plot. If three LOCs are chosen, ALOHA will display the threat zones in red, orange, and yellow. When you use ALOHA's default LOCs, the red zone represents the worst hazard.

There are two separate dispersion models in ALOHA: Gaussian & Heavy Gas.

4.1.1.2Gaussian Model:

ALOHA uses the Gaussian model to predict how gases that are about as buoyant as air will disperse in the atmosphere. Such neutrally buoyant gases have about the same density as air. According to this model, wind and atmospheric turbulence are the forces that move the molecules of a released gas through the air, so as an escaped cloud is blown downwind, "turbulent mixing" causes it to spread out in the crosswind and upward directions. According to the Gaussian model, a graph of gas concentration within any crosswind slice of a moving pollutant cloud looks like a bell-shaped curve, high in the center (where concentration is highest) and lower on the sides (where concentration is lower), At the point of a release, the pollutant gas concentration is very high, and the gas has not diffused very far in the crosswind and upward directions, so a graph of concentration in a crosswind slice of the cloud close to the source looks like a spike. As the pollutant cloud drifts farther downwind, it spreads out and the "bell shape" becomes wider and flatter.

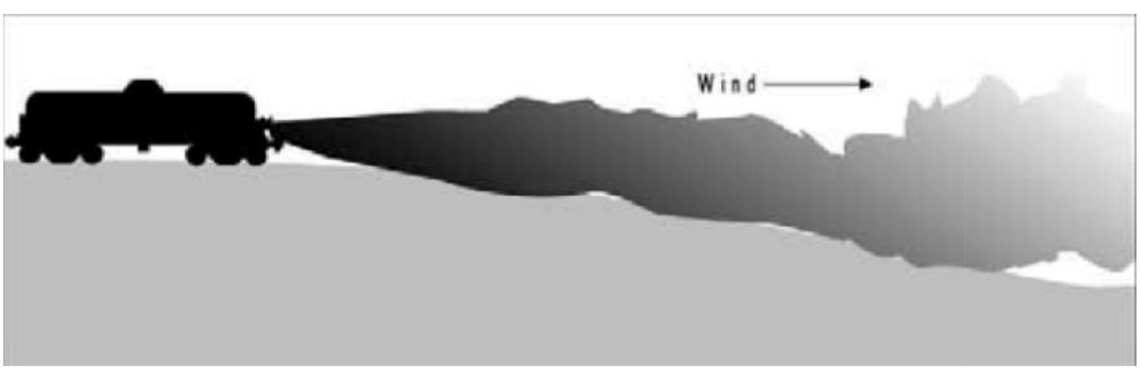
Gaussian distribution (left) & Gaussian Spread (right)



4.1.1.3Heavy gases:

When a gas that is heavier than air is released, it initially behaves very differently from a neutrally buoyant gas. The heavy gas will first "slump," or sink, because it is heavier than the surrounding air. As the gas cloud moves downwind, gravity makes it spread; this can cause some of the vapor to travel upwind of its release point. Farther downwind, as the cloud becomes more diluted and its density approaches that of air, it begins behaving like a neutrally buoyant gas. This takes place when the concentration of heavy gas in the surrounding air drops below about 1 percent (10,000 parts per million). For many small releases, this will occur in the first few yards (meters). For large releases, this may happen much further downwind.

Cloud spread as a result of gravity.



The heavy gas dispersion calculations that are used in ALOHA are based on those used in the DEGADIS model (Spicer and Havens 1989), one of several well-known heavy gas models. This model was selected because of its general acceptance and the extensive testing that was carried out by its authors.

4.1.1.4Classification of Heavy Gases:

A gas that has a molecular weight greater than that of air (the average molecular weight of air is about 29 kilograms per kilomole) will form a heavy gas cloud if enough gas is released. Gases that are lighter than air at room temperature, but that are stored in a cryogenic (low temperature) state, can also form heavy gas clouds. If the density of a gas cloud is substantially greater than the density of the air (the density of air is about 1.1 kilograms per cubic meter), ALOHA considers the gas to be heavy.

4.1.2 Fires & Explosions

ALOHA version 5.4, can model fire and explosion scenarios as well as toxic gas dispersion scenarios. This section provides information about fires and explosions, and then explains how to model fires and explosions in ALOHA.

ALOHA allows to model chemical releases from four types of sources: Direct, Puddle, Tank, and Gas Pipeline.

③ Direct: chemical release directly into the atmosphere (bypassing ALOHA's source calculations).

③ Puddle: chemical has formed a liquid pool.

③ Tank: chemical is escaping from a storage tank.

③ Gas Pipeline: chemical is escaping from a ruptured gas pipeline.

ALOHA Sources & Scenarios

Source	Toxic Scenarios	Fire Scenarios	Explosion Scenarios
Direct			
Direct Release	Toxic Vapor Cloud	Flammable Area (Flash Fire)	Vapor Cloud Explosion
Puddle			
Evaporating	Toxic Vapor Cloud	Flammable Area (Flash Fire)	Vapor Cloud Explosion
Burning (Pool Fire)		Pool Fire	
Tank			
Not Burning	Toxic Vapor Cloud	Flammable Area (Flash Fire)	Vapor Cloud Explosion
Burning		Jet Fire or Pool Fire	
BLEVE		BLEVE (Fireball and Pool Fire)	
Gas Pipeline			
Not Burning	Toxic Vapor Cloud	Flammable Area (Flash Fire)	Vapor Cloud Explosion
Burning (Jet Fire)		Jet Fire	

4.1.2.1 Fire

A fire is a complex chain reaction where a fuel combines with oxygen to generate heat, smoke, and light. Most chemicals fires will be triggered by one of the following ignition sources: sparks, static electricity, heat, or flames from another fire. Additionally, if a chemical is above its auto ignition temperature it will spontaneously catch on fire without an external ignition source.

There are several properties that measure how readily—that is, how easily—a chemical will catch on fire. Here we'll discuss three of these properties: volatility, flash point, and flammability limits. Volatility is a measure of how easily a chemical evaporates. A flammable liquid must begin to evaporate—forming a vapor above the liquid—before it can burn. The more volatile a chemical, the faster it evaporates and the quicker a flammable vapor cloud is formed. The flash point is the lowest temperature where a flammable liquid will evaporate enough to catch on fire if an ignition source is present. The lower the flash point, the easier it is for a fire to start. Flammability limits, called the Lower Explosive Limit (LEL) and the Upper Explosive Limit (UEL), are the boundaries of the flammable region of a vapor cloud. These limits are percentages that represent the concentration of the fuel—that is, the chemical—vapor in the air. If the chemical vapor comes into contact with an ignition source, it will burn only if its fuel-air concentration is between the LEL and the UEL. To some extent, these properties are interrelated—chemicals that are highly volatile and have a low flash point will usually also have a low LEL.

Once the chemical catches on fire, three things need to be present to keep the fire going: fuel (the chemical), oxygen, and heat. This is often referred to as the fuel triangle. If any one of those components is eliminated, then the fire will stop burning.

Like other reactions, a fire can also generate byproducts—smoke, soot, ash, and new chemicals formed in the reaction. Some of these reaction byproducts can be hazardous themselves. While ALOHA cannot model all the complex processes that happen in a fire (like the generation and distribution of byproducts), it can predict the area where the heat radiated by the fire—called thermal radiation—could be harmful.

Thermal radiation is the primary hazard associated with fires. However, it is also important to consider the hazards associated with any secondary fires and explosions that may occur.

4.1.2.2Thermal Radiation Levels of Concern:

A Thermal Radiation Level of Concern (LOC) is a threshold level of thermal radiation, usually the level above which a hazard may exist. When you run a fire scenario, ALOHA will suggest three default LOC values. ALOHA uses three threshold values (measured in kilowatts per square meter and denoted as kW/m2) to create the default threat zones:

③ Red: 10 kW/m^2 (potentially lethal within 60 sec);

③ Orange: 5 kW/m^2 (second-degree burns within 60 sec); and

③ Yellow: 2 kW/m^2 (pain within 60 sec).

The thermal radiation effects that people experience depend upon the length of time they are exposed to a specific thermal radiation level. Longer exposure durations, even at a lower thermal radiation level, can produce serious physiological effects. The threat zones displayed by ALOHA represent thermal radiation levels; the accompanying text indicates the effects on people who are exposed to those thermal radiation levels but are able to seek shelter within one minute.

ALOHA's default thermal radiation values are based on a review of several widely accepted sources for this topic (e.g., American Institute of Chemical Engineers 1994, Federal Emergency Management Agency et al. 1988, and Lees 2001).

Thermal Radiation Burn Injury Criteria.

Radiation Intensity (kW/m^2)	Time for Severe Pain (S)	Time for 2nd Degree Burns (S)
1	115	663
2	45	187
3	27	92
4	18	57
5	13	40
6	11	30
8	7	20
10	5	14
12	4	11

Note: The durations that correspond to effects like pain or second-degree burns can vary considerably, depending on circumstances. The effects above were observed on bare skin that was exposed directly to the thermal radiation. Some types of clothing can serve as a protective barrier against thermal radiation and can affect the exposure duration. However, exposure duration should be kept to a minimum, even at low levels of thermal radiation.

4.1.3 Overpressure

A major hazard associated with any explosion is overpressure. Overpressure, also called a blast wave, refers to the sudden onset of a pressure wave after an explosion. This pressure wave is caused by the energy released in the initial explosion—the bigger the initial explosion, the more damaging the pressure wave. Pressure waves are nearly instantaneous, traveling at the speed of sound.

Although a pressure wave may sound less dangerous than a fire or hazardous fragments, it can be just as damaging and just as deadly. The pressure wave radiates outward like a giant burst of air, crashing into anything in its path (generating hazardous fragments). If the pressure wave has enough power behind it, it can lift people off the ground and throw them up against nearby buildings or trees. Additionally, blast waves can damage buildings or even knock them flat— often injuring or killing the people inside them. The sudden change in pressure can also affect pressure-sensitive organs like the ears and lungs. The damaging effects of the overpressure will be greatest near the source of the explosion and lessen as you move farther from the source.

ALOHA predicts an explosion's effects, assess the surroundings at the explosion site as you interpret ALOHA's threat zone plot. Large objects (like trees and buildings) in the path of the pressure wave can affect its strength and direction of travel. For example, if many buildings surround the explosion site, expect the actual overpressure threat zone to be somewhat smaller than ALOHA predicts. But at the same time, more hazardous fragments could be generated as the blast causes structural damage to those buildings.

4.1.3.1Overpressure Levels of Concern

An Overpressure Level of Concern (LOC) is a threshold level of pressure from a blast wave, usually the pressure above which a hazard may exist. When you run a vapor cloud explosion scenario, ALOHA will suggest three default LOC values. ALOHA uses three threshold values to create the default threat zones:

- ③ Red: 8.0 psi (destruction of buildings);
- ③ Orange: 3.5 psi (serious injury likely); and
- ③ Yellow: 1.0 psi (shatters glass).

ALOHA's default overpressure values are based on a review of several widely accepted sources for this topic (e.g., American Institute of Chemical Engineers 1994, Federal Emergency Management Agency etal. 1988, and Lees 2001).

Explosion Overpressure Damage Estimates

Overpressure* (psig)	Expected Damage
0.04	Loud noise (143 dB); sonic boom glass failure.
0.15	Typical pressure for glass failure.
0.40	Limited minor structural damage.
0.50-1.0	Windows usually shattered; some window frame damage.
0.70	Minor damage to house structures.
1.0	Partial demolition of houses; made uninhabitable.
1.0-2.0	Corrugated metal panels fail and buckle. Housing wood panels blown in.
1.0-8.0	Range for slight to serious laceration injuries from flying glass and other missiles.
2.0	Partial collapse of walls and roofs of houses.
2.0-3.0	Non-reinforced concrete or cinder block walls shattered.
2.4-12.2	Range for 1-90% eardrum rupture among exposed populations.
2.5	50% destruction of home brickwork.
3.0	Steel frame building distorted and pulled away from foundation.
5.0	Wooden utility poles snapped.
5.0-7.0	Nearly complete destruction of houses.
7.0	Loaded train cars overturned.
9.0	Loaded train box cars demolished.
10.0	Probable total building destruction.
14.5-29.0	Range for the 1-99% fatalities among exposed populations due to direct blast effects.

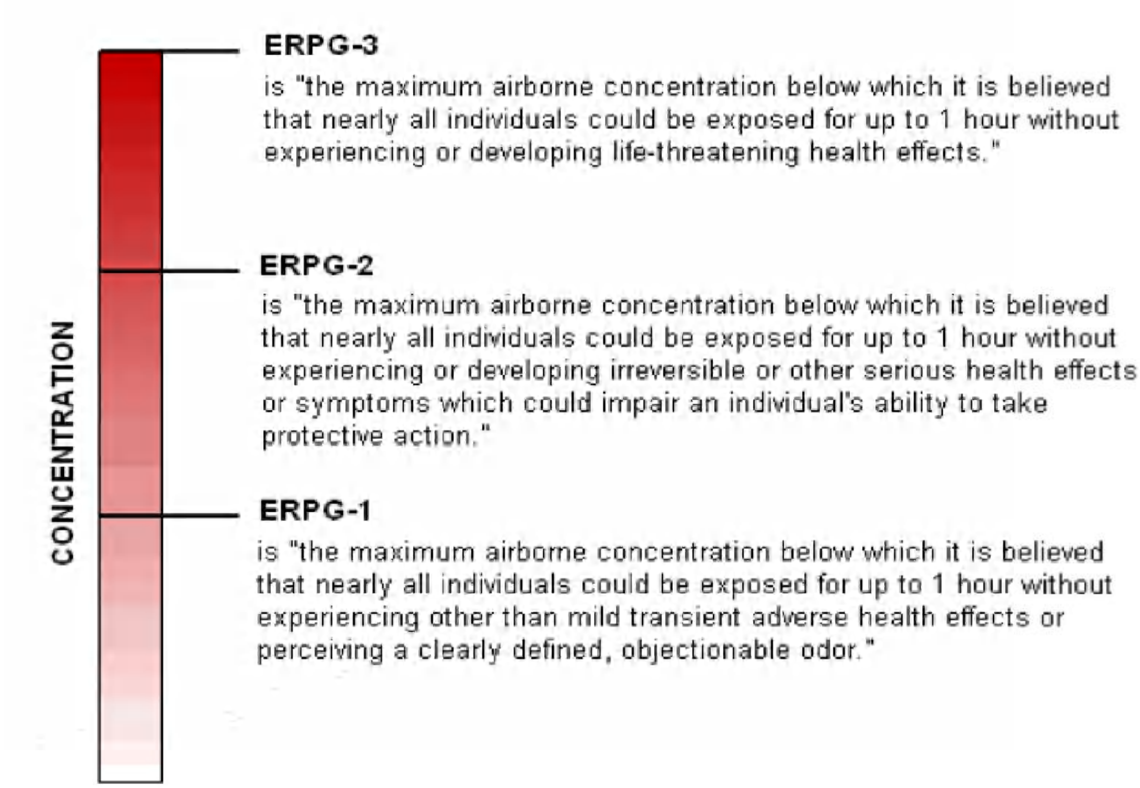
* These are peak pressures formed in excess of normal atmospheric pressure by blast and shock waves.

4.2 Effect at different Heat Radiations & Overpressure

4.2.1 Emergency Response Planning Guidelines (ERPGs)

ERPGs were developed as planning guidelines, to anticipate human adverse health effects caused by exposure to toxic chemicals.

The ERPGs are three-tiered guidelines with one common denominator: a 1-hour exposure period. The tiers are defined as follows:



Interpreting ERPG:

The ERPG guidelines do not protect everyone. Hypersensitive individuals would suffer adverse reactions to concentrations far below those suggested in the guidelines.

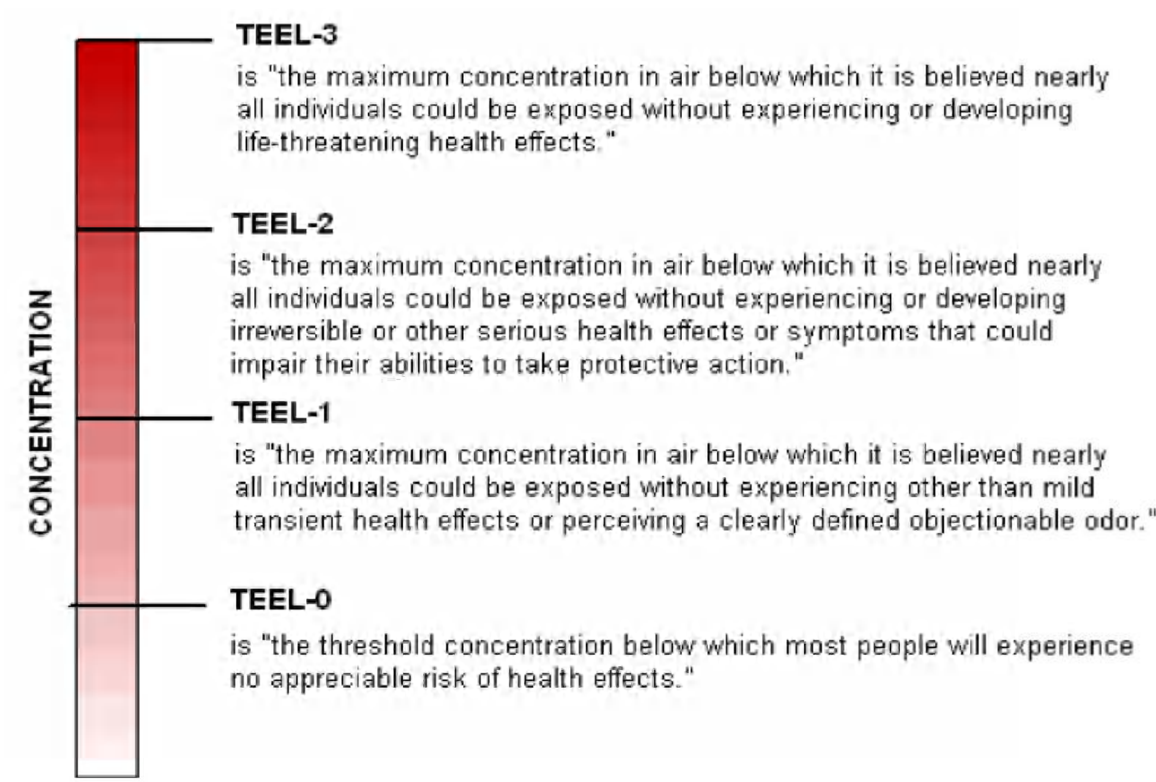
The guidelines are focused on one period of time: 1 hour. Exposure in the field may be longer or shorter. However, the ERPG committee strongly advises against trying to extrapolate ERPG values to longer periods of time.

ERPGs do not contain safety factors usually incorporated into exposure guidelines such as the TLV. Rather, they estimate how the general public would react to chemical exposure. Just below the ERPG-1, for example, most people would detect the chemical and may experience temporary mild effects. Just below the ERPG-3, on the other hand, it is estimated that the effects would be severe, although not lifethreatening. The TLV, on the other hand, incorporates a safety factor to prevent ill effects to exposed workers.

4.2.2 Temporary Emergency Exposure Limit (TEEL)

TEELs are temporary levels of concern designed to be used as toxic exposure limits for chemicals for which Acute Exposure Guideline Levels (AEGLs) or Emergency Response Planning Guidelines (ERPGs) have not yet been defined. Like AEGLs and ERPGs, they are designed to represent the predicted response of members of the general public to different concentrations of a chemical during an incident.

Each TEEL includes four tiers, defined as follows:



4.3 Various emergencies that may be expected at the port area

- Leak / Spill and fire and explosion at the chemical jetties of hazardous chemicals.
- Medical Injury
- Sabotage
- Civil disturbance
- Hostage situation
- Severe Weather

Earthquake

Tsunami

Accidents in the channel.

4.4 Leak / Spill and Fire & Explosion of Hazardous Chemicals at the Jetties

Consequence analysis of impact distances for selected maximum credible loss scenarios of some selected chemicals handled at the chemical berths. The distance worked are indicative and to be used as a guide line.

4.5 Important assumptions considered for the Study

1. Representative chemicals have been chosen at each jetty. The distance shown in the table / map are applicable to any jetty (1 to 6) where the same chemical could be handled.

   If the port is ready to handle the indicated distances for the chosen chemicals, then it can handle any other chemical emergency also under any weather conditions except storm / cyclone etc.

2. Wind speed 10m/sec from SW at 3 meter height.
3. Ground roughness – Open / Concrete
4. Cloud cover – Partial (5 Tenths)
5. Ambient Temperature – 40 degree C Average
6. Atmospheric stability Class “C”
7. Relative Humidity – 50%
8. Leak of 1000 litres of chemical
9. State of chemical at the time of leak – Liquid
10. Source: Direct Source
11. Source: Evaporating Puddle
    - Downwind toxic effects
    - Vapour cloud flash fire
    - Overpressure from vapour cloud explosion
12. Source: Burning Puddle
    - Thermal Radiation

13. Puddle diameter Average – 10 M

14. Puddle volume 1000 Litres.

4.6 Maximum Credible Loss Scenarios

The Maximum Credible Loss Scenarios (MCLS) give the possible failure scenarios, which takes into account the maximum inventory that can get released at the time of such a failure considering the intervention time based on safety systems provided at the facility.

The most hazardous chemicals taken into consideration for the study are:

Berth No: 1 – LPG & Toluene

Berth No: 2 – Benzene, ACN & Aniline

Berth No: 3 – Methanol, 1,3 Butadiene & Acetone

Berth No: 4 – VCM & Propylene

Berth No: 5 – Ammonia & HSD

Berth No: 6 – Motor Spirit & SKO

4.7 Impact Distances for MCLS under study

4.7.1 Jetty No – 1 Instantaneous Release / Evaporation Puddle / Burning Puddle for LPG

Chemical		Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance for		
		TEEL - 3 33000 ppm	TEEL - 2 17000 ppm	TEEL - 1 5500 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	10.0kW/m^2	5.0kW/m^2	2.0kW/m^2
		m	m	m	m	m	m	m	m	m	m	m
Jetty One	LPG (Instantaneous Release)	31	46	88	68	204	LOC not exceeded	48	61	-----	------	-----
	LPG (Evaporation Puddle)	13	24	54	35	130	LOC not exceeded	21	42	-----	------	-----
	LPG (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	34	42	57

- Emergency equipment should be placed more than 60 meters away from the unloading hoses / source of leak to prevent damage to them due to over pressures.
- All fire fighting operation should be carried out from a 57 meter distance from the unloading hose, unless fire suits and close proximity suits are used by the fire fighting personnel.
- Whatever is the emergency (fire) at the berth, the sprinklers / water curtain at the berth edge should be activated. •All persons not directly connected with the operation should be moved beyond 88 meters from the fire / leak
- There should be no source of ignition in the chemical jetty (1 to 6) areas.
- The complete chemical jetty complex is a flame proof zone at all times.

4.7.2 Jetty No – 1 Instantaneous Release / Ev TOLUENE

Chemical	Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance For		
	ERPG - 3 1000 ppm	ERPG – 2 300 ppm	ERPG – 1 50 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	10.0kW/m^2	5.0kW/m^2	2.0kW/m^2
	m	m	m	m	m	m	m	m	m	m	m

Jetty One	TOLUENE (Instantaneous Release)	208	395	1.0Km	71	233	LOC not exceeded	52	72	-----	------	-----
	TOLUENE (Evaporation Puddle)	< 10	21	73	< 10	< 10	No part of the cloud was above the LEL	No part of the cloud was above the LEL	No part of the cloud was above the LEL	-----	------	-----
	TOLUENE (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	29	35	47

- All emergency equipment should be placed more than 72 meters away from the source of leak.
- Fire fighting should be carried out from a distance of more than 47 meter unless fire suits / fire proximity suits are worn by the fire fighting personnel.
- All persons not directly connected with the emergency operation should be moved more than 1 km away from the source of leak.
- All other fire fighting precautions should be adhered to.

4.7.3 ACRYLONITRILE (ACN)

Chemical		Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance For		
		ERPG - 3 75 ppm	ERPG - 2 35 ppm	ERPG – 1 10 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	$10.0 kW/m^2$	$5.0 kW/m^2$	$2.0 kW/m^2$
		m	m	m	m	m	m	m	m	m	m	m
Jetty Two	ACN (Instantaneous Release)	1.0 Km	1.5 Km	2.8 Km	62	211	LOC not exceeded	41	61	-----	------	-----
	ACN (Evaporation Puddle)	49	76	148	< 10	< 10	No part of the cloud was above the LEL	No part of the cloud was above the LEL	No part of the cloud was above the LEL	-----	------	-----
	ACN (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	19	23	30

- In case of an emergency involving Acrylonitrile in the form of a major leak with or without a fire, all fire fighters handling the emergency must wear Breathing apparatus, in addition to the usual fire suits.
- All persons not connected with the emergency operation should move beyond 2.8Km distance.

- All supporting personnel must be ready with BA sets.
- The nearby shanty should be evacuated.
- All security staff must have respiratory protection.
- All persons handling the emergency should be sent to the Kandla Port Hospital for checking for CAN poisoning.

4.7.4 ANILINE

Chemical		Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance For		
		TEEL – 3 20 ppm	TEEL – 2 12 ppm	TEEL – 1 8 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	10.0kW/m^2	5.0kW/m^2	2.0kW/m^2
		m	m	m	m	m	m	m	m	m	m	m
Jetty Two	**ANILINE** (Instantaneous Release)	1.8 Km	2.3 Km	2.7 Km	72	237	LOC not exceeded	53	73	-----	------	-----
	ANILINE (Evaporation Puddle)	12	20	29	< 10	< 10	No part of the cloud was above the LEL	No part of the cloud was above the	No part of the cloud was above the	-----	------	-----

							LEL	LEL				
	ANILINE (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	20	23	31

- All persons handling the emergency must wear full protection suits to avoid skin contact. BA should be worn by the persons handling the emergency.
- The adjoining shanty should be evacuated.
- Persons handling the emergency should check up if their nails, lips, earlobes have turned blue. If so, immediately move them to Kandla Port hospital.

4.7.5 BENZENE

Chemical	Dispersion Distances	LEL	Overpressure Distances	Pool Fire Heat Radiation Distance

					Distances					For		
		ERPG - 3 1000 ppm	ERPG - 2 150 ppm	ERPG -1 50 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	10.0kW/m^2	5.0kW/m^2	2.0kW/m^2
		m	m	m	m	m	m	m	m	m	m	m
Jetty Two	BENZENE (Instantaneous Release)	228	625	1.1 Km	80	265	LOC not exceeded	61	76	-----	------	-----
	BENZENE (Evaporation Puddle)	23	81	145	< 10	20	No part of the cloud was above the LEL	No part of the cloud was above the LEL	No part of the cloud was above the LEL	-----	------	-----
	BENZENE (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	29	35	47

- A Benzene fire gives out dense black smoke which could reduce the visibility. All fire fighters must wear a chemical protection suit while handling the emergency, wear BA.
- All those not connected with the emergency handling should move beyond 1.1 km up wind.
- Initial fire fighting should be from a distance of 47 meter, unless fire suits, proximity suits are worn. All security staff must have respiratory protection.
- All persons handling the emergency should be sent to the Kandla Port hospital for urine test to check for Benzene poisoning.

4.7.6 1:3, BUTADIENE

Chemical		Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance For		
		ERPG - 3 5000 ppm	ERPG - 2 200 ppm	ERPG - 1 10 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	$10.0kW/m^2$	$5.0kW/m^2$	$2.0kW/m^2$
		m	m	m	m	m	m	m	m	m	m	m
Jetty There	1:3, BUTADIENE (Instantaneous	92	524	2.4 Km	62	206	LOC not exceeded	48	63	-----	------	-----

	Release)											
	1:3, BUTADIENE (Evaporation Puddle)	22	157	736	13	53	LOC not exceeded	< 10	21	-----	------	-----
	1:3, BUTADIENE (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	34	42	57

- Initial fire fighting should be from a distance of more than 57 meters. The fire fighters should wear BA sets and chemical protection suits.
- The shanty should be evacuated beyond 2.4 Km distance.

4.7.7 ACETONE

Chemical		Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance For		
		TEEL - 3 5700 ppm	TEEL - 2 3200 ppm	TEEL - 1 200 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	$10.0kW/m^2$	$5.0kW/m^2$	$2.0kW/m^2$
		m	m	m	m	m	m	m	m	m	m	m
Jetty Three	**ACETONE** (Instantaneous Release)	97	134	591	56	190	LOC not exceeded	40	56	-----	------	-----
	ACETONE (Evaporation Puddle)	10	17	111	< 10	22	No part of the cloud was above the LEL	No part of the cloud was above the LEL	No part of the cloud was above the LEL	-----	------	-----

	ACETONE (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	20	24	32

- Fire fighters should note that acetone and methanol fires are non luminescent and there could be a tendency to go nearer to the puddle /pool on fire. This should be done by fire fighters fully equipped with fire suits / proximity suits. Acetone / Methanol are water soluble, which is advantageous for fire fighting.

4.7.8 METHANOL

Chemical	Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance		
	ERPG - 3 5000 ppm	ERPG - 2 1000 ppm	ERPG- 1 200 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	10.0kW/m^2	5.0kW/m^2	2.0kW/m^2
	m	m	m	m	m	m	m	m	m	m	m

Jetty Three	**METHANOL** (Instantaneous Release)	178	431	1.0 Km	49	190	LOC not exceeded	LOC not exceeded	33	-----	------	-----
	METHANOL (Evaporation Puddle)	< 10	33	89	< 10	< 10	No part of the cloud was above the LEL	No part of the cloud was above the LEL	No part of the cloud was above the LEL	-----	------	-----
	METHANOL (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	11	12	15

- Fire fighters should note that acetone and methanol fires are non luminescent and there could be a tendency to go nearer to the puddle /pool on fire. This should be done by fire fighters fully equipped with fire suits / proximity suits. Acetone / Methanol are water soluble, which is advantageous for fire fighting.

4.7.9 Jetty No – 4 Instantaneous Release / Ev PROPYLENE

Chemical		Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance For		
		TEEL - 3 20000 ppm	TEEL-2 10000 ppm	TEEL -1 1500 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	10.0kW/m^2	5.0kW/m^2	2.0kW/m^2
		m	m	m	m	m	m	m	m	m	m	m
Jetty Four	**PROPYLENE** (Instantaneous Release)	51	80	233	74	253	LOC not exceeded	52	66	-----	------	-----
	PROPYLENE (Evaporation Puddle)	30	53	163	51	194	LOC not exceeded	29	52	-----	------	-----
	PROPYLENE (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	33	41	55

- All emergency handling should be from a distance of more than 66 meters unless full fire suits / proximity suit is worn.

- All personnel not directly connected with the emergency should be moved beyond 233 meters form the leak area.

4.7.10 Jetty No – 4 Instantaneous Release / Ev VINYL CHLORIDE (VCM)

Chemical		Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance		
		ERPG - 3 5000 ppm	ERPG - 2 1000 ppm	ERPG - 1 200 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	10.0kW/m^2	5.0kW/m^2	2.0kW/m^2
		m	m	m	m	m	m	m	m	m	m	m
Jetty Four	**VCM** (Instantaneous Release)	47	108	376	45	152	LOC not exceeded	30	48	-----	------	-----
	VCM (Evaporation Puddle)	< 10	15	52	< 10	23	No part of the cloud was above the LEL	No part of the cloud was above the LEL	No part of the cloud was above the LEL	-----	------	-----

	VCM (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	< 10	< 10	< 10

- VCM is highly toxic, hence all persons handling the emergency involving VCM should wear full respiratory protection (BA sets) and handle the emergency from a distance of more than 48 meters.
- Nearby shanty should be put on the alert for evacuation in case emergency evacuation is needed.
- All persons handling the emergency should be sent to the Kandla Port hospital for VCM poisoning check up.

4.7.11 Jetty No – 5 Instantaneous Release / Ev AMMONIA

Chemical	Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance For		
	AEGL - 3 1100 ppm	AEGL - 2 160 ppm	AEGL - 1 30 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	$10.0kW/m^2$	$5.0kW/m^2$	$2.0kW/m^2$

		m	m	m	m	m	m	m	m	m	m	m
Jetty Five	**AMMONIA** (Instantaneous Release)	219	589	1.4 Km	33	80	LOC not exceeded	LOC not exceeded	26	-----	------	-----
	AMMONIA (Evaporation Puddle)	96	260	617	< 10	16	No part of the cloud was above the LEL	No part of the cloud was above the LEL	No part of the cloud was above the LEL	-----	------	-----
	AMMONIA (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	< 10	11	13

- Emergencies involving Ammonia will be mostly leakage / spillage.
- Ammonia is flammable with difficulty.
- Ammonia emergencies should be handled by wearing BA sets.
- Ammonia is soluble in water, which will make it easier to handle the emergency.
- Do not direct water jet onto the liquid ammonia puddle, this could cause spurting of the liquid. Let the ammonia vapours come into the water spray / fog.

AEGLs represent threshold exposure limits for the general public and are applicable to emergency exposure periods ranging from 10 minutes to 8 hours. AEGL-2 and AEGL-3, and AEGL-1 values as appropriate will be developed for each of five exposure periods (10 and 30 minutes, 1 hour, 4 hours, and 8 hours) and will be distinguished by varying degrees of severity of toxic effects. It is believed that the recommended exposure levels are applicable to the general population including infants and children, and other individuals who may be susceptible.

The three AEGLs have been defined as follows:

AEGL-1 is the airborne concentration, expressed as parts per million or milligrams per cubic meter (ppm or mg/m3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

AEGL-2 is the airborne concentration (expressed as ppm or mg/m3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

AEGL-3 is the airborne concentration (expressed as ppm or mg/m3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

Airborne concentrations below the AEGL-1 represent exposure levels that can produce mild and progressively increasing but transient and nondisabling odor, taste, and sensory irritation or certain asymptomatic, nonsensory effects. With increasing airborne concentrations above each AEGL, there is a progressive increase in the likelihood of occurrence and the severity of effects described for each corresponding AEGL. Although the AEGL values represent threshold levels for the general public, including susceptible subpopulations, such as infants, children, the elderly, persons with asthma, and those with other illnesses, it is recognized that individuals, subject to unique or idiosyncratic responses, could experience the effects described at concentrations below the corresponding AEGL.

4.7.12 Jetty No – 5 Instantaneous Release / Evaporation Puddle / Burning Puddle for HSD

Chemical		Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance For		
		TEEL 8600 ppm	TEEL 3300 ppm	TEEL 400 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	10.0kW/m^2	5.0kW/m^2	2.0kW/m^2
		3	2	1								
		m	m	m	m	m	m	m	m	m	m	m
Jetty Five	**HSD** (Instantaneous Release)	59	112	370	73	240	LOC not exceeded	53	71	-----	------	-----
	HSD (Evaporation Puddle)	<10	15	85	14	48	LOC not exceeded	10	19	-----	------	-----

	HSD (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	35	42	58

- High Speed Diesel fires should be handled with care, by wearing fire suits / proximity suits.
- Foam should be used for fire fighting.

4.7.13 Jetty No – 6 Instantaneous Release / Evaporation Puddle / Burning Puddle for MOTOR SPIRIT

Chemical	Dispersion Distances	LEL Distances	Overpressure Distances	Pool Fire Heat Radiation Distance

		TEEL - 3 1500 ppm	TEEL - 2 610 ppm	TEEL - 1 610 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	10.0kW/m^2	5.0kW/m^2	2.0kW/m^2
		m	m	m	m	m	m	m	m	m	m	m
Jetty Six	**MOTOR SPIRIT** (Instantaneous Release)	159	258	258	68	227	LOC not exceeded	51	66	-----	------	-----
	MOTOR SPIRIT (Evaporation Puddle)	51	85	85	16	70	LOC not exceeded	11	24	-----	------	-----
	MOTOR SPIRIT (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	37	45	61

- Motor spirit fires should be handled with care, by wearing fire suits / proximity suits.
- Foam should be used for fire fighting.

4.7.14 Jetty No – 6 Instantaneous Release / Evaporation Puddle / Burning Puddle for SKO

Chemical		Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance For		
		TEEL – 3 1250 ppm	TEEL – 2 1000 ppm	TEEL - 1 600 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	$10.0 kW/m^2$	$5.0 kW/m^2$	$2.0 kW/m^2$
		m	m	m	m	m	m	m	m	m	m	m
Jetty Six	**SKO** (Instantaneous Release)	141	159	209	74	239	LOC not exceeded	54	73	-----	------	-----

	SKO (Evaporation Puddle)	< 10	< 10	< 10	< 10	< 10	No part of the cloud was above the LEL	No part of the cloud was above the LEL	No part of the cloud was above the LEL	-----	------	-----
	SKO (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	28	35	48

- SKO fires should be handled with care, by wearing fire suits / proximity suits.
- Foam should be used for fire fighting.

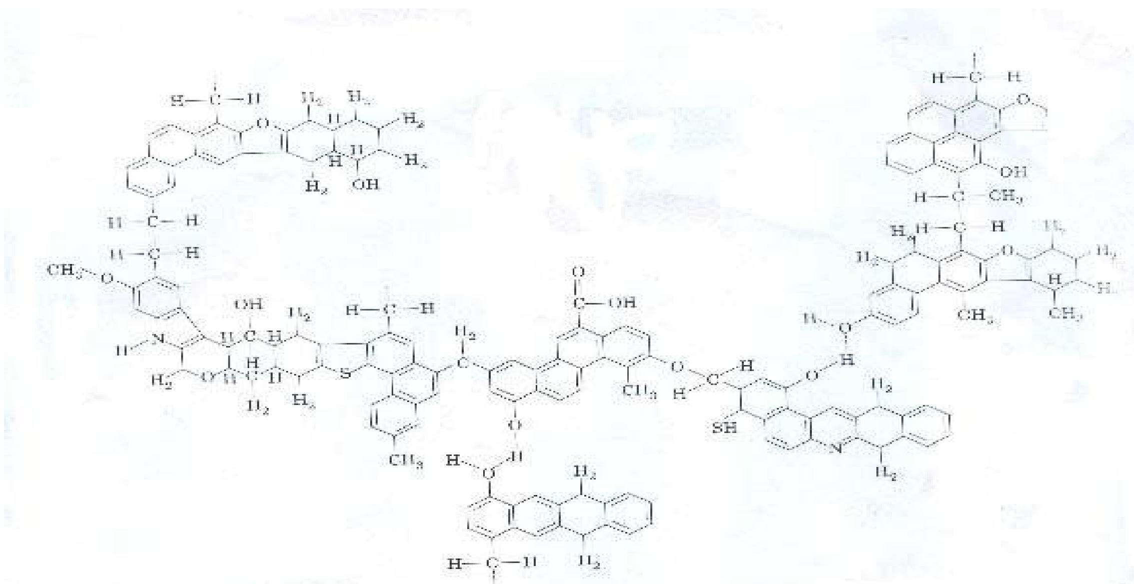
4.8 Coal Storage at Open Yard

4.8.1 General Characteristics of Coal

Coal is a fossil fuel extracted from the ground by underground mining or open pit mining. It is a readily combustible, black or brownish – black sedimentary rock. It is composed primarily of carbon along with assorted other elements.

Carbon forms more than 50% by weight and more than 70% by volume of coal.

Coal usually contains a considerable amount of incidental moisture, which is the water trapped within the coal in between the coal particles. The structure of a coal molecule is represented as follows:



Methane gas is another component of coal. Methane in coal is dangerous as it can cause explosion and may cause the coal to spontaneously combust.

4.8.2 Effects of Coal Burning

Combustion of coal, like any other compound containing carbon, produces CO_2, along with minor amount of SO_2.

Coal can be set on fire by spontaneous combustion

4.8.3 Spontaneous Combustion in Coal

The risk from fire exists where significant amounts of coal are in use of storage. Coal is a combustible material, making it susceptible to a variety of ignition scenarios. One of the most frequent and serious causes of coal fires is spontaneous combustion, which has been responsible for a number of incidents within the department in recent years.

Preventing spontaneous combustion coal fires involves attention to many different factors. Among the most critical are the type, age and composition of coal, how it is stored and how it is used. Given the right kind of coal, oxygen, and a certain temperature and moisture content, coal will burn by itself.

Spontaneous combustion has long been recognized as a fire hazard in stored coal. Spontaneous combustion fires usually begin as “hot spots” deep within the reserve of coal. The hot spots appear when coal absorbs oxygen from the air. Heat generated by the oxidation can initiate the fire.

Such fires can be very stubborn to extinguish because of the amount of coal involved (often hundreds of tons) and the difficulty of getting to the seat of the problem. Moreover, coal in either the smouldering of flaming stage may produce copious amounts of methane and carbon monoxide gases. In addition to their toxicity, these gases are highly explosive in certain concentrations, and can further complicate efforts to fight this type of coal fire.

Even the most universal fire fighting substance, water, cannot be used indiscriminately, because of the remote possibility of a steam explosion; it is advisable that water be applied carefully and from a safe distance. Certain chemicals such as carbon dioxide or nitrogen may mitigate fire effects, but their use has had mixed success from a DOE (Department of Energy) perspective. The above information suggests that coal fires require awareness and prior planning to extinguish efficiently, completely, and safely.

4.8.4 Causes of Spontaneous Coal Fires

The following general factors have been mentioned as contributing causes:

- Coal handling procedures allowed for long-time retention of coal, which increases the possibility of heating
- New coal added on top of old coal created segregation of particle sizes, which is a major cause of heating
- Too few temperature probes installed in the coal bunker resulted in an excessive period of time before the fire was detected.
- Failure of equipment needed to fight the fire
- Ineffective capability and use of carbon dioxide fire suppression system
- Delay in the application of water

4.8.4.1Preventing Spontaneous Combustion in Stored Coal

High quantities of coal are stored in bunkers, silos, hoppers and open air stockpiles. How susceptible such stocks of coal are to fire from spontaneous combustion depends on a number of factors, from how new the coal is to how it is piled.

4.8.5 Recommendations for Coal Storage

- Storing coal with low sulphur content is helpful. Sulphur compounds in coal liberate considerable heat as they oxidize.

- Air circulating within a coal pile should be restricted as it contributes to heating; compacting helps seal air out.

- Moisture in coal contributes to spontaneous heating because it assists the oxidation process. Moisture content should be limited to 3 %; sulphur content should be limited to 1 %, “as mined.” Coal having high moisture content should be segregated and used as quickly as possible. Efforts should be made to keep stored coal from being exposed to moisture.

③ Following the “First in, First out” rule of using stock reduces the chance for hot spots by helping preclude heat build up for portions of stock which remain undisturbed for a long term. The design of coal storage bins is important in this regard.

③ A high ambient temperature aids the spontaneous heating process. Remove coal as quickly as possible. The longer large coal piles are allowed to sit, the more time the spontaneous process has, to work.

③ The shape and composition of open stock piles can help prevent fires. Dumping coal into a big pile can lead to problems. Rather, coal should be packed in horizontal layers (opinions range from 1 ½’ to 3’ high) which are then levelled by scraping and compacted by rolling. This method helps distribute the coal evenly and thus avoids breakage and segregation if fine coal. Segregation of coal particles by size should be avoided, as it may allow more air to enter the pile and subsequent heating of finer sizes.

③ The height of the coal pile/stock is also important; limit un - layered, un - compacted high grade coal to a height of 15’ maximum height.

③ Properly inspect, test and maintain installed fire protection equipment.

③ Maintain an updated pre-fire plan and encourage regular visits to coal facilities by the site or local emergency response force.

4.8.6 Roll Packing

Roll packing helps to exclude O_2 and thus to prevent fires by discouraging spontaneous combustion. Coal is distributed by a grab bucket or by other means in a uniform layer. The layer is then levelled by scraping and compacted by rolling. Distributing the coal evenly avoids breakage and segregation of the coal. The firm packing helps shed water.

4.8.7 Checking Temperature

Steam rising from a pile or the odour of burning coal is an indication of spontaneous heating, but an earlier or more reliable indication is obtained by checking the temperature/ hot spots/CO detection.

Rise of temperature can be noted by use of thermocouples. Hot spots can be detected by use of IR coal fire monitors. CO detectors can indicate that coal combustion has started.

4.9 Risk Analysis for Coal Fires in Storage Yard Berth 14

Data used for calculation of impact distance for coal fires. Type of coal – Bituminous (Medium Volatile)

Emissivity Constant (ε)	=	0.9 for Bituminous Coal
Stefan Boatmen constant	=	5.6×10^{-8} KW/m^2K^4

√ /

FQ 4Π*K* 4.9.1 Formula used for Calculation of Impact Distance (D) =

Where D	=	Distance from flame centre to receiving point.
Where F	=	Fraction of heat radiation = 0.15 (Conservative)
Where Q	=	Total Heat Generated /Emitted by Coal
Where K	=	Thermal Radiation level

Maximum temperature attained by flame of Coal Tf = 900DegC = 1173K

Ambient surrounding temperature Ta= 27DegC to 35DegC = 300K – 308K

$Q = \sigma A \varepsilon (T f^4 - T_a^4)$

σ = 5.68 x 10 -8 kW/m2K4

$T f^4 = (1173)^4$ K

$T_a^4 = (300)^4$ K

For active coal burning area = 10m^2

$Q = 5.6 \times 10^{-8} \times 0.9 \times 10 \, (1173^4 - 300^4)$

Q = 950 kW

For Heat radiation 4 kW/m^2 impact distance D

$D = \sqrt{(950\times0.15) / (4\times3.14\times 4)} = 1.68 = 1.7m$

For Heat radiation 12.5 kW/m^2 impact distance D

$D = \sqrt{(950\times0.15) / (4\times3.14\times12.5)} = 0.9527 = 1\ m$

For Heat radiation 37.5 kW/m^2 impact distance D

$D = \sqrt{(950\times0.15) / (4\times3.14\times37.5)} = 0.55m$

For active coal burning area – 100 m^2

$$Q = 5.6 \times 10^{-8} \times 0.9 \times 100 (1173^4 - 300^4)$$

$$= 9500 \text{ kW/m2}$$

For Heat radiation 4 kW/m2 impact distance D

$$D = \sqrt{(9500 \times 0.15) / (4 \times 3.14 \times 4)} = 5.32 \text{ m}$$

For Heat radiation 12.5 KW/m2 impact distance D

$$D = \sqrt{(9500 \times 0.15) / (4 \times 3.14 \times 12.5)} = 3.012 \text{ m}$$

For Heat radiations 37.5 KW/m2 impact distance D

$$D = \sqrt{(9500 \times 0.15) / (4 \times 3.14 \times 37.5)} = 1.74 \text{ m}$$

The Damage Effects Due to Thermal Radiation of Varying Intensity

Incident Radiation Intensity (kW/m^2)	Type of Damage
37.5	Sufficient to cause damage to process equipment unless the equipment is fully thermally fire protected (Insulation, fire proofing, sprinkler protection etc)
12.5	Minimum energy required for piloted ignition of wood, melting plastic tubing, etc.
4.5	Sufficient to cause pain to personnel if unable to reach within 20 seconds, blistering of skin (1st degree burns) is likely.

4.9.2 Summary:

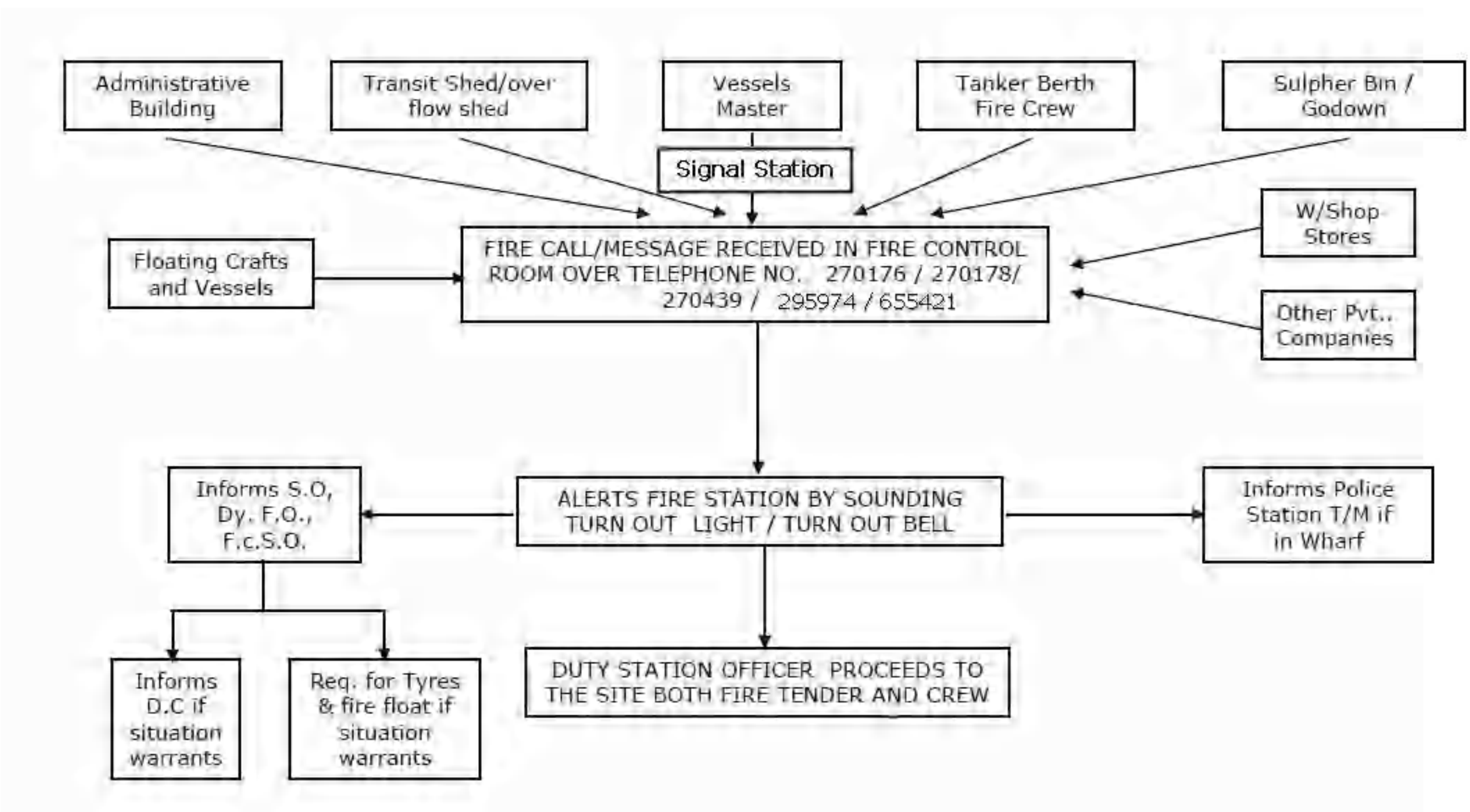
Heat Radiation Impact distance for	Active Burning Coal Area	
	10 m^2	100 m^2
4 kW/m^2	1.7 m	5.3 m
12.5 kW/m^2	1.0 m	3.0 m
37.5 kW/m^2	0.5 m	1.74 m

Assuming that 100m^2 surface area of the coal stack is smouldering no person should approach the stock within 6 m distance.

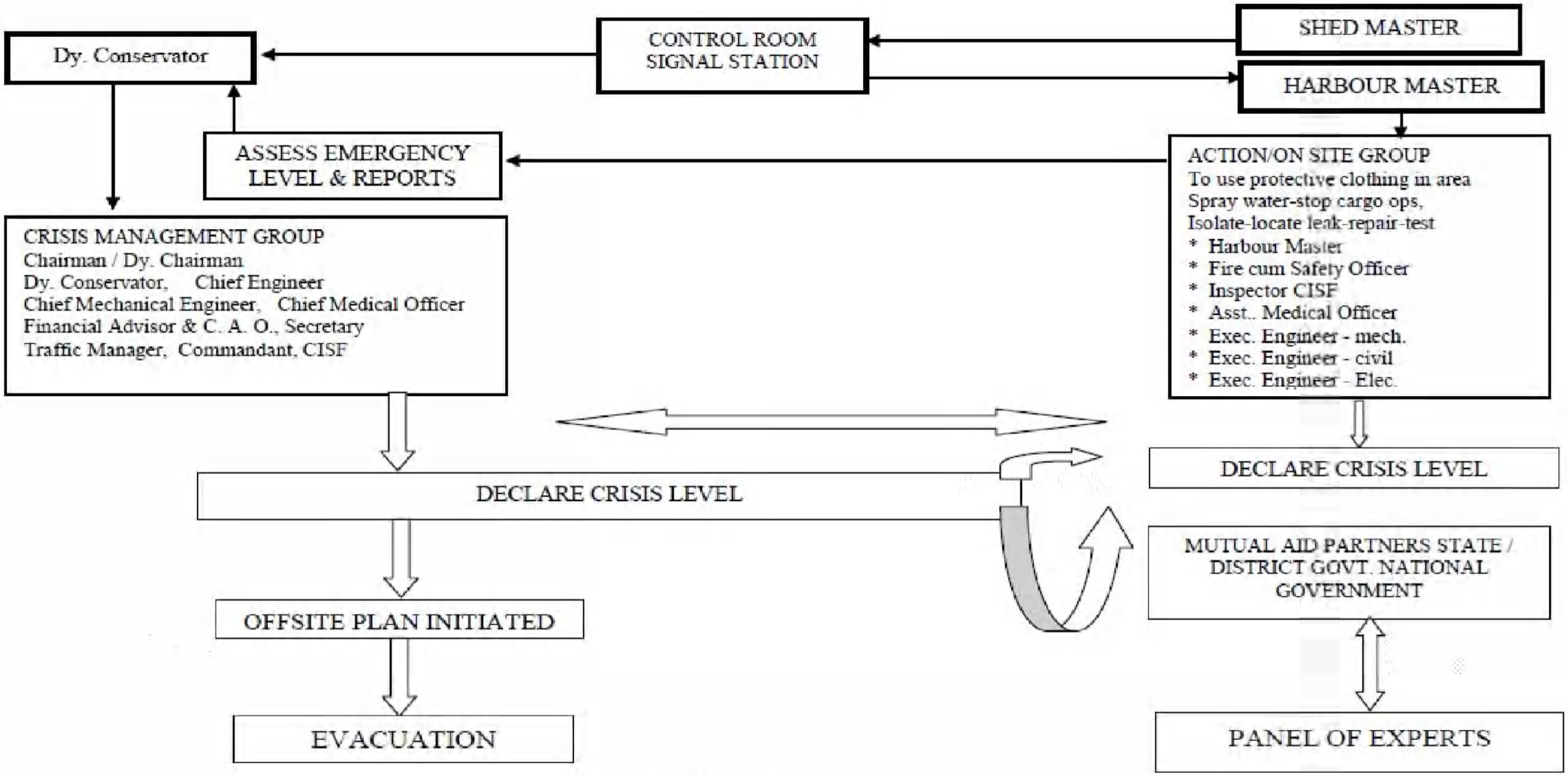
All fire fighting should be done from more than 5.3 m away from the affected coal stack unless the fire fighter is fully clothed with fire protective clothing and respiratory protection

Please note that CO could also be emitted during a coal fire due to incomplete combustion. Hence adequate respiratory protection should be used like canister gas mask or Self Contained Breathing Apparatus –SCBA

4.10Fire & Explosion Response Plan



4.11 Fire & Toxic Leakage



PROCESS

(1) Master or informer raises alarm

(2) Informs control room at the Fire Station

(3) Advises D.C. and H.M and Action Group

(4) Action group commences to use protective clothing in area -Spray water-stop cargoes/Isolate – locate leak-repair test

(5) Declare crisis level

(6) Crisis level endorsement by crisis management group

(7) If crisis level declared is greater

(8) Mutual aid partners contacted and district emergency plan initiated

(9) If necessary evacuation commenced partial or full.

4.12 Details of Fire Fighting Equipment available at Kandla Port

4.12.1 Fire Water Tender – 6 Nos

Water Tank Capacity: 6000 liters. (Discharge Capacity 2000 liters at $10kg/cm^2$& 300 liters at $40kg/cm^2$).

Fire Monitor Discharge capacity 2750 lpm at 7kg/cm2 with effective throw/Jet of minimum 45 meters.

Fire Fighting Equipments:

- RRL Hose 15mtrs X 63mm (ID)
- Foam AFFF 3%
- Various type of Branches
- Hose Fittings
- Small Gears
- Personnel Protective equipment (PPE)
- Additional Foam Fighting System
- Communication System
- Public Address system
- Extension Ladder

4.12.2 Foam Fire Tender – 3 Nos

Water Tank Capacity: 5000 liters. (Discharge Capacity 2000 liters at $10kg/cm^2$& 300 liters at $40kg/cm^2$).

Foam Tank Capacity: 1000 liters.

Fire Monitor Discharge capacity 2750 lpm at 7kg/cm^2 with effective throw/Jet of minimum 45 meters.

Additional CO_2 Extinguishing System.

Fire Fighting Equipments:

- RRL Hose 15mtrs X 63mm (ID)
- Foam AFFF 3%
- Various type of Branches
- Hose Fittings
- Small Gears
- Personnel Protective equipment (PPE)
- Additional Foam Fighting System
- Communication System
- Public Address system
- Extension Ladder

4.12.3 Multi Purpose Fire Tender – 1 No

Water Tank Capacity: 5000 liters. (Discharge Capacity 2000 liters at 10kg/cm^2& 300 liters at 40kg/cm^2).

Foam Tank Capacity: 1000 liters.

Fire Monitor Discharge capacity 2750 lpm at 7kg/cm^2 with effective throw /Jet of minimum 45 meters.

Additional CO_2 Extinguishing System.

Additional Dry Chemical Powder Extinguishing System.

Fire Equipments:

- RRL Hose 15mtrs X 63mm (ID)
- Foam AFFF 3%
- Various type Branches
- Hose Fittings
- Small Gears
- Personnel Protective equipment (PPE)
- Addition Foam Fighting System
- Communication System
- Public Address system
- Extension Ladder

4.12.4 Dry Chemical Powder Fire Tender – 1 No

2Nos. Dry Chemical Powder Cylinder Capacity: 1000 Kgs. each cylinder.

Fire Monitor Discharge capacity 2750 lpm at 7kg/cm^2 with effective throw / Jet of minimum 45 meters.

Fire Equipments:

- Various type of Branches
- Small Gears
- Personnel Protective equipment (PPE)
- Communication System
- Public Address system

4.12.5 Tank Lorry - 01 No.

- Tank Capacity 12,000 liters.
- Anti Pollution Scheme.

4.12.6 Fire Jeep – 01 No.

Pump Discharge Capacity 1800 liters at $7 kg/cm^2$.

Fire Fighting Equipments:

- RRL Hose 15mtrs X 63mm (ID)
- Various type of Branches
- Hose Fittings
- Small Gears
- Personnel Protective equipment (PPE)
- Communication System
- Public Address system
- Extension Ladder

4.12.7 Safety Jeep – 01 No.

For proper Coordination, Inspection, in around the Port (Oil & Chemical Tank Farm & Administrative Works).

Fire Fighting Equipments:

- Small Gears
- Personnel Protective equipment (PPE)

- Communication System
- Public Address system

4.12.8 Ambulance – 01 No.

For Transportation of Injured Ship Official, Ship Crews and Victims.

4.13Station wise Manpower Brake Up (Manned Round The Clock)

4.13.1 Emergency Response Centre / Old Kandla Fire Station (Liquid Cargo Jetty)

- Fire cum Safety Officer – 01
- Deputy Fire Officer – 01
- Station Officers – 02 Nos
- Leading Fireman– 02 Nos
- Pump Operator cum Driver – 03 Nos
- Fireman – 08 Nos
- Auto Diesel Mechanic– 01
- Junior Clerk– 01

Oil Jetty No. 1 (LPG Jetty)

- Leading Fireman – 01
- Pump Operator cum Driver – 01
- Fireman– 04 Nos

Oil Jetty No. 2

- Leading Fireman– 01
- Fireman– 04 Nos

Oil Jetty No. 3

- Leading Fireman – 01
- Fireman– 04 Nos

Oil Jetty No. 4

- Leading Fireman – 01
- Pump Operator cum Driver – 01
- Fireman– 04 Nos

Oil Jetty No. 5 (IFFCO Jetty)

- Leading Fireman – 01
- Pump Operator cum Driver – 01
- Fireman– 04 Nos

While LPG Tanker is discharging the LPG at Oil Jetty No.1, a Station Officer shall be in charge till the unberthing of LPG Vessel.

Above Fire Crews will be posted at Oil Jetties depending upon the Nature of Risk Cargo Handled.

4.13.2 Tilak Fire Station (Dry Cargo Jetty).

- Station Officers– 01 No

- Leading Fireman– 01 No
- Pump Operator cum Driver– 02 Nos
- Fireman – 04 Nos

For Running & Maintenance of First Aid, Fire Equipments installed at various work places of Kandla Port.

- Leading Fireman– 01 No
- Fireman – 02 Nos

4.13.3 Azad Fire Station (Dry Cargo Jetty).

- Station Officers– 02 Nos
- Leading Fireman– 01 No
- Pump Operator cum Driver– 02 Nos
- Fireman – 04 Nos

4.14 Fire fighting facility at Chemical / Oil Handling Berths

4.14.1 Oil Jetty No: 1

Fixed foam / water remote controlled monitors mounted on towers at each end of each berth.

There are three vertical turbine pumps each of 500m3/hr capacity. One each of Electrical Fire Water Pumps, Diesel Engine Fire water pumps, Electrical flushing pumps.

Jetty one LPG side – 12 DCP – 5Kg Fire Extinguishers, 2 DCP – 150 Kg Trolley mounted fire extinguishers.

4 Fire suits, 2 BA sets with 2 spare respirable air cylinders.

Fire equipment Room:

- Foam / DCP – 15 Nos fire extinguishers
- Helmets – 5 Nos
- Hose length (15 meters) 10 Nos
- Manual Siren – 1No
- Gum Boots – 6 Pairs
- Ropes
- Foam compound 1000 Liters
- Hose fittings
- Branch Pipes
- Fire Axe
- Safety shower – 1 No
- Water curtains
- Fire suits – 2 Nos
- Canister gas mask – 1 No
- Telephone
- Mobile foam trolley – 100 Liters

4.14.2 Oil Jetty No: 2

Fixed foam / water remote controlled monitors mounted on towers at each end of each berth.

There are two vertical turbine pumps each of 800m^3/hr capacity, two jockey pumps of 25m^3/hr capacity, two foam pumps each of 22m^3/hr capacity, two foam /water remote controlled tower monitors, and six jumbo curtains installed at the jetty face.

Fire equipment Room:

- Foam /DCP – 10 Nos each fire extinguishers
- Helmets – 6 Nos
- Fire Hoses - 10 Nos
- BA set – 1No
- Gum Boots – 6 Pairs
- Foam making branch pipes – 2 Nos
- Female coupling –8 Nos
- Jet branch pipes –5 Nos
- Fire suits -2 Nos
- Foam compound - 50 x 30 Liters
- Chemical Suits- 2 Nos
- Telephone – 1 No
- Fire Axe- 1No
- DCP Fire extinguishers – 10 Nos
- Foam Fire extinguishers – 10 Nos
- Fire Buckets – 10 Nos
- Oil Dispersant – 10 x 20 Liters
- Rubber hand gloves – 6 Nos
- Hose length – 15 meters (10 Nos)

4.14.3 Oil Jetty No: 3, 4 & 5

In Oil Jetty No: 3, there are two foam pumps, with foam tank, 2 remote controlled tower monitors for foam / water spray, 2 sets of jumbo curtains at jetty face, one flame detection system, one 50KW DG set and control console.

Oil Jetty No: 4, there are three vertical turbine pumps each of 500m^3/hr capacity, 2 foam pumps with foam tank, 2 remote control tower monitors of capacity 3000 liters per minute of water, 3 jumbo curtains at jetty face, 50 KW DG set and control console.

Oil Jetty No: 5, there are two fire water pumps each of $270m^3/hr$ capacity, (One electrical driven pump, and one diesel engine pump each).

Fire equipment Room:

- Fire buckets – 8 Nos
- Manual Fire Sirens – 1 No
- Foam branch pipes – 4 Nos
- Mechanical foam generator – 2Nos
- Foam compound – 1000 Liters
- BA set – 1 No
- Gum Boots – 6 Pairs
- Helmets – 6 Nos
- Hose length (15 Meters) – 10 Nos
- DCP fire extinguishers – 10 Nos
- Foam fire extinguishers – 5 Nos
- Fire suits – 2 Nos
- Dispersant chemicals - 6 x 20 Lets
- Double female couplings – 8 Nos
- Male coupling – 2 Nos
- Diffuser – 2 Nos
- Water Curtain – 1 No
- Jet Branch Pipe – 2Nos
- Canister Gas Masks – 1 No
- Portable foam / water monitor – 1 No
- DCP Unit – 2 x 150 Kg
- Mobile foam generator
- Safety Shower – 1No

4.14.4 Oil Jetty No: 6

- 2 – Nos Diesel engine fire water pumps 820m^3/hour each.
- 1 – HP Jockey pump electrical 80m^3/hour
- Fire blankets (water jel)
- Smoke detectors in fire pump house
- Hand tool set
- Water curtains nozzles – 2 Nos •AFFF foam
- DCP fire extinguishers – 6 Nos
- Trolley mounted DCP fire extinguishers – 4 Nos
- CO_2 fire extinguishers – 6 Nos
- Foam fire extinguishers – 6 Nos

4.15 General Fire fighting guidelines at the Oil Jetty

1. Stop all loading / unloading operations and close valves.

2. All fire fighters will be apprised of the chemicals and POL products normally handled at the jetties. A set of MSDS is available at the fire station.

3. As a general rule all fire fighting will be carried out from a distance of 60 meter (Average heat radiation experience of 2kw/m^2). If the fire fighters are required to go closer to the fire then fire suits / close proximity suit must be worn. If necessary, water cover could be provided to the fire fighters going closer to the fire.

4. The water curtain along the edge of the berth will be activated for fire / leak / spill emergency at the berth.

   Fire float Agni Shanti, and any available tug should be immediately put on alert.

5. All emergency equipment should be placed beyond the over pressure distance of about 60 meters (Average overpressure distance for 1.0 psi experience) to avoid damage to them.

6. The remote water / foam monitor should be operated to control the fire at the jetty. If properly used the fire will be immediately controlled.

7. All persons not connected with handling the emergency should be moved beyond the TEEL – 1 / ERPG – 1 level distance which is an average distance of 1 Km. But if toxic chemical release takes place then the people from the shanty should be moved beyond 3 Km distance of the fire.

8. All security staff (CISF) should also have access to respiratory protection as they may not be able to leave their post.

9. External help should be obtained as soon as it is felt that the emergency is grave.

10. CISF guards will keep note of all incoming aid equipment.

11. After the emergency is over the Deputy Conservator / Harbour Master will assign a senior management team to verify that there is no longer a threat of further fire / leak / spill, to assess damage and initiate repairs

    as needed.

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

4.16 General guidelines in case of Toxic Chemical spill / leak

1. Stop all loading / unloading operations and close valves.

2. All emergency operation should be carried out from up wind direction. This may always not be possible. All persons handling a chemical leak / spill should wear chemical protection suit and respiratory protection like gas mask / BA sets.

3. Fire float “Agni Santi” and any available tug should be put on alert or pressed into operation.

4. Deputy Conservator / Harbour Master should be informed of a chemical spill however small it may be.

5. CISF should have access to respiratory protection as they may not be able to leave their post.

6. In case of a major chemical leak / spill the neighbouring shanty should be evacuated especially if chemicals like, Acrylonitrile, Benzene, Aniline, 1:3 Butadiene, Vinyl Chloride, Styrene has spilled.

7. Attempts could be made to salvage the spilled chemical or dispersant could be applied to the spill.

8. The chief fire officer should be kept informed of the chemicals being loaded / unloaded at the port chemical berths on a daily basis.

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

IDENTIFICATION OF EMERGENCIES AT THE OIL & CHEMICAL FACILITIES AROUND THE

KANDLA PORT

5.1 Impact Distances

Under the Risk Assessment Study for the Kandla Port Trust carried out by Tata AIG Risk Management Services Ltd in the year 1999, various failure scenarios have been identified for different facilities around the port and these have been simulated using Phast / Safeti software. These failure scenarios have been categorized into Maximum Credible Loss Scenarios (MCLS) and Worst Case Scenarios (WCS).

These failures can be due to number of reasons like material failure, human error. The failures could also be on account of natural disasters like earthquake, flood etc or they could be due to external factors like missile attack or terrorist attack. On failure due to any account mentioned above and depending on the extent of damage, there can be partial or total loss of confinement of hazardous materials handled in the port.

5.2 Maximum Credible Loss Scenarios (MCLS) considered for the study

5.2.1 Scenario 1 – Butadiene Sphere of United Storage and Tank Terminals Ltd.

There are 4 Butadiene Spheres in the terminal. We have considered the 1000 M.T. sphere for the study. Butadiene is stored at 3 to 4 Degree C and pressure in the sphere is maintained at 0.8 bar. The temperature of Butadiene is controlled by brine chillers cooled by Freon refrigeration system. The probability of BLEVE is very remote, considering there are two compressors and DG set is provided to take care of full power load of terminal in case of power failure. However, for Consequence Analysis study, we have considered BLEVE of 1000 M.T. Butadiene Sphere. It is assumed that the catastrophic rupture of the sphere takes place at a pressure of 25 bar.

Initial temperature (K) : 395. Initial pressure (bar (g))
: 25.0

5.2.1.1Radiation Effects: Bleeve / Fire Ball

Sr. No.	Radiation levels (Kw/sq m)	Distance in meters	
		5m/s C	2m/s D
1.	4	1558	1558
2.	12.5	919	919
3.	37.5	526	526

5.2.1.2Explosion Effects

Sr. No.	Over pressur e		Distance in meters	
	BAR(g)	PSI (g)	5.0m/s;C	2.0m/s; D
1.	0.0207	0.3	3246	3246
2.	0.1379	2	841	841
3.	0.2068	3	650	650

Comments:

1. In case of BLEVE a radius of 526 m. could be subjected to heat radiation, intensity of 37.5 kw/m^2. This would affect the facilities of Synthetics and chemicals, Indo Nippon, Kesar Enterprises, Bayer ABS & Chemicals and Resins. A portion of IFFCO facility (boundary) would also be subject to 37.5 KW per m^2 radiation intensity. This could cause fires in the neighbouring areas and this is likely to lead to domino effect. Employees within a radius of 1.5 km. from the sphere would suffer burn injuries.

2. Structural damage is likely within a radius of 650 m. from the sphere. This would damage nearby tanks, buildings and is likely to lead to domino effect which could aggravate the emergency. Upto a distance of 3.2 k.m there would be window glass breakage.

3. The possibility of BLEVE is less likely as the Horton spheres are maintained at low temperatures and at low temperature. There is also a standby DG set to take care of 100% electrical load of the terminal. The spheres are protected by water spray ring system along with a hydrant system.

5.2.2 Scenario 2 - Phenol storage of United Storage and Tank Terminals Ltd.

In the United storage terminal there is a phenol storage tank. In the event of bottom nozzle rupture or a large overflow from the tank, phenol would spill out and the contents would be within the dyke.

5.2.2.1Dispersion Distance for PHenol

Sr. No.	Concentration of interest ppm	Dispersion Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	100	103	90

5.2.2.2Radiation Effects – Pool Fire

Sr. No.	Radiation levels (Kw/sq m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	4	32	32
2.	12.5	25	22
3.	37.5	12	12

<u>Comments</u>:

Phenol has IDLH of 100 ppm concentration and the vapours are toxic. Toxic vapour of 100 ppm. Concentration would disperse upto 90 to 103 meters in the downward direction. This scenario may have a moderate off site implication due to toxic vapours.

5.2.3 Scenario 3 - Toluene storage of United Storage and Tank Terminals Ltd.

It is assumed that the tank has a diameter of 15 m. and dyke dia of 30 meters. In case of bottom nozzle failure of large overflow toluene would accumulate in the dyke. In case, the pool encounters the source of ignition, a pool fire would result.

5.2.3.1Dispersion Distance for Toluene

Sr. No.	Concentration of interest Vol %	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	1.2 (LEL)	63	72

5.2.3.2Radiation Effects – Pool Fire

Sr. No.	Radiation levels (Kw/sq m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	4	59	44
2.	12.5	25	22
3.	37.5	20	19

5.2.3.3Flash Fire

Sr. No.	Distance (m)	Distance in meters (1/2 LEL Distance)	
		5.0m/s;C	2.0m/s; D
1.	Furthest extent (m) for flash fire	111	121

Comments:

In case of a pool fire, the radiation effect is likely to be contained within the site. A flash fire distance is approximately 120 m. This means that a flammable cloud could cause a flash fire due to source of ignition within 120 m. in the downward direction. The flash fire would result in a pool fire.

The terminal has its own independent fire protection and fire fighting system which can reduce the affected distance by immediate actions like spray of foam compound over the pool formed in the dyke to prevent ignition and reduce the rate of evaporation.

5.2.4 Scenario 4 – Acrylonitrile storage of Bayer ABS

Acrylonitrile polymerises in the presence of light and at high temperature. If polymerization takes place in the tank, it could explode resulting in large release of Acrylonitrile. Acrylonitrile could also be released in the event of bottom nozzle failure of tank or overflow into the dyke.

5.2.4.1Dispersion Distance for Acrylonitrile

Sr. No.	Concentration of interest ppm	Dispersion distance in meters	
		5.0m/s;C	2.0m/s; D
1.	4 (IDLH)	4026	12000

5.2.4.2Radiation Effects – Pool Fire

Sr. No.	Radiation levels (kW/sq m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	4	80	85
2.	12.5	57	53
3.	37.5	42	32

5.2.4.3Flash Fire

Sr. No.	Distance (m)	Distance in meters (1/2 LEL Distance)	
		5.0m/s;C	2.0m/s; D
1.	Furthest extent (m) for flash fire	118	125

Comments:

1. Acrylonitrile has boiling point of 77Degree C and IDLH 4 ppm concentration. However, it should be noted that on polymerization and in fire condition, Acrylonitrile would decompose to release hydrogen cyanide and NOx.

2. The dispersion distance for 4 ppm concentration of Acrylonitrile vapours could be 12 kms if the wind speed is 2 m/sec and atmospheric stability D. However, this distance could be reduced if timely action is taken.

3. Bayer ABS maintains a good safety code of practice. They have conducted various safety studies and have a good maintenance system. Moreover the emergency management plan is well prepared and rehearsed in house. The standard of housekeeping in the terminal is good. The personnel working in the terminal have a good knowledge of the actions to be taken in the event of an emergency.

5.2.5 Scenario 5 - Styrene storage of Bayer ABS

Bayer ABS has a 1210 KL styrene tank. Styrene can undergo violent polymerization above 65 degree C, which could be explosive. It is assumed that the tank diameter is 12.5 m. and bund is 22.5 x 22.5 m^2. In case of bottom nozzle failure, overflow, shell rupture, the material would accumulate in the dyke and if it would encounter the source of ignition, a pool fire would result.

5.2.5.1Radiation Effects

Sr. No.	Radiation levels (Kw/sq m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	4	52	43
2.	12.5	26	21
3.	37.5	23	17

Comments:

1. The radiation effect would be restricted to the site and is not likely to have off site implication. However, on polymerization and fire condition, styrene generates enormous quantity of soot and splinter could fly off. This could affect neighboring areas.

2. The high safety standards maintained and observed at site would go a long way in preventing catastrophic scenarios.

5.2.6 Scenario 6 - Benzene storage of Indo Nippon

In Indo Nippon terminal Benzene is stored in an 1800 KL tank. Pool fire scenario has been considered for the tank assuming tank diameter as 12 m. and dyke dia as 25 m.

5.2.6.1Dispersion Distance for Benzene

Sr. No.	Concentration of interest Vol%	Dispersion Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	1.3	119	120

5.2.6.2Radiation Effects: Pool Fire

Sr. No.	Radiation levels (Kw/sq m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	4	55	42
2.	12.5	23	20
3.	37.5	20	16

5.2.6.3Flash Fire

Sr. No.	Distance (m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	Furthest extent (m) for flash fire	175	175

Comments

In case of pool fire radiation effect would be restricted to site.

5.2.7 Scenario 7 - Methanol storage of Indo Nippon

Methanol is stored in 2500 KL tank, dyke dia is assumed as 30 m. And tank dia as 15 m.

5.2.7.1Dispersion Distance for Methanol

Sr. No.	Concentration of interest Vol%	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	6	36	47

5.2.7.2Radiation Effects: Pool Fire

Sr. No.	Radiation levels (Kw/sq m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	4	66	73
2.	12.5	48	48
3.	37.5	37	34

5.2.7.3Flash Fire

Sr. No.	Dispersion (m)	Dispersion Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	Furthest extent (m) for flash fire	172	83

5.2.7.4Explosion Effects – Late Ignition

Sr.	Over pressure	Distance in meters

No.	BAR(g)	PSI (g)	5.0m/s;C	2.0m/s; D
1.	0.0207	0.3	110	137
2.	0.1379	2	80	95
3.	0.2068	3	78	91

Comments:

1. In case of pool fire, the radiation effect would be restricted to the site.

2. Methanol has a low boiling point i.e. (65oC.), hence if timely action is not taken, a large amount of Methanol would vaporize and unconfined vapour cloud would be formed which if it encounters a source of ignition would explode.

3. In case of unconfined vapour cloud explosion there may be a moderate implication on the surrounding facilities (Synthetics & chemicals and J R Enterprises).

5.2.8 Scenario 8 - Refrigerated Butadiene storage tank of Synthetics and chemicals

There are two atmospheric storage tanks of Butadiene having capacity of 2000 MT each. The storage temperature is maintained at minimum 8oC. Ammonia is used as refrigerant. The tank is double walled tank, catastrophic rupture of the tank is improbable. It is assumed that if the roof of the tank fails and a pool fire has taken place whose diameter equals the diameter of the tank.

5.2.8.1Radiation Effects: Pool Fire

Sr. No.	Radiation levels (Kw/sq m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	4	46	74
2.	12.5	41	41
3.	37.5	33	19

5.2.8.2Flash Fire

Sr. No.	Distance (m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	Furthest extent (m) for flash fire	97	4

Comments:

The radiation distance would be contained within the site.

5.2.9 Scenario 9 - IFFCO Ammonia Sphere

IFFCO has refrigerant ammonia storage tanks. There are two 1500 m/tons Horton Spheres. In case of external fire, the sphere would be heated up. The external fire would cause the shell above the liquid level to get weakened.

5.2.9.1Dispersion Distance for Ammonia

Sr. No.	Concentration of interest ppm	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	500 (IDLH)	10440	9908

Comments:

1. A toxic ammonia cloud of IDLH concentration (500 ppm would disperse upto 10 km. in the downward direction.

2. Considering that ammonia is highly soluble in water and it is a light gas, the severity of the scenario could be greatly reduced by timely action. I.e. application of water spray to ammonia cloud.

3. The ammonia storages are well protected. The company has its own fire and safety department with fire engines and fire fighting personnel on duty round the clock. The company has a good preventive maintenance programme. Safety training is given to all employees.

5.2.10 Scenario 10- Phenol storage of Kesar Enterprises

Kesar Enterprises terminal phenol is stored in a 566 KL steam jacketed tank. In case of overflow or bottom nozzle failure, phenol would accumulate in the dyke.

5.2.10.1Dispersion Distance for Phenol

Sr. No.	Concentration of interest ppm.	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	100 (IDLH)	103	90

5.2.10.2Radiation Effects: Pool Fire

Sr. No.	Radiation levels (kW/sq m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	4	32	32
2.	12.5	25	22
3.	37.5	12	12

Comments:

1. Phenol vapour of IDLH 100 ppm would disburse upto 131 to 197 m. in downward direction. This may have a moderate off-site implication.

5.2.11 Scenario 11 - Acrylonitrile storage of Kesar enterprises.

In Kesar terminal, Acrylonitrile is stored in a 2526 KL tank. Acrylonitrile polymerises in the presence of light and at high temperature. In case of polymerization, the distances affected could be as follows.

5.2.11.1Dispersion Distance for Acrylonitrile

Sr. No.	Concentration of interest ppm	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	4	4075	12150

5.2.11.2Radiation Effects: Pool Fire

Sr. No.	Radiation levels (kW/sq m)	Distance in me ters	
		5.0m/s;C	2.0m/s; D
1.	4	91	96
2.	12.5	65	58
3.	37.5	46	35

5.2.11.3Flash Fire

Sr. No.	Distance (m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	Furthest extent (m) for flash fire	119	126

Comments

1. The dispersion distance for Acrylonitrile for a cloud of 4 ppm concentration is approximately 12 km in the downwind direction, if the wind speed is 2 m/s at atmospheric stability is D. However, this would be greatly reduced if timely action is taken.

2. The polymerization products include Hydrogen Cyanide and Nox.

5.2.12 Scenario 12 - Aniline storage - JK Synthetics Terminal

Aniline is stored in the JK Terminal. The tank diameter is considered 12m and dyke diameter as 25m.

5.2.12.1Dispersion Distance for Aniline

Sr. No.	Concentration of interest ppm	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	100	92	177

Comments:

1. In case of overflow of tank or bottom nozzle rupture aniline would accumulate in the dyke.
2. Aniline has an IDLH value of 100 ppm. Toxic vapour of aniline would disperse upto 177 m. in the downwind direction, if the wind speed is 2m/sec.

   an atmospheric stability D.

3. The rate of evaporation could be reduced by blanketing with water.

5.2.13 Scenario 13 - BLEVE of LPG road tanker

LPG Road Tankers are filled up at the IOCL terminal. In case of over pressurization of the bullets a BLEVE could take place. Over pressurization could take place because of external fire. In case of an accident of the road tanker on the road, LPG would spill out and could result in an unconfined vapour cloud explosion. One 10 ton LPG road tanker has been considered for the study.

5.2.13.1Radiation Effects – Bleeve / Fireball

Sr. No.	Radiation levels (Kw/sq m)	Distance in meters	
		5m/sC	2m/s D
1.	4	345	345
2.	12.5	196	196
3.	37.5	108	108

5.2.13.2 Explosion Effects

Sr. No.	Over pressure		Distance in mete rs	
	BAR(g)	PSI (g)	5.0m/s;C	2.0m/s; D
1.	0.0207	0.3	707	707
2.	0.1379	2	183	183
3.	0.2068	3	141	141

5.2.14 Scenario 14 - Naphtha storage of BPCL

In case of a dyke fire or tank roof fire of a naphtha storage tank in BPCL terminal the damage distances would be as follows.

Sr No	Commodity	Scenario	Wind Speed (M/S)	Damage Distance for Pool fire(Meters)		
				4 kW/m 2	12.5 kW/m2	37.5 kW/m2
1.	Naphtha	Dyke fire	3	205	71	31
2.	Naphtha	Tank Roof Fire	3	188	65	29

5.2.15 Scenario 15 - Catastrophic rupture of 15000 MT cryogenic LPG tank of IOCL

The possibility of catastrophic rupture of the cryogenic LPG tank is very remote. However in case of such a scenario the damage distances would be as follows.

5.2.15.1 Explosion Effects

Sr. No.	Over pressure	Distance in meters

	BAR(g)	PSI (g)	5.0m/s;C	2.0m/s; D
1.	0.0207	0.3	316	302
2.	0.1379	2	169	176
3.	0.2068	3	157	166

5.2.16 Scenario 16 - Catastrophic rupture of ammonia road tanker

In case of catastrophic rupture of ammonia road tanker the damage distances would be as follows.

5.2.16.1Dispersion Distance for Ammonia

Sr. No.	Concentration of interest ppm	Dispersion Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	500	1866	1592

5.2.17 Scenario 17 - Leak from Acrylonitrile road tanker

In case of leak from one compartment (Capacity 3 tons) from an Acrylonitrile road tanker, the affected distances would be as follows.

5.2.17.1Dispersion Distance for Acrylonitrile

Sr. No.	Concentration of interest ppm	Dispersion Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	400	574	1508