RISK ANALYSIS REPORT

FOR

M/S **RAN CHEMICALS PRIVATE LIMITED**

PREPARED BY

RAKESH GUPTA ASSOCIATES

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CHAPTER 1 - INTRODUCTION

RAN CHEMICALS PVT LTD

M/S. RAN CHEMICALS PVT. LTD. located at Kh. No. 45, Mouza – Khapri, Tah. Kalmeshwar, Dist. Nagpur (M.S.), seeking consent from MOEF EC authority for expansion and production capacity augmentation. TOR has been granted by SEAC committee. In one of the specific tor conditions they asked proponent to prepare dedicated RA report (Letter attached in EIA report). In turn RCPL assigned the job of carrying out RISK ASSESSMENT of their plant to R K GUPTA ASSOCIATES, Nagpur, and accordingly, R K GUPTA is one of the FAE for RH (Category A). The RA study was carried out and summed up in this submission. During the course of field-visit, perusal of key documents were undertaken and discussed one to one on plant site visit on at times.

Mr. Rohit Khanduri, Director (Works) coordinated about this activity in the meeting, objective, scope and methodology of the RA was explained and the co-operation of all the HODs & Officers was sought to provide the information without any apprehension. During the course of field-visits, discussions were also held with Section-Officials in different Departments/Plants present at the section. Most of them accompanied the FAE during the field-visit of the Plants and Departments' areas.

M/S. RAN CHEMICALS PVT. LTD. is one of the leading manufacturers of specialty CHEMICALS used in Textile, Powder Paint and Paper Industry. The plant is equipped with microprocessor-based system for minimal variations in quality. Modern engineering for safe operations and infrastructure to produce Eco-Friendly, Efficient and Economical Products. They are Manufacturers and exporters of specialty CHEMICALS and polymers.

Acrylics: Water based emulsions, inverse emulsions, acrylic dispersion in water etc. Polyester: Water based polyester resin & carboxyl terminated polyester resin and polymeric surfactants.

M/S. RAN CHEMICALS PVT. LTD. has a sizable percentage of turnover as exports in Europe and other countries as their products are able to compete with products from multinationals in performance and quality.

Names of Persons Furnishing Information: MR. ROHIT KHANDURI, DIRECTOR (WORKS)

Description of the Industrial Activity Namely

SITE: M/S. RAN CHEMICALS PVT. LTD. Is about 25 kms from the city Nagpur situated at KH. No. 45, mouza – khapri, tah.Kalmeshwar, dist. Nagpur (Maharashtra)THE SITE IS BOUNDED BY:

1. Farm on the North-Side,

2. Farm on the East-Side,
3. M/S. Minex Metal LTD. on the WEST-Side,
4. Farm on the SOUTH-Side.

LAND-AREA AND OTHER DETAILS ARE AS UNDER.

PARTICULARS	DETAILS AS REPORTED
Name of District	Nagpur.
Name of State	Maharashtra.
Nearest Railway station & its distance	Nagpur, 26 Kms from Plant.
Nearest Airport & its distance	Nagpur (Approx. 25 Kms from Plant.)
Year of Commissioning	1991-1992
Total-Area	27600 Sq. Meters
Plant-Area	7229 Sq. Meters
Undeveloped-Area (Green-Belt)	2386 Sq. Meters
Ownership of land	Owned by M/S RAN CHEMICALS P. LTD.
NO. Of Shifts	Three shifts working.

Approval of Factory-Site:

The plant was established in the year 1991-1992 by following the guidelines under The Factories Act 1948. Modified Factory-Plans are approved, vide Letter No क्रमांक / औसुवआ//नकाशे/32-2017/992-99 dated. 14th March 2017 by Additional Director, Department of Industrial Safety & Health, Nagpur. A copy of Covering letter for Drawing Approval is available with proponent.

CONSTRUCTION DESIGN:

The plant has a Plot-Area of 27600 Sq. Mtrs, which includes with commonbounding-wall measuring 6776 Sq. Mtrs of RCC-Constructed (Ground, Mezzanine and First Floor) Built-up area and remaining 2386 Sq. Mtrs under proposed expansion and under Green-Belt.

Stability Certificate under Form 1-A (Rule 3-A) was issued on 20/01/2015and is valid for five years. A copy of the same is enclosed as Annexure.

Petroleum & Explosives Safety Organisation (PESO) License no. P/PQ/MH/15/2069 (P7359) dated 06/12/2016 renewed upto 31/12/2022

MPCB-Consent Letter No. B.O./MPCB/AST/EIC No. – NG-12106-15/R/CC/12810 dated. 07.10.2015. The consent is granted for period from 01/04/2011 to 31/03/2016. Renewal Consent to operate is granted from 31.03.2016 to 31.03.2021

PROTECTION ZONE (EXPLOSION PROTECTION, SEPARATION):

1. All the equipment's/Reactors are having sufficient space around and minimum clear space distance is maintained between any two equipments.
2. Thermic Fluid Heater and boiler are installed away from the Plant in separate shed with safety facilities like Foam type Fire hydrant line and monitor, Fire /smoke detectors, Self-operating DCP cylinders and sufficient number of ABC fire extinguishers,
   Thermic Fluid circulation pump system having standby pump and motor and Diesel operating engine which can operate in case of emergency
3. All Air compressors having Auto Drain valves and Spring-Loaded safety released valves

ACCESSIBILITY OF PLANT:

This unit is well-connected to Nagpur–city by road at a distance of 20.65 Km & Kalmeshwar Tahashil 9 km & 3 Km from NH07. It is situated Kh. No. 45, Mouza – Khapri, Tah. Kalmeshwar, Dist. Nagpur (Maharashtra) which is on Link road between 14th Miles to Kalmeshwar MIDC.

MAXIMUM NUMBER OF PERSON WORKING ON THE SITE AND PARTICULARLY OF THOSE PEOPLE EXPOSED TO THE HAZARDS:

Total Manpower of this unit is as under:

TYPE OF PERSONNEL	NO. OF PERSONNEL
Officers & Company-Workers	102 + 12 = 114
Contract-Workers	69
Total	**183**

Maximum number of persons, who may be present in factory at any time is about 120 in a day. Persons exposed to Hazard-Area: Maximum 04-05 persons are exposed to the Hazardous Areas for chemicals handling.

RAN CHEMICAL PVT. LTD. propose to enhance production capacity by adopting state of art technology with due compliance with MOEF guidelines and regulation.

PLANT UTILITY

Water:

Existing: 99.5m3/day
Proposed: 177m3/DAY

Power:

1000kw + DG set

EXISTING AND PROPOSED PRODUCTION

SR. NO.	PRODUCT	CATEGORY	UOM	QUANTITY
EXISTING PRODUCTION CAPACITY				
1	Polyester based resin and other polyesters	Chemical, Petrochemical & Electrochemical	MT/Day	28.0
2	Finishing agents and preparation used in textile	-Do-	MT/Day	1.4
3	Spent Methanol and Glycol (By-Product)	-	MT/Day	1.2
Total (Existing)			**MT/ Day**	**29.4**
PROPOSED PRODUCTION CAPACITY				
1	Polyester based resin and other polyesters	Chemical, Petrochemical & Electrochemical	MT/Day	36
2	Finishing agents and preparation used in textile	-Do-	MT/Day	14.6
3	Spent Methanol and Glycol (By-Product)	-	MT/Day	0.8
Total (Proposed)			**MT/Day**	**50.6**
TOTAL (EXISTING + PROPOSED)			**MT/DAY**	**80.0**

CHAPTER 2 - MANUFACTURING PROCESS

MANUFACTURING PROCESS OF VARIOUS PRODUCTS

1. WATER-SOLUBLE RESIN

All Raw Materials after getting approval from Q/C dept are charged in the Etherification reactor. Then these raw materials are heated to 250°C under atmospheric pressure with the help of Hot Thermic Fluid of 265±5 °C. Vapours getting generated sent to partial condenser through fractionation column. Vent temperature of Partial condenser is maintained to 98±2°C. Scrubbing system being incorporated to check fugitives and carryover if any. Once the required parameters of Reaction Mass achieved, it is then transferred to Polycondensation reactor. In Polycondensation reactor is subjected to slow vacuum pulling which is started at collection of condensation, is done in a receiver. Reaction mass temperature is maintained to 250±10 °C. Once the vacuum reached to -710 mm Hg condenser bypassed and direct high vacuum apply in the reactor up to 0.1 torr. At defined current and frequency, the achieved reaction mass is getting drained in the tray. These trays then cool to Room temperature and pre-crushing and grinding are done in processing section. After Q/C approval these required size powder is filled in bags

2. WATER-INSOLUBLE RESIN

All Raw Materials after getting approval from Q/C dept are charged in the reactor. Then these RM heat to 250°C under atmospheric pressure with the help of Hot Thermic Fluid of 265±5 °C. Vapours getting generated send to partial condenser through fractionation column. Vent temperature of Partial condenser is maintained to 98±2°C.Scrubbing system being incorporated for check on fugitive and carryover if any.

Once the required parameters of Reaction achieved the Reaction Mass cool to 180°C and Part 2 chemicals are added. slowly reaction mass temperature is increased. After maintaining reaction mass at 245°C for 2 hours the sample are checked. After getting defined quality parameter 3rd stage started for maintaining is done for 4 hours to achieve final quality parameters. Once final Parameter gets achieved this reaction mass is fed to cooling belt and crusher and finally to bagging section.

FOLLOWING FACILITIES SHALL BE USED FOR MANUFACTURING AND IN PROCESSING OF AFORESAID CHEMICALS -

- Cooling Tower Water,
- Chilled Water,
- Thermic Fluid,

- Nitrogen,
- Compressed Air
- Stand-By Power

DETILS OF STANDBY POWER

There is provision of Stand-by DG-Sets provided for alternate power arrangement in the Plant, details of which are as under.

Sr.No.	USAGE TYPE	MAKE	CAPACITY	YEAR OF MFG.
1.	Stand-by	Caterpillar	320KVA	2006
2.	Stand –By	Caterpillar	500KVA	2008

DETAILS OF AIR-COMPRESSOR

A total of 4air-compressors are provided in the plant, all are of normal reciprocating-type. Other details of these air-compressors are tabled as under.

Sr.No.	TYPE OF AIR-COMPRESSOR	MAKE	MODEL	CAPACITY (m3/hr)	PRESSURE (bar)
1	Reciprocating	ELGI	TS03-120	14.5	12
2	Reciprocating	ELGI	TS05-120	30	12
3	Reciprocating	ELGI	TS300	13.8	12
4	Reciprocating	IR	2545	72.5	10

Personal-Protective-Equipments (PPEs)

Personal-Protective-Equipments such as Ear Plug, Safety Goggle, Safety Shoes, Heat Protective hand gloves, Mask / Special Protective Mask, Helmet, Face Shield & Heat Protective Gloves, Respiratory Masks, Cotton Hand gloves, Goggles. Safety Belt, Helmet

A List of PPEs with Type, Location & Quantity details, as provided, is enclosed in Annexure.

Location of First-Aid Boxes

A First-Aid Box is located at -

1. Factory Main Gate
2. Plant Control Room

Lighting – Arrestors

Provided at strategic places.

DESCRIPTION OF HAZARDOUS CHEMICALS

Sr. No.	TANK NO.	CHEMICAL	TYPE OF STORAGE-VESSEL	STORAGE CAPACITY	PURITY
1		PTA	Jumbo bag / bags	225 ton	99-100%
2		DMT	Jumbo bag / bags	25 ton	99 -100 %
3		NPG solid	Bags	60 ton	99 -100 %
4		NPG liquid	Tank/ Drums	13 ton	99 -100 %
5		MEG	Tanks / Drums	50kl	99 -100 %
6		DEG	Tanks / Drums	25kl	99 -100 %
7		Alcohols from C12-24	Drums / Carboy	10ton	99 -100 %
8		Expoxy Curing agent	Drums / Carboy/bags	3ton	99 -100 %
9		EOPO surfactant (polyolsetc)	Drums / Carboy/bags	5 ton	99 -100 %
10		Esterification catalyst	Drums / Carboy/ bags	500 kg	99 -100 %
11		Specialty Tri acids	Drums / Carboy/ bags	5ton	99 -100 %
12		Other Specialty raw materials	Drums / Carboy/ bags	2ton	99 -100 %
13		Ester Catalyst	Drums / Carboy/ Bags	1ton	99 -100 %
14		Hydroxy acids	Drums / Carboy	3Ton	99 -100 %
		Fatty acids (C10-32)	Drums / Carboy/bags	8 Ton	
15		Na salt of 5sulpho Dimethyl isopthalic	Jumbo bag / bags	25 ton	99 -100 %
16		Isopthalic acid	Jumbo bags/ Bags	20 ton	99 -100 %

17		Tri malliticunhydride	Bags	8 ton	99 -100 %
18		Specialty diols glycols	Drums / Carboy	10	99 -100 %
19		Specialty di acids	Drums / Carboy	5 ton	99 -100 %
20		Specialty tri glycols	Drums / Carboy	5 ton	99 -100 %
21		Polycondensation catalyst	Drums / Carboy/bags	1 ton	99 -100 %

The Degree of purity of the hazardous chemical:

All the chemicals coming to RAN chemicals PVT LTD are having Suppliers Test Certificate of analysis which ensuring the purity and all others necessary parameters. Before unloading Q/C has to reinsure all the parameters in Lab

Information on The Preliminary Hazard Analysis:

a. Type of Accidents:
   1. Fire.
   2. Building collapses due to explosion
   3. Electrical shock due to improper grounding/earthing and because of naked live-wire coming into human contact.

b. System Elements or Events Which Can Lead to Major Accidents:
   1. Short circuiting of electrical system due to improper grounding / loose contacts.
   2. Fire due to human neglect / overheating of electrical contacts due to over loading of electrical conductors.
   3. Combustible fuels like Diesel-oil.

c. Hazards:
   1. Fire.
   2. Spillages of Oil and CHEMICALS.
   3. Electrical shocks due to short circuiting /electrical local arcing etc.
   4. Injuries of any serious nature to human being or breathlessness.

Description of Safety-Relevant-Units

a. Special Design Criteria:

All reactors, Equipments, tanks and Pipe lines are designed as per ASTM std. Process controls and Alarms are provided w.r.t. Hazards.

b. Controls and Alarms:

Fire incidents are communicated by coded-Sirens. Controls in the premises are provided for temperature control, pressure control. Siren for emergency purpose is installed. Temperature-Indicators are provided to all equipments which are involved in process.

c. Fire-Communication and Alarming-System:

Fire incidents are communicated by fixed Warning Bell, walkie talkie & Mobiles Phones
The system checked periodically.

d. Pressure-Relief-System:

All reactors are having Safety relief valves of 2-inch size and set pressure is 1.4Kg/Cm2 G and vent to connected in Cooling tower tank through a condenser.

Air Compressors are having Pressure regulating valves and spring-loaded Safety release valves. Nitrogen trolley bank which we are using, are tested regularly, PRV and SRV station is forkeeping System pressure to 2 kg/cm^{2}max. All statutory and precautionary Calibration, setting and verification being carried out by approved competent external agencies (Certificates are annexed). Thermic Fluid Heater and lines are having PRV and SRV

e. Collecting Tanks/Dump Tanks:

All esterification reactors are connected in the bottom and can be transferred in any of these reactors.

All Safety Release Valves connected to reactor are dumped in Cooling tower Tank via Common header of 6”

f. Sprinkler-System:

There are local sprinklers in fire-fighting system. Eye-Wash cum Safety-Showers are provided at 2-3 points

g. Fire-Protection:

Fire engine with 137 cu. Meter /hr capacity with water storage capacity of 200 Cu. Meter

- Electrically operated pump is available
- AFFF 40 liters with nozzles are available at site

- Fire hydrant hose points, hydrant monitors and sand buckets are provided at various points
- DCP Fire Extinguishers of 4 to 20 kg capacity are available
- Self-acting Fire extinguishers are provided at above of Thermic furnace, TFH pump and expansion tank.
- Smoke detectors are provided at 8 difference fire prone points in the factory.
- Auto Operating DCP Fire extinguishers are provided at Thermic fluid pump, expansion and furnace

FIRE-PUMP DETAILS:

Two Fire Pumps, in all, are provided in the Plant, details of which are as under.

Sr. No.	Particular pump	Type	CAPACITY	RPM	POWER (KW)
1.	Hydrant Pump Kiloskar Make Type **CE65/8 Head 70m Engine type - 4R1040NA**	Fix Main Fire Diesel Engine pump	137 m^3/h	2150	50
2.	Grundfos Make pump Type **NB 50-200/210 A-F2-B-BAQE**	Main Fire pump (Motorized)	88.6 m^3/h	2940 rpm	17.5

FIRE-EXTINGUISHER DETAILS:

Portable Fire-Extinguishers are provided near equipments at various locations, and record maintained. There are a total of 30 Fire-Extinguishers. Details in annexure.

FIRE-HYDRANT & ITS ALLIED-EQUIPMENTS AVAILABLE:

Fire-Hydrant pipeline (pressurized) around the production-area is connected to Fire Water Pumps (electric and diesel operated).

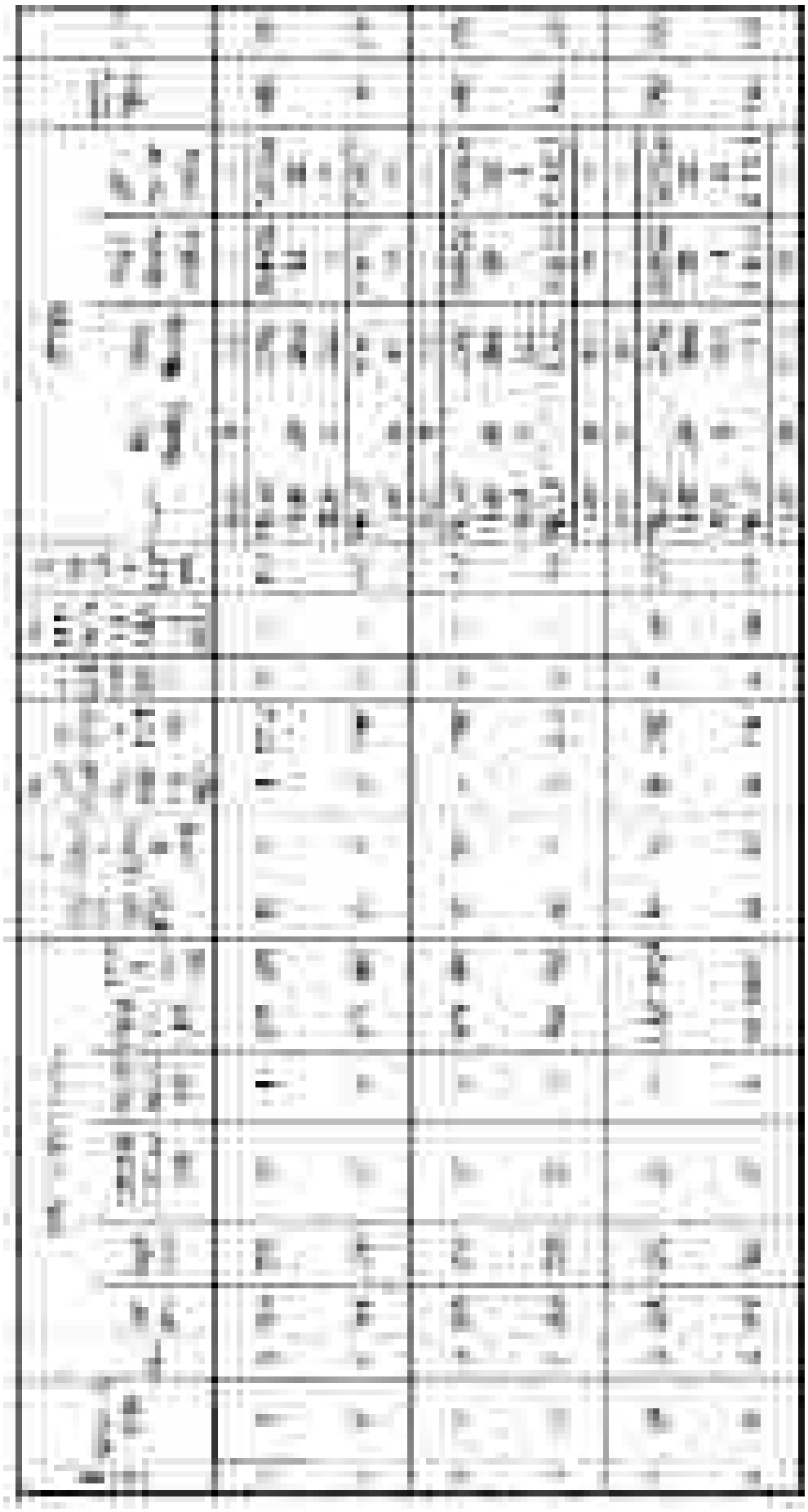
There is provision of 9 Fire Hydrant-Ports & 8 Fire Hose-Reel Boxes.

A Fire-Hydrant Layout, indicating Hydrant-Pipeline, Hydrant-Ports, Hose-Reel Boxes, etc., is enclosed in Annexure. Which is also displayed at Gate and Plant Control Room.

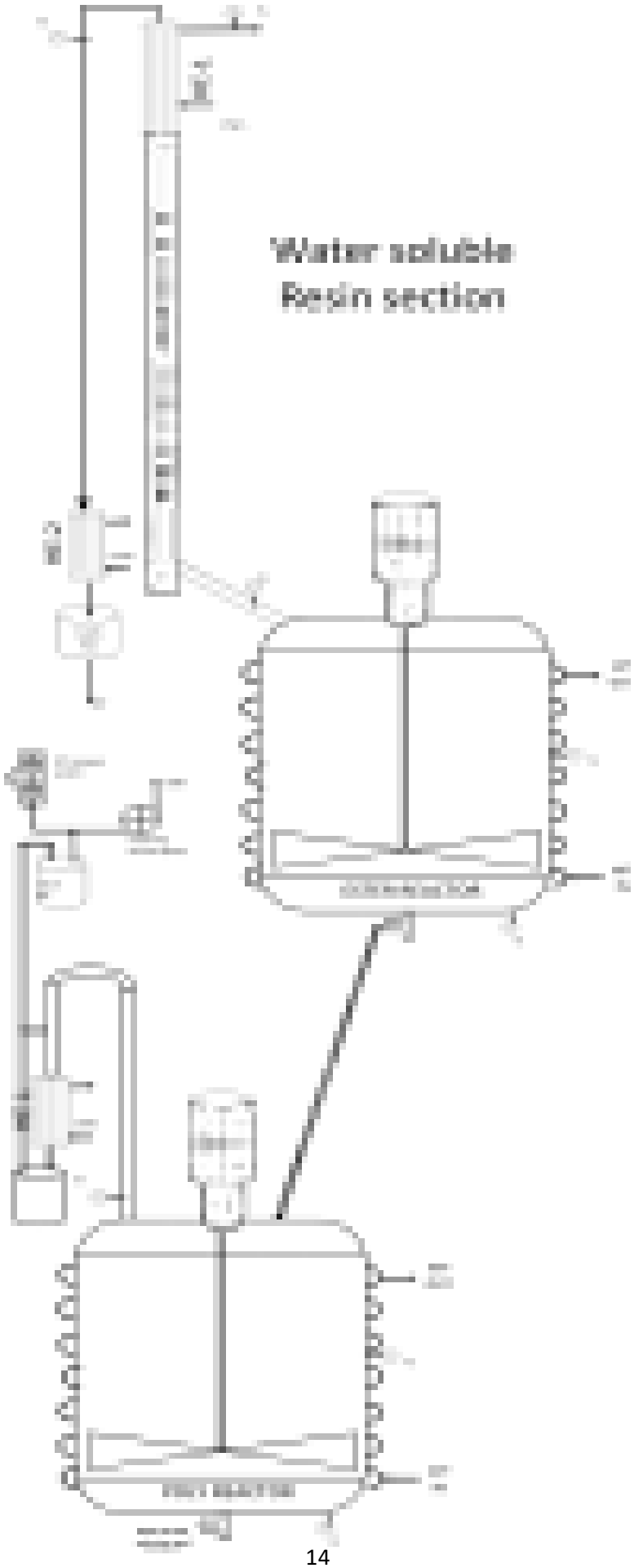
PERSONAL-PROTECTIVE-EQUIPMENTS (PPEs) AVAILABLE:

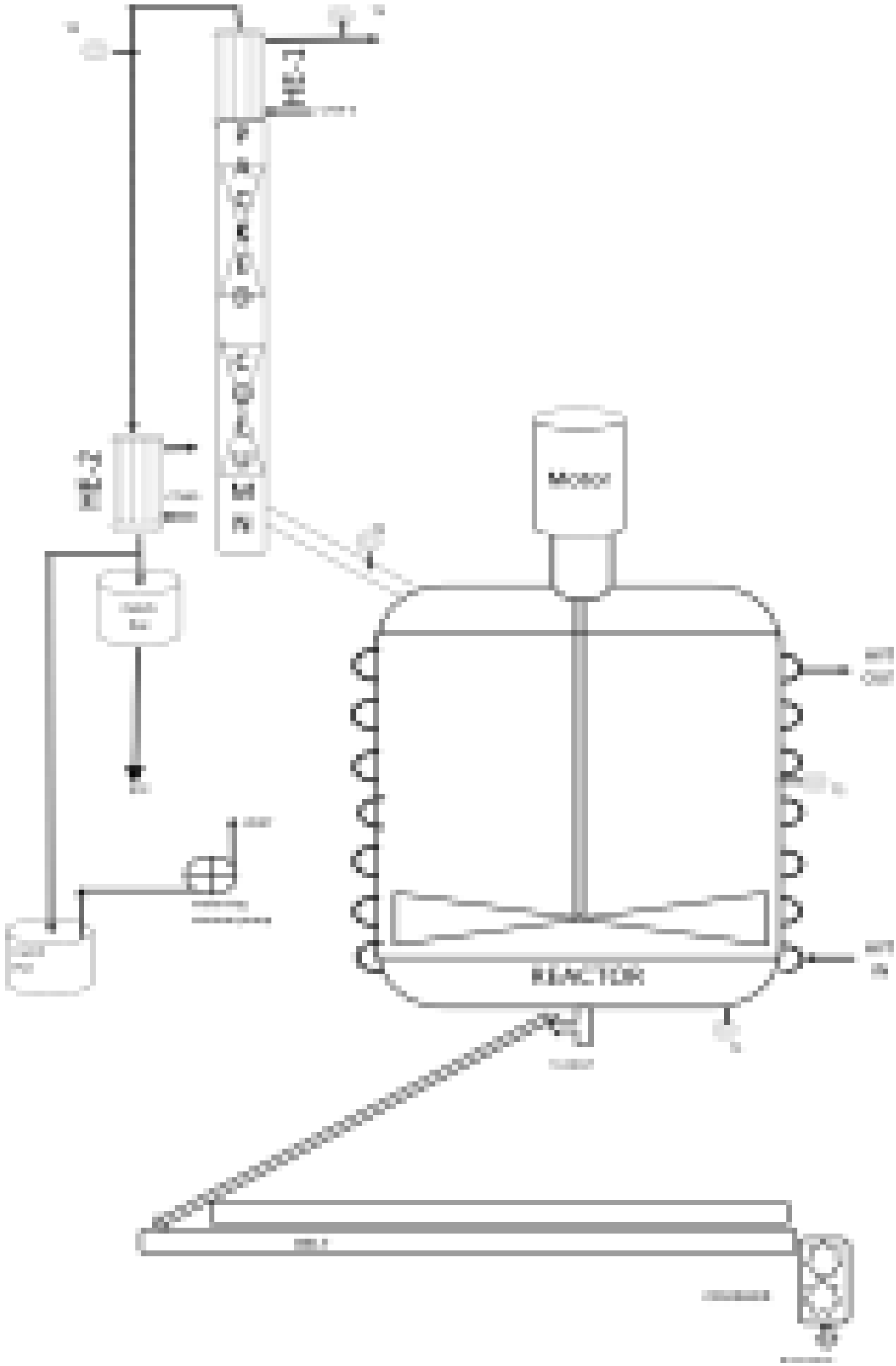
Ear Plug, Safety Goggle, Safety Shoes, Heat Protective hand gloves, Mask / Special Protective Mask, Helmet, Face Shield & Heat Protective Gloves, Respiratory Masks, Cotton Hand gloves, Goggles. Safety Belt, Helmet, etc. are provided.

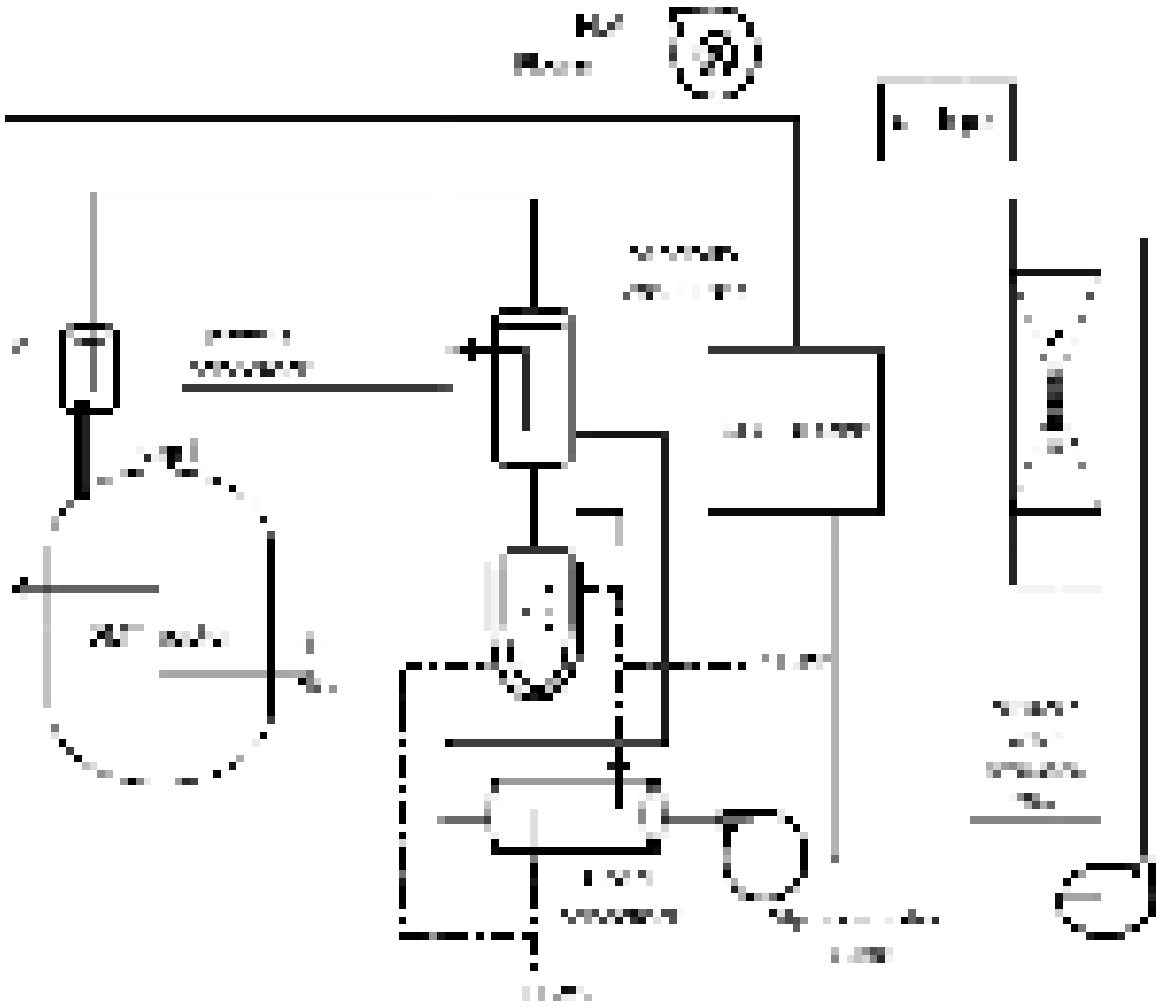
REACTORS COMPARATIVE ENGG. DATA



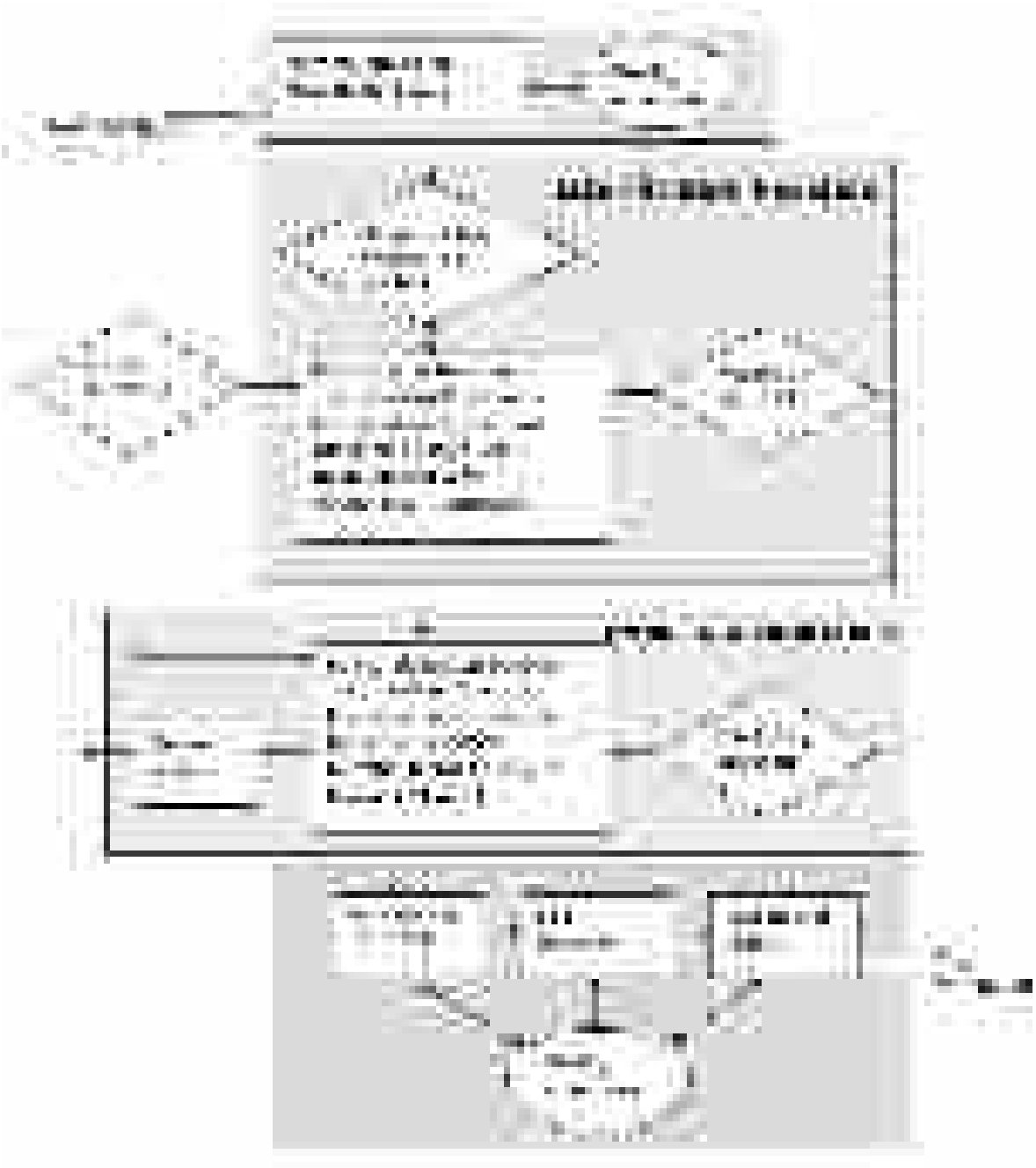
CHEMICAL PRIVATE LIMITED


Water soluble
Resin section

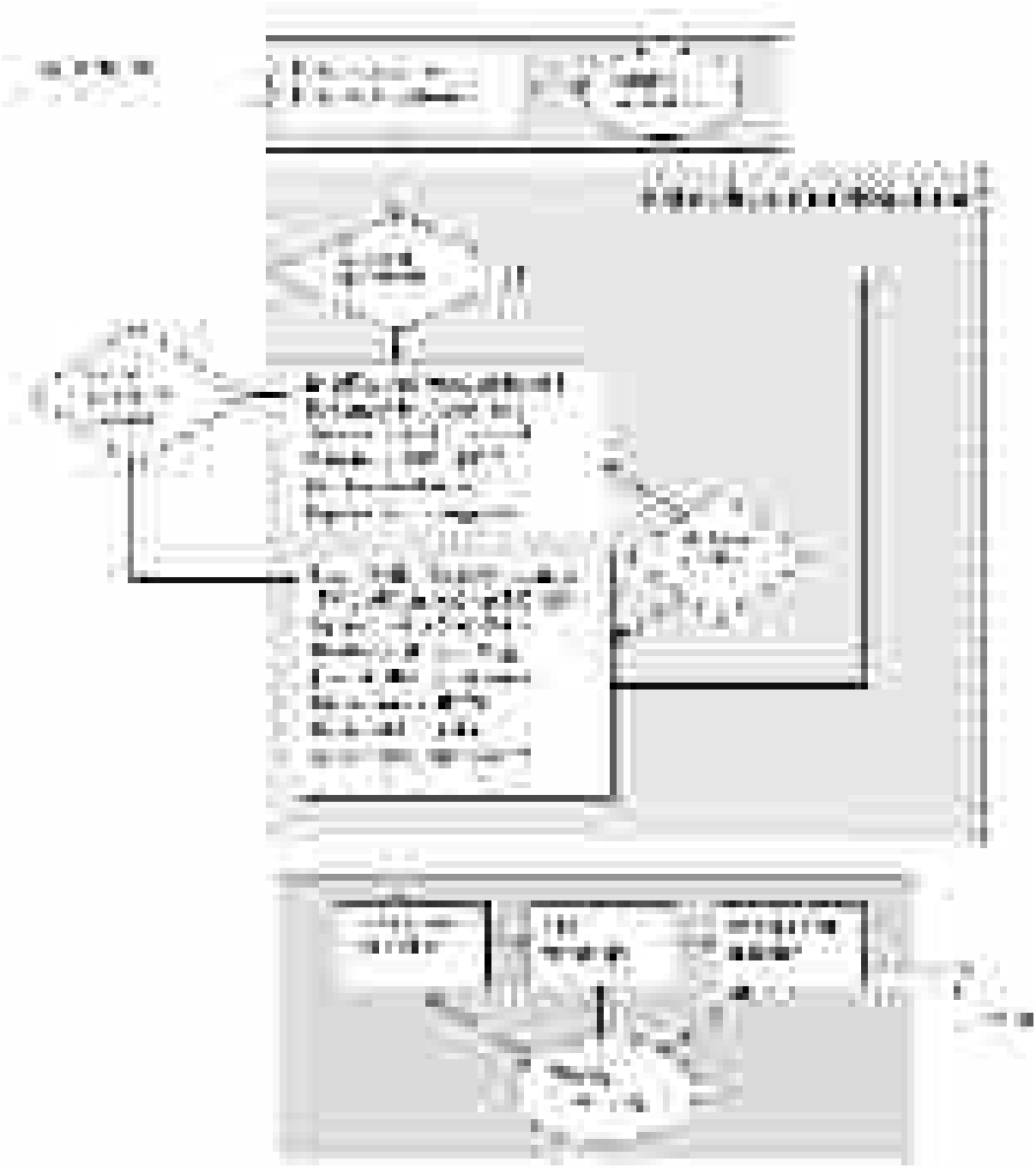

HE-1
HE-2
REACTOR



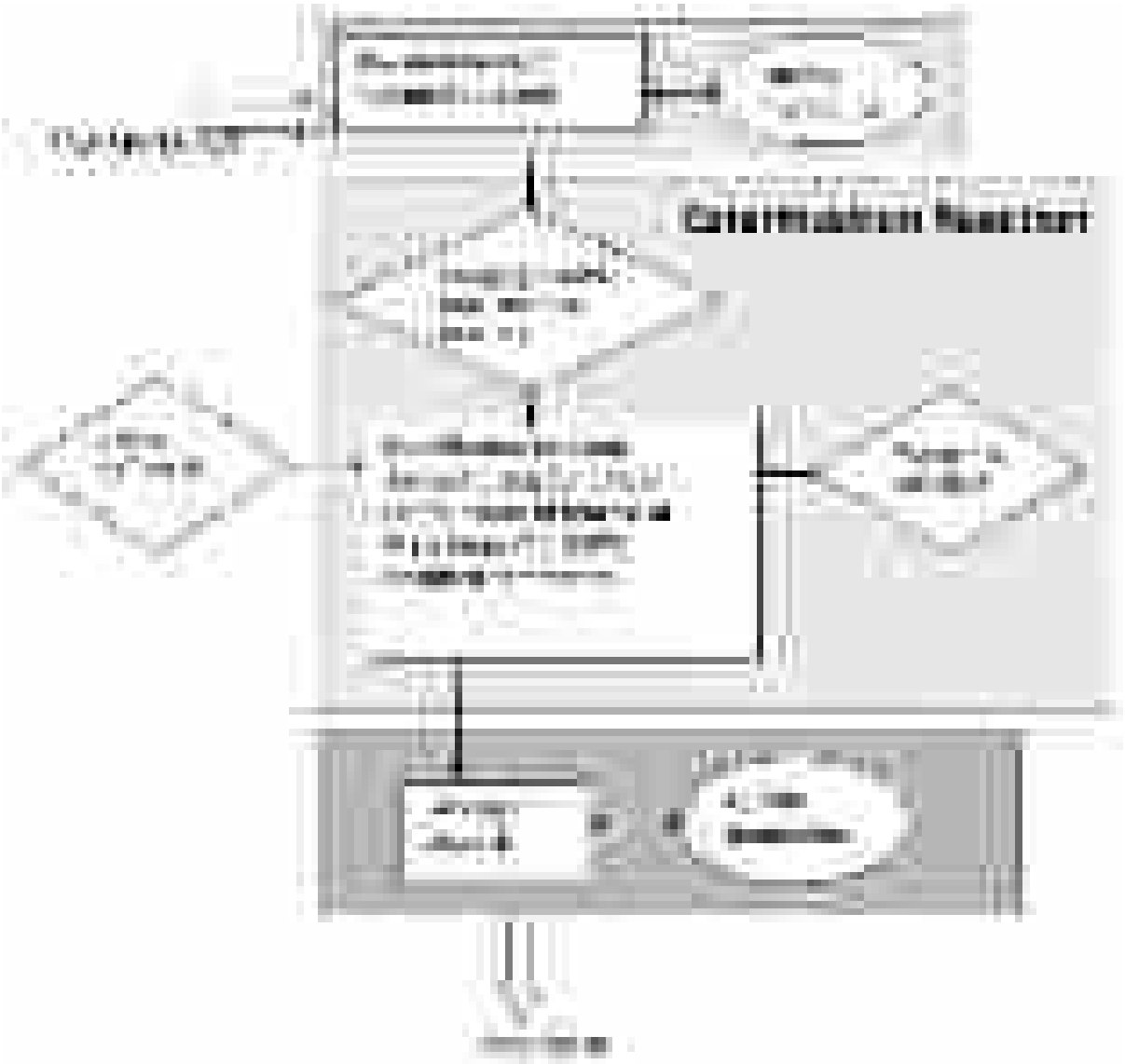
PROCESS FLOW DIAGRAM



FLOW CHART OF WATER-SOLUBLE RESIN



FLOW CHART OF POWDER COATING POLYESTER RESIN



FLOW CHART OF FINISHING AGENTS

Utilities

Following are the utilities for chemical manufacturing -

1) Compressor ---900cfmx2 /500/500cfm

2)Hydrant Pump Engine 173m3/Hr @7kg/M2
90m3/Hr Pump 25hp Hydrant

3) Cooling Tower
50tr/ 40tr/250tr×2 /800/1000tr

4) Chiller 20tr/40tr/85tr

5) Coal Fired Thermic Fluid Htr 6lac Kcal/Hr/15lac Kcal/Hr

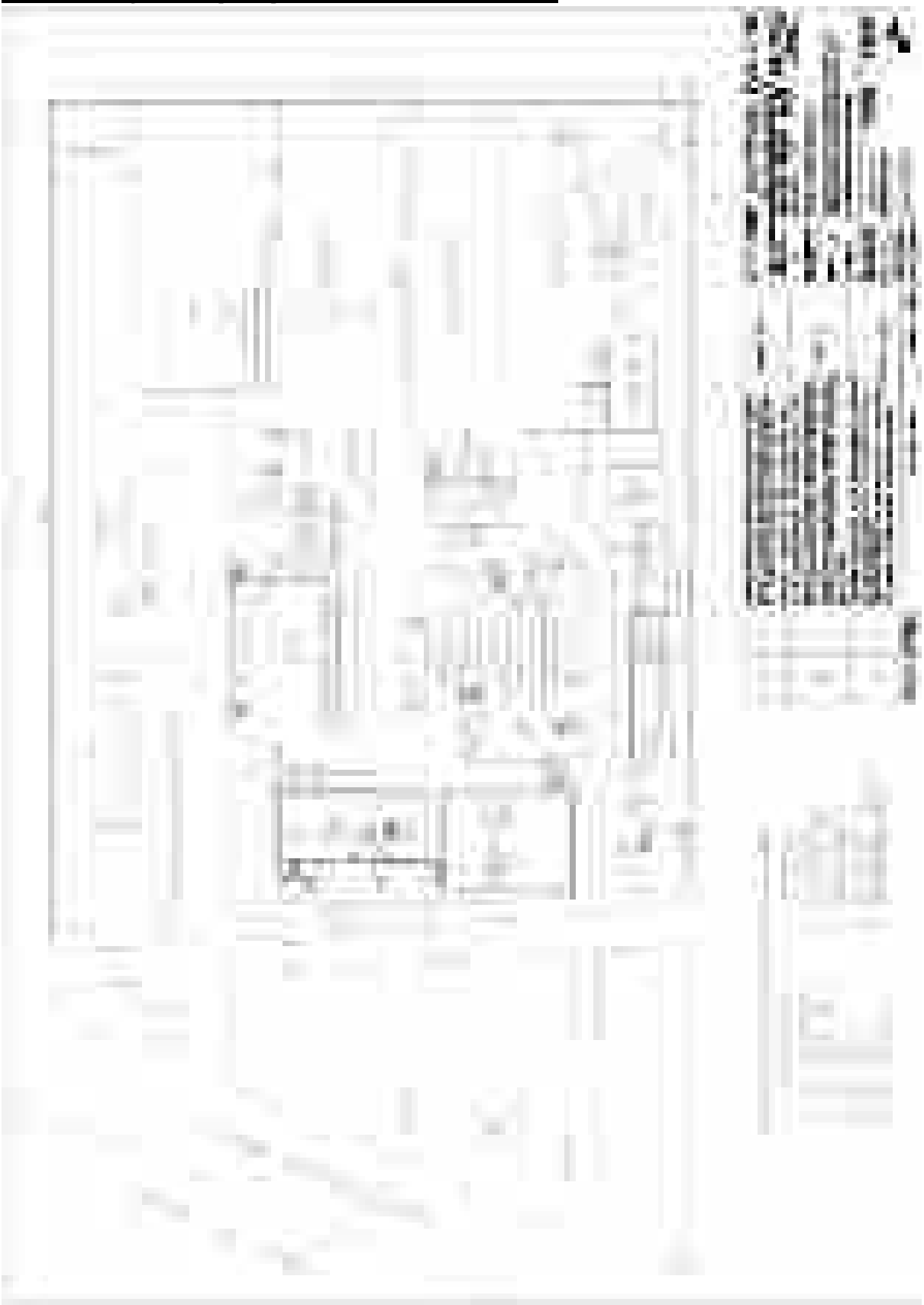
6) Coal Fired IBR Boiler 1tn/hr

7) Radiator Cooling Pump 40m^3/hr
Radiator Cooling Fan 1/2/3

8) Transformer 800kva

9) Dg Set 320kva/500kva

Plant Layout (proposed installation)



CHAPTER 3 - RISK ASSESSMENT PROCESS

Objective of Risk assessment and DMP

Disaster is an undesirable occurrence of events of such magnitude and nature so as to adversely affect production and cause damage to environment. Emergency response & disaster management plan has an important aspect of sound safety management to reduce the probability of serious loss to people, equipment, material, environment, process, reservoir, *etc*. RAN CHEMICAL PVT. LTD. handles wide variety of hydrocarbons and processes which are prone to explosion hazard and risk associate may be very serious some times. A DMP should include risk and hazard, assessment, loss prevention methodology, emergency response programmes and overall disaster management system.

The risk and hazard analysis stage are a very important part of the risk management process. Petrochemical complex processes comprise complex processes, which are not intrinsically safe. Hazard Identification and preventive measures are therefore an integral part of setting up of any petrochemical complex and its operation to avoid huge losses to mankind and environment.

Industrial accidents result in great personal and financial loss. Managing these accidental risks in today's environment is the concern of every industry including petrochemical based processing plants, because either real or perceived incidents can quickly jeopardize the financial viability of a business. Many facilities involve various manufacturing processes that have the potential for accidents which may be catastrophic to the plant, work force, environment, or public.

The main objective of risk assessment study is to propose a comprehensive but simple approach to carry out risk analysis and conducting feasibility studies for industries, planning and management of industrial prototype hazard analysis study in Indian context.

Risk analysis and risk assessment should provide details on Quantitative Risk Assessment (QRA) techniques used world-over to determine risk posed to people who work inside or live near hazardous facilities, and to aid in preparing effective emergency response plans by delineating a Disaster Management Plan (DMP) to handle onsite and offsite emergencies. Hence, QRA is an invaluable method for making informed risk-based process safety and environmental impact planning decisions, as well as being fundamental to any decision while siting a facility. QRA whether, site-specific or risk specific for any plant is complex and needs extensive study that involves process understanding, hazard identification, consequence modelling, probability data, vulnerability models/data, local weather and terrain conditions and local population data. QRA may be carried out to serve the following objectives:

- Identification of safety areas
- Identification of hazard sources
- Generation of accidental release scenarios for escape of hazardous materials from the facility
- Identification of vulnerable units with recourse to hazard indices

- Estimation of damage distances for the accidental release scenarios with recourse to Maximum Credible Accident (MCA) analysis
- Hazard and Operability studies (HAZOP) in order to identify potential failure cases of significant consequences
- Estimation of probability of occurrences of hazardous event through fault tree analysis and computation of reliability of various control paths
- Assessment of risk on basis of above evaluation against the risk acceptability criteria relevant to the situation
- Suggest risk mitigation measures based on engineering judgement, reliability and risk analysis approaches
- Delineation/upgradation of DMP
- Safety Reports: with external safety report/ occupational safety report.

The risk assessment report may cover the following in terms of the extent of damage with resource to MCA analysis and delineation of risk mitigations measures with an approach to DMP.

- Hazard identification – identification of hazardous activities, hazardous materials, past accident records, *etc.*
- Hazard quantification – consequence analysis to assess the impacts Risk Presentation
- Risk Mitigation Measures
- DMPs

Figure: Risk Assessment – Conceptual Framework

Methods of risk prediction should cover all the design intentions and operating parameters to quantify risk in terms of probability of occurrence of hazardous events and magnitude of its consequence. Table shows the predictive models for risk assessment.

Table: Choice of Models for Impact Predictions: Risk Assessment

Name	Application	Remarks
EFFECT WHAZAN	Consequence Analysis for Visualization of accidental chemical release scenarios & its consequence Consequence Analysis for Visualization of accidental chemical release scenarios & its consequence	Heat load, press wave & toxic release exposure neutral gas dispersion
EGADIS	Consequence Analysis for Visualization of accidental chemical release scenarios & its consequence	Dense gas dispersion
HAZOP and Fault Tree Assessment	For estimating top event probability	Failure frequency data is required
Pathways reliability and protective system hazard analysis	For estimating reliability of equipments and protective systems	Markov models
Vulnerability Exposure models	Estimation of population exposure	Uses probit equation for population exposure
F-X and F-N curves	Individual / Societal risks	Graphical Representation

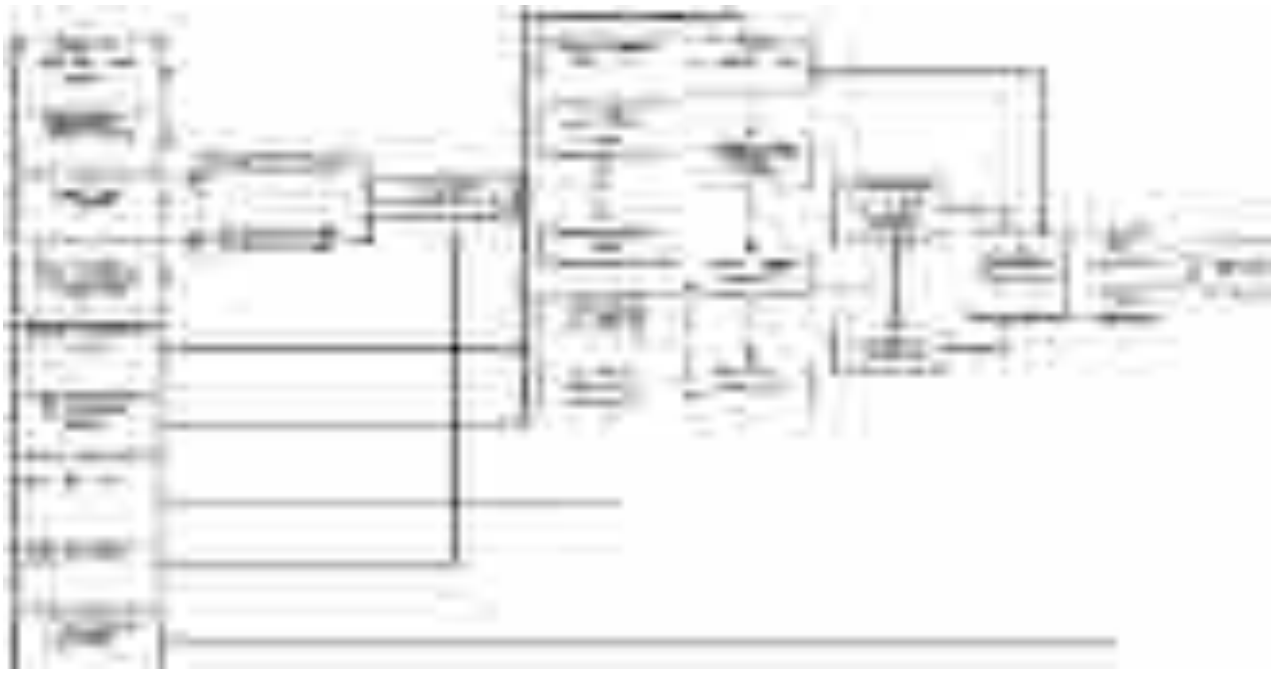


Figure: Comprehensive Risk Assessment - At a Glance

STORAGE AND HANDLING OF HAZARDOUS MATERIALS

Both hazardous and non-hazardous materials generated within the project facility shall be temporarily accommodated in appropriate units placed within the project facility built/made in line with the safety, health and environmental standards.
The size of these temporary units would depend on the quantity and type of hazardous waste materials like oils, fuels, *etc*., with appropriate storage capacities placed in the project facility in compliance with the Hazardous Waste Management and Handling Rules. Also, if gas cylinders must be stored in the facility, rules applicable for gas cylinders under the Explosives Act shall be followed. Later, these materials must be disposed off at a centralized disposal facility with utmost care following safety norms. Each unit in the facility should be have fire hydrant system to handle fire hazards.

CONSEQUENCE ANALYSIS

This part deals with the quantification of various effects of release of HZ chemical release products on the surrounding area by means of mathematical models and internationally recognized Safety software.

It is intended to give an insight into how the physical effects resulting from the release of hazardous substances can be calculated by means of computerized models and how the vulnerability models can be used to translate the physical effects in terms of injuries and damage to exposed population & environment.

Table: Mathematical and Analytical Model for Hazard Analysis

SN	Phenomenon	Applicable Models
1	**Outflows:** • Liquid, Two phase • Mixtures, Gas/vapor	Bernoulli flow equation; phase equilibrium; multiphase flow models; orifice/nozzle flow equations; gas laws; critical flow criteria
2	**Discharges:** • Spreading liquid • Vapor jets • Flashing liquids • Evaporation of liquids on land & water	Spreading rate equation for non-penetrable surfaces based on cylindrical liquid pools Turbulent free jet model Two zone flash vaporization model Spreading, boiling & moving boundary heat transfer models; Film & meta-stable boiling phenomenon; cooling of semi-infinite medium
3	**Dispersion:** Heavy Gas	• Boundary dominated, stable stratified & positive dispersion models (similarity)

SN	Phenomenon	Applicable Models
	Natural Gas Atmospheric stability	• 3D Models based on momentum, mass & energy conservation • Gaussian Dispersion models for naturally buoyant plumes • Boundary layer theory (turbulence), Gauss Ian distribution models
4	**Heat Radiation:** • Liquid pool fires • Jet fires • Fire balls	Burning rate, heat radiation & incident heat correlation (semi imperial); Flame propagation behavior models Fire jet dispersion model API fire ball models relating surface heat flux of flame, geometric view factor & transmission coefficients
5	**Vulnerability:** • Likely damage	Probit functions; Non-Stochastic vulnerability models

First, attention is paid to the factors, which are decisive for the selection of the models to be used in a particular situation, after which the various effect models are discussed.

FACTORS WHICH INFLUENCE THE USE OF PHYSICAL EFFECT MODEL

In order to calculate the physical effects of the incidental release of hazardous substances the following steps have been carried out in succession:

- Understanding of the form in which the hazardous substance is in existence (i.e. liquid of highly volatile nature in case of petroleum Product)
- Determination of the various ways in which the release can take place
- Determination of the outflow volume or quantity (as a function of time) i.e. estimating rate of evaporation from the pool of liquid;

In the case of petroleum Product, quantity of leaked or spilled Product along with pool size has been calculated. Finally, the analysis results in computation of heat radiation intensity (KW/m^2) with respect to distance for various MCA scenarios. In this analysis, final effect calculations have been made for pool fire for heat radiation intensity effects with respect to distance from dyke wall.

MODELS FOR DETERMINING THE SOURCE STRENGTH FOR THE RELEASE OF HAZARDOUS SUBSTANCES

Source strength of a release means the quantity of the substance released with respect to time. The release may be instantaneous or continuous. In case of

instantaneous release, the strength of the source is given in kg whereas in continuous release source strength depends on the outflow time and expressed in kg/s. In order to find the source strength, it is first necessary to determine the state of a substance in a vessel or pipe along with physical properties, viz. vapor pressure & minimum ignition energy required. Phase of petroleum Product at the time of accidental release is also to be determined. This may be gas, gas condensed to liquid or liquid in equilibrium with its vapor.

INSTANTANEOUS RELEASE

In the event of the instantaneous release of a liquid a pool of liquid will form. The evaporation can be calculated on the basis of pool size, volatile nature of the product (i.e. vapor pressure) and meteorological conditions.

SEMI-CONTINUOUS OUTFLOW

In the case of a semi continuous outflow, it is again first of all necessary to determine whether it is gas, a gas condensed to liquid or liquid that is flowing out. The following situations can occur here.

(A) Gas Outflow:

The model with which the source strength is determined in the event of a gas outflow is based on the assumption that there is no liquid in the system.

(B) Liquid Outflow:

In case of liquid outflow, discharge due to overall head difference takes place.

MODEL FOR EVAPORATION

In application of evaporation models, petroleum product is a case of volatile liquid. From the pool, which has formed, evaporation will take place as a result of the heat flow from the ground and solar radiation. The evaporation model only takes account of the heat flow from the ground since the heat resulting from solar radiation is negligibly small compared with the former. The evaporation rate depends on the kind of liquid and the kind of subsoil.

MODEL FOR DISPERSION

The gas or vapor released either instantaneously or continuously will be spread in the surrounding area under the influence of the atmospheric turbulence. In the case of gas dispersion, a distinction is required to be made between neutral gas dispersion and heavy gas dispersion.

The concentrations of the gas released in the surrounding area can be calculated by means of these dispersion models. These concentrations are important for

determining the nature of accidents for example an explosive gas cloud formation injuries will occur in the case of toxic gases.

Heavy Gas Dispersion Model

If the gas density is higher than that of air due to higher molecular weight or marked cooling, it will tend to spread in a radial direction because of gravity. This results in a "gas pool" of a particular height and diameter. As a result of this, in contrast to a neutral gas, the gas released may spread against the direction of the wind.

MODEL FOR HEAT LOAD AND SHOCK WAVES

MODEL FOR FLARE

If an out-flowing vapor (in case of class A Products) forms a cloud with concentrations between the lower and upper explosion limit and ignition takes place, momentary/instantaneous/luminous fire film may occur for fraction of seconds. A model with which the length of a torch and the thermal load for the surrounding area can be calculated, assumes an elliptic shaped torch. The volume of the flare in this model is proportional to the outflow.

In order to calculate the thermal load, flare is regarded as a point source located at the center of the flare. This center is taken as being half a flare length from the point of outflow. The schematic of flare is depicted in subsequent table.

MODEL FOR JET FIRE

In this event, if out-going stream is due to small opening / hole in the storage tank / valve joints having sufficient liquid head may result in jet fire if it catches ignition source.

MODEL FOR SPILLED/POOL FIRE

The schematic of a pool fire is depicted in **Figure**. The heat load on objects outside a burning pool of liquid can be calculated with the heat radiation model. This model uses average radiation intensity, which is dependent on the liquid. Account is also taken of the diameter-to-height ratio of the fire, which depends on the burning liquid. In addition, the heat load is also influenced by the following factors:

* Distance from the fire
* Relative humidity (water vapor has relatively high heat absorbing capacity)
* The orientation i.e. horizontal/vertical of the object irradiated with respect to the fire

VULNERABILITY MODEL

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

$$Pr = k_1 + k_2 \ln V$$

in which,

Pr = Probit, a measure for the percentage of people exposed who incur a particular injury (relation between percentages &Probit is given in Table 17.

k_1 = A constant depending on the type of injury and type of load

k_2 = A constant depending on the type of load

V = Load or dose

Table: Relationship between Percentage and Probit

Percentage	Probit									
	0	1	2	3	4	5	6	7	8	9
0	-	2.67	2.95	3.12	3.25	3.36	3.45	3.52	3.59	3.66
10	3.72	3.77	3.82	3.87	3.92	3.96	4.01	4.05	4.08	4.12
20	4.16	4.19	4.23	4.26	4.29	4.33	4.36	4.39	4.42	4.45
30	4.48	4.50	4.53	4.56	4.59	4.61	4.64	4.67	4.69	4.72
40	4.75	4.77	4.80	4.83	4.85	4.87	4.90	4.92	4.95	4.97
50	5.00	5.03	5.05	5.08	5.10	5.13	5.15	5.18	5.20	5.23
60	5.25	5.28	5.31	5.33	5.36	5.39	5.41	5.44	5.45	5.50
70	5.52	5.55	5.58	5.61	5.64	5.67	5.71	5.74	5.77	5.81
80	5.84	5.88	5.92	5.95	5.99	6.04	6.08	6.13	6.18	6.23
90	6.28	6.34	6.41	6.48	6.55	6.64	6.75	6.88	7.05	7.33
-	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
99	7.33	7.37	7.41	7.46	7.51	7.58	7.65	7.75	7.88	8.09

INJURIES RESULTING FROM FLAMMABLE LIQUIDS AND GASES

In the case of flammable liquids and gases and immediate ignition a pool fire or a flare will occur depending on the conditions. The injuries in this case are mainly caused by heat radiation.

DAMAGE MODELS FOR HEAT RADIATION

It is assumed that everyone inside the area covered by the fire ball, a torch, a burning pool or gas cloud will be burned to death or will asphyxiate. The following Probit functions are an example of a method, which can be used to calculate the percentage of lethality, and first-degree burns that will occur at a particular thermal load and period of exposure of an unprotected body.

Lethality: $Pr = -36.83 + 2.56 \ln (t.q^{4/3})$

First degree burn symptoms: $Pr = -39.83 + 3.0186 \text{ in } (t.q^{4/3})$

In which, t = exposure time in seconds and;
q = thermal load W/m^2

Two values have been chosen for the exposure time to heat radiation:

* 10 seconds: for exposed persons in populated area it is assumed that they will have found protection from the heat radiation e.g. from a wall, within 10 seconds
* 30 seconds: this pessimistic assumption applies if people do not run away immediately or when no protection is available

Thermal radiations for particular Heat Radiation Intensity (kw/m^2) give different impacts. It depends on Intensity of Heat Radiation and surrounding facilities. Following table describes the damage due to particular Heat Intensity.

Table: Damages Envisaged at Various Heat Loads

Incident Radiation intensity, KW/m^2	Type of damage Intensity	
	Damage to Equipment	**Damage to People**
62.0	Spontaneous Ignition of Wood	100% Lethality (severe damage)
37.5	Sufficient to cause damage to process equipment	100% lethality in 1 min. and 1% lethality in 10 sec.
25.0	Minimum energy required to ignite wood, at infinitely	50% Lethality in 1 min. and Significant injury in 10 sec.

Incident Radiation intensity, KW/m^2	Type of damage Intensity	
	Damage to Equipment	Damage to People
	long exposure (non-piloted)	
19.0	Maximum thermal radiation intensity allowed on thermally unprotected equipment	-----
12.5	Minimum energy required for piloted ignition of wood, melting plastic tubing etc.	1% lethality in 1 min.
9.5	----	Pain threshold reached after 15 seconds
6.4	------	Pain threshold reached after 8 seconds. Second Degree burns after 20 seconds.
4.5	-------	Sufficient to cause pain to personnel if unable to reach cover within 20 seconds, however blistering of skin (first degree burns) is likely
2.0	PVC insulated cables damaged	----
1.6	-----	Will cause no discomfort to long exposure. Pain threshold reached after 60 seconds
0.7	-----	Equivalent to solar radiation. Exposed skin reddens and burns on prolonged exposure

Source: Reference Green book "Methods for Determination of Possible Damage", TNO, Netherlands;World Bank (1988); Technical Report No. 55: Techniques for Assessing Industrial Hazards; D.C.: The World Bank

The level of damage caused is a function of duration of exposure as well as heat flux. This is true both for the effects on buildings and Installation equipment as well as personnel. However, the variation in likely exposure time is much more marked with personnel due to possibility of findings shelter.

The following table gives the relationship between exposure time and heat flux against the fatality probability factors. Fatality Probability due to thermal radiation:

Percentage of Fatality	10%	50%	99%
Heat Flux (KW/m^2)	**Times in Seconds**		
1.6	500	1300	3200
4.0	150	370	930
12.5	30	80	200

Percentage of Fatality	10%	50%	99%
Heat Flux (KW/m^2)	**Times in Seconds**		
37.5	8	20	50

In general it might be possible to take to a "shelter" within 30-60 seconds. As can be seen from above table, the change between very low to very high fatality probabilities occurs between flux levels of 12.5 kw/m^2 and 37.5 kw/m^2.

For transient fires like fire ball, the steady state heat flux levels cannot be used to estimate the damage. The degree of thermal radiation in terms of total incident thermal energy dose levels are relevant as shown in table below:

Physiological effect of Threshold Thermal Dose:

Thermal Threshold Dose (KJ/m^2)	Effects
37.5	3rd Degree Burns
25.0	2nd Degree Burns
12.5	1st Degree Burns
6.5	Threshold of Pain or blistering of skin

IMPACT OF OVERPRESSURE

Pressure wave's results due to catastrophic failure or rupture of storage tank/pipeline etc. it results in generation of high-pressure waves which have potential to cause damage to property/personnel/equipments/neighbouring areas. A peak over pressure of 0.1 bar is taken as the limit for fatal injury and 0.03 bar as the limit for the occurrence of wounds as the result of flying fragments of glass. Following inferences are used to translate an explosion in terms of damage to the surrounding area:

- Everyone within the contours of the exploding gas cloud will die as a result of burns or asphyxiation. Establishments in this zone will be fully destroyed.

- In houses with serious damage it is assumed that one in eight persons present will be killed as a result of the building collapsing. Within the zone with a peak over pressure of 0.3 bar the risk of death in houses is 0.0125, i.e. one in eighty people will be killed.

Table: Damage Effects of Blast Overpressure

Peak Overpressure (Bar)	Damage Level
5.0 – 8.0	Major structural damage (assumed fatal to people inside building or within other structures) 100% Lethality
3.5 – 3.0	Oil storage tank failure 50% Lethality
2.0 – 3.0	Eardrum rupture Threshold Lethality
1.33 - 2.0	Repairable damage. Pressure vessels intact; light structures collapse Severe lung Damage
1.0 – 1.33	Window breakage, possibly causing some injuries 50% eardrum Rupture
0.3	Heavy (90% Damage)
0.1	Repairable (10% Damage)
0.03	Damage of glass
0.01	Crack of windows

SUMMARY OF DAMAGE CRITERIA

The summary of damage criteria adopted in the study based on vulnerability models and published health criteria for arriving at damage distances for the identified effects are:

Table: Damage Criteria for Pool Flare/Jet Fire

SN	Damage	Exposure Time = 10s		Exposure Time = 3s	
		With Protection	Without Protection	With Protection	Without Protection
1	100% lethality & severe damage to life & property	Within pool	Within pool	Within pool	Within pool
2	1% Lethal Injury (kW/M^2)	21.1	16.5	9.3	7.3
3	1% First Degree Burns (KW/m^2)	8.5	6.9	4.5	3.0

RESULT OF MAXIMUM CREDIBLE ACCIDENT ANALYSIS (MCA)

MCA can be defined as the maximum possible loss possible in the event of worst scenario due to any unforeseen condition /inadvertent reasons may result in release of hazardous substance and cause damage to surrounding if subjected to any

favorable condition for the escalation into hazardous effect like toxic, radiation, reaction etc. to theproperty, equipment, environment or life.

In this plant we will evaluate hazard potential of hazardous chemical as defined in MSIHC rule 1989 on the basis of maximum inventory be released in total or partially depending under prevailing conditions at times and that too in worst possible scenario in the incidence of "release or loss of containment" which may have damage potential to plant/property/life or any physical loss. Regarding evaluation of damage we anticipate worst scenario prevailing at times under any worst atmospheric whether condition and inherent quality of hazardous substance which might undergo "release". Having released hazardous substance when comes into atmosphere and get favorable condition like wind condition, ignitionsource, quantity of release can be predicted extent of damage be it toxic, radiation, reaction-explosion etc.are being the possible damage criteria under prevailing conditions.

CATAGORIZATION/EVALUATION OF RISK

Based on ranking of likelihood and frequencies, each identified hazard has been evaluated based on the likelihood of occurrence and the magnitude of consequences. The significance of the risk is expressed as the product of likelihood and the consequence of the risk event, expressed as follows:

Significance = Likelihood X Consequence.

The **Table** below illustrates all possible product results for the five likelihood and consequence categories while the **Table** assigns risk significance criteria. Depending on the position of the intersection of a column with a row in the risk matrix, hazard prone activities have been classified as low, medium and high thereby qualifying for a set of risk reduction / mitigation strategies.

Table: Risk Matrix

	Likelihood →

			Frequent	Probable	Remote	Not Likely	Improbable
			5	4	3	2	1
Consequence →	Catastrophic	5	25	20	15	10	5
	Major	4	20	16	12	8	4
	Moderate	3	15	12	9	6	3
	Minor	2	10	8	6	4	2
	Insignificant	1	5	4	3	2	1

Table: Risk Criteria and Action Requirements

Risk Significance	Criteria Definition & Action Requirements
High (16 - 25)	**"Risk requires attention"** – HSE Management need to ensure that necessary mitigation are adopted to ensure that possible risk remains within acceptable limits
Medium (10 – 15)	**"Risk is tolerable"** – HSE Management needs to adopt necessary measures to prevent any change/modification of existing risk controls and ensure implementation of all practicable controls.
Low (5 – 9)	**"Risk is acceptable" –** Identified risks are managed by well-established controls and routine processes/procedures. Implementation of additional controls can be considered.
Very Low (1 – 4)	**"Risk is acceptable" –** All risks are managed by well-established controls and routine processes/procedures. Additional risk controls need not to be considered

Risk category as per incidents mentioned under heading 4.5 is as per below:

Table: Categorization of Risk as per Identified MCA Scenarios

SN	Risk Source	Risk Category
1	Spilled product Fire	Low
2	Pool Fire	Intermediate
3	Tank On Fire	Intermediate
4	Unconfined Vapour Cloud Explosion	Intermediate (because no habitation in surrounding of installation for a minimum 500 m distance)
5	Spillage of product when road tanker meets with an accident enroute resulting in fire	Low
6	fire in parking area outside Depot premises	Low
7	storage tank hit by a flying object/under fire due to some explosion in close vicinity areas	Intermediate (if controlled within time)

FAILURE FREQUENCY

The frequency analysis of the hazards identified with respect to the ongoing operations shall be undertaken to estimate the likelihood of their occurrences. Hazard frequencies were estimated based on the analysis of historical accident frequency data and professional judgment. Following table shows frequency categories and likelihood ranking of occurrence of any incident as per failure frequency.

Table: Frequency Categories and Criteria

Likelihood Ranking	Criteria Ranking (cases / year)	Frequency Class
5	>1.0	Frequent
4	$>10^{-1}$ to <1.0	Probable
3	$>10^{-3}$ to $<10^{-1}$	Remote
2	$>10^{-5}$ to $<10^{-3}$	Not Likely
1	$>10^{-6}$ to $<10^{-5}$	Improbable

For the identified accident scenarios, the categorization and probability of Spilled fire is as follows, which is inferred on the basis of past accident analysis, information & approach provided in Green Book & Purple Book.

Table-- Probability of Occurrences of Identified MCA Scenarios

SN	Accident Scenario	Probability
1.	Spilled Product catching fire	Very Low (about 10^{-5} per year)
2.	Jet Fire in Pipeline/Product Pump House/Tank Farm/TLF Shed/T/T Decanting Area/Tank Truck	Very Low (about 10^{-5} per year)
3.	Pool Fire class A in storage tank, in Main Tank farm	Very Low (about 10^{-6} per year)
4.	Pool Fire in class B tank in Main Tank farm	Very Low (about 10^{-6} per year)
5.	Tank on Fire	Very Low (about 10^{-7} per year)
6.	Vapor Cloud Explosion due to major release of Class A product from storage unit	Extremely Low (about 10^{-8} per year)

UNCERTAINTY SURROUNDING CONSEQUENCE ANALYSIS

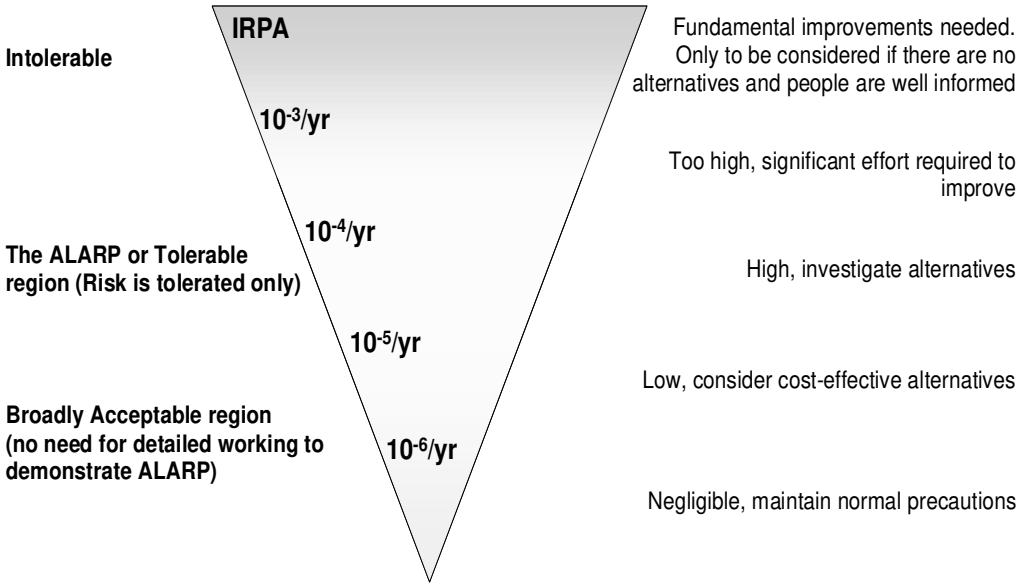
Analytical and mathematical models employed in quantification of damage distances are based on many considerations, which have been discussed earlier.

In many cases, very general data is available on component and equipment failures, for which statistical accuracy is often poor. Probability data has been found quite subjective, so that, when combined in a fault tree or event tree the incident frequencies thus computed may not have a higher confidence range. Furthermore, it is difficult to infer the comparison between frequencies of two catastrophic events, for example propensity of 10^{-4} and 10^{-5} per annum.

ALARP PRINCIPLE

ALARP stands for "**as low as reasonably practicable**". The **ALARP principle** is that *the residual risk shall be as low as reasonably practicable*. It has particular connotation as a route to reduce risks **SFAIRP** (so far as is reasonably practicable) in UK Health and Safety law.

For a risk to be ALARP it must be possible to demonstrate that the cost involved in reducing the risk further would be grossly disproportionate to the benefit gained. The ALARP principle arises from the fact that infinite time, effort and money could be spent on the attempt of reducing a risk to zero. It should not be understood as simply a quantitative measure of benefit against detriment. It is more a best common practice of judgment of the balance of risk and societal benefit. Following figure shows ALARP diagram.



MANUFACTURE, STORAGE & IMPORT OF HAZARDOUS CHEMICAL'S RULES, UNDER ENVIRONMENT PROTECTION ACT, 1986, MoEF, GOI, 2000 (MSIHC RULES):

1. Indicative Criteria for Identification of Toxic, Flammable & Explosive Chemicals:

a. ***Toxic Chemicals***

Chemicals having the following values of acute toxicity and which, owing to their physical and chemical properties, are capable of producing major accident hazards:

S N	Degree of Toxicity	Medium lethal dose by the oral route (oral toxicity) LD50* (mg/Kg body weight of test animals)	Medium lethal dose by the dermal route (dermal toxicity) LD 50 (mg/Kg body weight of test animals)	Medium lethal concentration by inhalation route (four hours) LC50* mg/L inhalation in test animals)
1.	Extremely toxic	1-50	1-200	0.1-0.5
2.	Highly toxic	51-500	201-2000	0.5-2.0

* LD50/LC50: Lethal Dose / Lethal Concentration of a compound for 50 % of the population exposed.

b. Flammable Chemicals

i. Flammable Gases: Chemicals which in the gaseous state at normal pressure & mixed with air become flammable and the boiling point of which at normal pressure is 23^{O}C or below,

ii. Highly Flammable Liquids: chemicals which have a flash point lower than 23°C and the boiling point of which at normal pressure is above 20°C,

iii. Flammable Liquids: chemicals which have a flash point lower than 65^{O}C and which remain liquids under pressure, where particular processing conditions, such as high pressure and high temperature, may create major accident hazards

c. Explosives

Chemicals which may explode under the effect of flame, heat or photo-chemical conditions or which are more sensitive to shocks or friction than dinitrobenzene.

*2.*Description of Applicable Provisions of MSIHC Rules, 2000

Applicable Provisions	Description
2	Definitions (e.g. hazardous chemical, major accident, isolated storage, pipeline, threshold quantity etc.)
3	Duties of Government Authorities
4(1)(a) & 4(2)(i)	General responsibility of the occupier for the chemicals listed in schedule I to prevent major accident and provide safety related information; including antidotes, equipment & safety training etc.
5	Notification of major accidents to concerned authority
6	Industrial activity to which Rule 7 to 15 apply
7	Notification of sites to competent authority
8	Updating of site notification following changes in threshold quantity
9	Transitional provision for the existing activity
10	Preparation of safety report by the occupier & to carry out an independent Safety Audit once in a year
11	Updating of safety report based on modification
12	Further information on safety reports to the authority

Applicable Provisions	Description
13	Preparation of on-site emergency plan by the occupier & to conduct mock drill once in every 6 months
14	Preparation of off-site emergency plan by the authority to conduct mock drill once in every year
15	Information to be given to persons liable to be affected by a major accident
16	Disclosure of information notified under the rules
17	Collection, development and dissemination of information on hazardous chemicals employed by the occupier
18	Import of hazardous chemicals
19	Improvement notices
20	Power of central government to modify the schedules
Schedule-1	Part-1: Indicative criteria & Part-II: List of 434 chemicals (for rules 2e(i), 4(1)(a), 4(2), 17 & 18)
Schedule-2	Isolated storages at installations, other than those covered by Schedule-4 (for rules 2e(ii), 4(1)(b), 4(2), & 6(1)(b))
Schedule-3	List of chemicals (for rules 2e(iii), 5, 6(1)(a) & 7-15)
Schedule-4	List of operation/processes (for rule 3 (h) (i))
Schedule-5	Concerned authorities(for rules 2(b) & 3)
Schedule-6	Information to be furnished for notification of major accidents (for rules 5(I))
Schedule-7	Information to be furnished for notification of site (for rules 7(I))
Schedule-8	Safety Report information (for rules 10 (I))
Schedule-9	Material Safety Data Sheet (MSDS) format (for rules 17)
Schedule-10	Format to maintain records of hazardous chemicals imported (for rule 17)
Schedule-11	Details to be furnished in On-site Emergency Plan (for rules 13 (1))
Schedule-12	Details to be furnished in Off-site Emergency Plan (for rules 14 (1))

LESSONS LEARNT FROM PAST ACCIDENTS

Reviewing the accident case histories in similar type of installations, factors pertaining to system design emphasize that:

- Accidents occur very rapidly, usually with inadequate time to manually control the system back to normal

- The time and effort required to develop a safe system design could always be is justified.

The following recommendations also include special design features for safer plants based on lessons learnt from accident case histories of Petrochemical& Chemical plants:

- Use of appropriate material of construction, especially when using old systems for new applications, retrofitting and maintenance.

- Ensure the quality of construction, especially for welds in accordance with the specifications.

- Check all purchased instruments and equipment for integrity, calibration and functionality.

- Do not install liquid filled flanges above electrical cables, a flange leak will douse the cable with liquid.

- Provide adequate supports for equipment and pipes, do not allow spring support to be completely compressed.

- Remove all temporary supports after construction is completed.

- Remove all temporary start-up or check-out branches, nipples, and plugs, and replace with properly designed welded plugs.

- Be sure all steam or electrical tracings are covered.

- Check to ensure all equipment’s are assembled correctly.

- When welding reinforcement pads to pipes or vessels are employed, ensure the trapped air can escape through a vent during heating.

- Do not install traps in lines where water can collect and develop a corrosion problem.

- Install bellows carefully and according to manufacturer's specifications. Bellows should be used cautiously. If required, inspect frequently and replace when necessary before they fail.

- Make static and dynamic analyses of pipe system to avoid excessive stresses or excessive vibrations.

- Design systems for easy operation and easy maintenance; for example, valves within easy reach of the operators, and design pipe networks for easy maintenance or with easy access to equipment requiring maintenance.

- Install bug screens on vent lines.

- Make structural analyses of relief system to avoid structural damage during emergency relief.

- Critical safety instruments must have backups.

- Provide hand operated or automatic block valves, or equivalent, for emergency shutdowns.

- Use electronic/mechanical level gauges, not sight glasses.

- Add fail-safe block valves with a positive indication of the valve position by limit switches.

Miscellaneous Designs for Preventing Fires and Explosions:

Feature	Explanation
Maintenance programs	The best way to prevent fires and explosions is to stop the release of flammable. Preventative maintenance programs are designed to up-grade system before failure occur
Fireproofing	Insulate vessel structures & pipes to minimize damage due to fires.
Control Rooms	Design control rooms to withstand explosions
Water Supplies	Provide supply for maximum demand Consider many firefighting systems running simultaneously, individual Diesel engine pumps are recommended.
Control Valve for Deluge	Place shut-offs well away from process areas
Manual Fire Protection	Install hydrants, monitors & deluge systems with adequate drainage
Separate units	Separate (space) plant on a site and units within plants. Provide access from two sides.

Feature	Explanation
Utilities	Design steam, water, electricity and air supplies to be available during emergencies. Place substations away from process area.
Personnel Areas	Locate personnel areas away from the hazardous process and storage areas.
Group Units	Group units in rows. Design for safe operation and maintenance. Create islands of risk by concentrating hazardous process units in one area. Space units so that “hot work” can be performed on one group while another are operating.
Isolation Valves	Install isolation valves for safe shutdowns
Dykes	Locate flammable storage vessels at periphery of units. Dyke vessels to contain and carry away spills
Block Valves	Automated block valve should be placed to stop and or control flows during emergencies. Ability to transfer hazardous material from one area to another should be considered.
On-line Analyzers	Add appropriate on-line analyzers to - Monitor the status of the process - Detect problems at the incipient stage - Take appropriate action to minimize effects of problems while itself in initial phase of development
Fail Safe Design	All controls need to be designed to fail safely. Add safeguards forautomated and safe shut-downs during emergencies

HAZARD FACTORS IN CHEMICAL INDUSTRY OPERATION

Based on systematic international surveys collated on several hundred large losses including fires and explosions, toxic chemicals, environmental run-offs, and boiler and allied industries over the past twenty years and also systematic study carried out in **TNO color books, Netherlands** the damage potential estimation due to loss of containment and results has been established. The case histories utilized in this study

included only those where enough information was available to assign hazard factors, which contributed to the losses. The following "hazard factors" have been reviewed.

1. Plant Site Problems:

* Unusual exposure to natural calamities such as windstorms, floods and earthquakes
* Poor location with respect to adequate water supply and other utilities
* exposure to serve hazards of nearby plants
* Unreliability of public fire and emergency protection traffic difficulties for emergency equipment
* Air and water pollution problems and inadequate waste disposal facilities
* Climatic problems requiring indoor facilities for hazardous process
* Poor drainage problems.

2. Inadequate Plant Layout and Spacing:

* Congested process and storage areas
* Lack of isolation for extra hazardous operations
* Difficulty in replacing faulty/inadequate equipment
* Lack of proper emergency exit facilities
* Inadequate space for maintenance or emergency operations
* Sources of ignition too close to hazards
* Critical plant areas exposed to external hazards
* Inadequate hazard classification of plant areas
* Lack of isolation of critical plant areas from community

3. Structure not in conformity with use requirement:

* Disregarding code requirements with regard to the buildings, electrical facilities, drainage, etc.
* Lack of fire resistive structural supports where required Failure to provide blast walls to isolate extra hazardous operations
* Inadequate explosion venting and ventilation of buildings Insufficient exit facilities
* Electrical equipment not in conformance to codes
* Unprotected critical wiring
* Inadequate hazard anticipation (explosion).

4. Inadequate material evaluation:

* Insufficient evaluation of the fire, health and stability characteristics of all materials involved
* Lack of established controls for the quantities of material involved
* Inadequate assessment of effect of processing environment on hazard characteristics of materials
* Lack of information on dust explosion tendencies of materials
* Toxicological (acute exposure, chronic exposure, carcinogenicity, teratogenicity, mutagenicity) hazards of materials not properly evaluated
* Incomplete hazard material inventory for the plant
* Lack of long term exposure information
* Improper packaging and labeling of chemicals

5. Chemical process problems:

* Lack of required information on process temperature or pressure variations hazardous situation may arise because of intermediate products or side reaction
* Inadequate evaluation of process reactions
* Lack of identification of processes subject to explosive reactions
* Inadequate evaluation of environment
* Requirement for extreme process conditions overlooked
* Lack of vapor cloud hazard evaluation.

6. Material Movement Problems:

* Hazards due to lack of control of chemicals during unit operations
* Inadequate control on hazardous explosive dusts
* Piping fittings, support and corrosion problems
* Improper identification of hazardous materials during transportation
* Inadequacies during loading and unloading
* Inadequate control on heat transfer operation
* Flammable gas and vapor problems in pneumatic conveyors

7. Operational Failures:

* Lack of detailed descriptions & recommended procedures for operating all sections of the plant
* Poor training program
* Lack of training with regard to industrial health and hygiene problems
* Lack of supervision
* Inadequate start-up and shut-down procedures

* Hazards due to poor inspection and housekeeping programs
* Lack of medical and biological surveillance programs

8. Equipment failures:

* Hazards built into the design of equipment
* Corrosion or erosion failures
* Metal fatigue
* Defective fabrication
* Inadequate controls
* Process exceeded design limits
* Poor maintenance program
* Inadequate repair and replacement program
* Lack of "fail-safe" instrumentation
* Poor check on construction specifications and criteria for material selection
* Inability of equipment to contain toxic and hazardous materials

9. In-effective Loss Prevention Program:

* Inadequate support of top management
* Lack of assigned responsibility
* Poor accident and industrial health prevention program
* Insufficient fire protection manpower, equipment and organization
* Insufficient explosion prevention and control program
* Lack of emergency planning - poor check on boiler and machinery risks
* Lack of loss prevention co-ordination with other plan groups
* Ineffective investigation of accidents, Lack of pre-employment physical examination of personal and periodic check-ups
* Lack of training on health hazards and use of personal protective equipment
* Lack of conformance with government regulations
* Individual hazard approach instead of "total loss control" concept.

CHAPTER 4 - BASIC ENVIRONMENT (CHEMICAL RAW/PRODUCT)

LIST OF RAW MATERIAL AND CONSUMPTION IN PROPOSED INSTALLATION

Raw Material	Existing	Proposed	Total
Di Ethylene Glycol (DEG)	40	64	104
Mono Ethylene Glycol (MEG)	90	144	234
Purified Terpthalic Acid (PTA)	350	560	910
Dimethyl Acetamide (DMA)	45	72	117
Dimethyl-Tryptamine (DMT)	5	8	13
PET Chips	80	128	208
2 Methyl 2.4pentinediol	30	48	78
Neo Pentyl glycol (NPG)	100	160	260
Iso Pthalic Acid	50	80	130
Spaciality Acid and Glycol	23	36.8	59.8
Emulsifier	12	19.2	31.2
Catayst And Spacialty	2	3.2	5.2
Trymethyl Aluminium	8	12.8	20.8

FINAL PRODUCTS

Products Existing

1) Polyester base resin and other poly - chem /petro/electro chem –**28mt/day**
2) Finishing agent for textile - **1.4tons/day**
3) Spent methanol andglycol (by-product) **- 1.2 tons/day**

Proposed

1) Polyester base resin and other poly - chem /petro/electro chem –**36t/day**
2) Finishing agent for textile - **14.6tons/day**
3) Spent methanoland glycol (by-product) **- 0.8tons/day**

CHAPTER 5 - STORAGE & HANDLING OF HAZARDOUS CHEMICALS

HAZARDOUS CHEMICAL

1) Tri Mellaticunhydride --TMA
2) Di Ethelene Glycol -DEG
3) Polyvynil Alcohol -PVA
4) Neopentyl Glycol-NPG
5) Dimethyl Terepthlate- DMT
6) Liquid NPG

Hazard Chemical Storage as per MSIHC Rule

Chemical	Storage	Quantity
PTA	Jumbo Bag	225 tons
DNT	Jumbo Bag	25 tons
NPG soild	Bags	60 tons
NPG Liquid	Tank	20 tons
MEG	Tank/Drum	50 KL
DEG	Tank/Drum	25 KL
Alcohol from C12-24	Drum Carbuoy	10 tons
Epoxy Curing Agent	Drum Carbuoy/Bags	3 tons
Eopo Surfactant	Drum Carbuoy	5 tons

WASTE GENERATION

Waste Material	Unit	Current Generation	New Additional Generation	Disposal
Effluent	CMD	10	15	Etp With Zld
Ash	MT/Month	60	50	Bricks Mfrr
Etp Sludge	KG/Day	4.5	4.5	ChwtsdfButibori
Spent Solvent	MT/Month	30	30	Sell toCCOE Approved Party
Discard Container/Container/Barrels/Bag	Nos/Day	4	2	ChwtsdfButibori
Carbuoy Drums Bags	Nos/Month	3500	2000	Recycler

CHAPTER 6 - VARIOUS HAZARDS & ITS CONTROL

HAZARDOUS CHEMICAL DETAILS

Sr no	Name of the Chemicals	Type of hazards	Hazardous chemical release	transformed in the event if abnormal conditions
1	Tri-Mellatic anhydride (TMA)	High Dust Concentration have a potential for combustion and explosion	Incomplete burning can produce CO2 and CO	1.CO2 and CO gases 2. Contact with water produces corresponding acids
2	Di-ethylene Glycol (DEG)	NO ENVIRNOMENTAL HAZARDS	Incomplete burning can produce CO2 and CO	
3	Polyvinyl Alcohol (PVA)	Dust may form Explosive mixture with air		
4	Neopentyl Glycol (NPG)	Irritation to eyes And NO ENVIRNOMENTAL HAZARDS	Incomplete burning can produce CO2 and CO	Combustible but not flammable
5	Di methyl Terephalate	Flammable above 141°C (Class 3). DMT in Vicinity of fire may melt/ignite and flow rapidly thus spreading fire.		
6	Liquid NPG		Incomplete burning can produce CO2 and CO	CO

PROCESS CONTROL MEASURES AND SAFETY FEATURES
SAFETY GIVEN TO REACTORS

Sr No	Particulars	Set	Actions	Reset
1	Reactor Pressure	≥ 0.3 kgs/cm3	Alarm at Control room	≤0.28 kg/cm2

2	Reactor Pressure	≥1.3 kg /cm2 g	SRV open and Vent to Cooling tower	≤ 1.2 kg/cm2
3	Reactor Temperature (DMT)	≥ 235 °C	Alarm at Control room	≤234°C
4	Partial Condenser vent temperature (T4)	≥ 101°C	Alarm at Control room	≤ 99°C
5	Cooling tower circulation line pressure	≤3 kg/cm2	Alarm at Control room	≥3.1 kg/cm2g
6	Vacuum drop rate in poly reactors		On/OFF valves Close	
7	Power Failure		1)Vacuum line valve close	
8	Leakage or breakdown in reactor		All reactors are connected at bottom and vacuum system	

THERMIC FLUID SYSTEM

Sr No	Particulars	Set	Action	Reset	Remarks
1	Pump Stopped	OFF	Alarm at Control room and TFH panel	ON	Or Start with Diesel engine
2	Circulation line pressure at Plant	≥ 3.0 Kg/Cm2	Alarm at Control Room	≤2.9Kg/Cm2 g	Adjust bypass valve
3	Circulation pressure Low	≤0.5 kg/cm2	Alarm at control room	≥ 1.5 kg/cm2	Ensure with TFH operator
4	Expansion tank temperature high	≥75 °C	Alarm at control room	≤74°C	Reduce the set point of TFH
5	Expansion tank Level high	≥85%			Reduce the set point of TFH
6	Expansion tank level low	≤5%			Stop Heating of TFH, take more Reactors are online

7	Fire in Expansion tank/ line or furnace		1)Fire alarm Active at control room 2) Self-acting ASF active		1)Take out fire from TFH, 2) Use AFFF system for major fire
8	Chemicals and Physical Property (Quarterlytesting)	Variation in Specification	Action to be taken as per change in spec		Based on variation replacement or purging to be done

This is based on physical site visit and statutory compliance observation at site has been summarised as under

RISK ASSESMENT (PRELIMINARY REPORT/INFORMATION)

Area/ Item to be looked into	**Perceived Risk/ chance of pollution /Mishap**	**Action being Taken/ proposed to be taken by RAN Chemicals**	**Reference /Supporting Documents provided**	**Remarks**	**Sign/Date**
1.Storage areas					
Solid raw materials	Reaction between different materials mixed up	Non-compatible materials not store together	Designated Area allotted to an individual Raw material considering its non-compatibilities of neighbouring chemicals	Well-marked sign board provided at various places	
Liquid Raw materials	Overflow of storage tank /leakage from piping /flange joint	Sprinkler provided inside Dyke walls provided	Batch tanks overflow to Main store tank	Remote switches are provided near	

		around liquid storage tanks	is provided Feed pump to stop interlock has provided at high level of tank	main and batch tanks to stop pumps	
Solid Finished products		Bags kept in wooden pellets			
Liquid By products	Lightning strike	Pump Valve, pipelines are of suitable MOC (SS316) and tested regularly	Continuity earthing of pipelines and equipment being checked by external agency	Record is maintained	
N2 Cylinder bank	Can get over pressurised in summer	Pressure regulator (Two stages) provided	Test certificate from N2 supplier (Cylinder and N2 purity)	Overflow from liquid storage to be collected in drums N2 Online analyser to check purity	
2. Reaction section					
Reactor and Accessories	High pressure in reactor released of vapour from vents Excess heating of reactor Leakage from reactor body	PRV/SRV provided on each reactor vent lines are provided in cooling tower instruction board (SOP) provision made for operators	All check points, Dos and don'ts, Instructions and SOP are included in batch log sheet		

	Wrong sequence of operation Excess material charged into reactors Reactor/agitator jammed Fire at drive motor Stability of structure Risk to personnel	cooling to limpet coil are also provided FLP motors are provided and fitting			
Product Recovery and Handling section (including by products (methanol) recovery and effluent stream to ETP	Condensers chocked Vapour released from vent Cooling belt not proper /piping leak Methanol storage tank overflow	Can be safely cleared after stopping batch and isolate of unit Additional cooling water arrangement provided if vent gases indicate escape of reactor / by products gas All piping, valves, joints storage are pressure tested @ 1.0Kg/Cm2 regularly Collection drum is provided	Testing to done from external agency Methanol receiver are provided with cooling arrangement Methanol tank is approved by department of explosive		
All units operating under pressure (reactors piping condenser)	Safety valves not working Connecting nozzle chocked Vessel corroded /wall thickness not sufficient	Cleaned regularly Vessel pressure tested regularly, Designed and fabricate @2.5 times working pressure	Safety valves are tested weekly Periodic Solvent cleaning and internal inspections are done		

			Thickness and pressure testing (form 13) done by external agency		
All reactor and other units (thermic fluid heating system) operating at high temperature (heatingcoils,piping, valves, pumps)	Temperature controller malfunctioning, vapour leaking from (pump) shaft self-ignition	Periodic calibration of temperature controller wrf to standard Preventive maintenance is done regularly and status being monitor in log sheet	Calibration done as per schedule or on fault		
All pressure relief valves & safely valves on reactors, thermic heating system	Reactor not released Vent line chocked Vapour released from vent to atmosphere	All PRV, SRV etc are tested regularly, connecting nozzles are cleaned regularly	Calibration is checked weekly and yearly calibration done by external agencies		
Temperature Indicator /sensor malfunction	High temperature in thermic fluid system, reactor can cause ignition	Regular checking of all temp. sensors & indicator done from individual reactors. This practise will be followed on plant extension also	Calibration is checked weekly and yearly calibration done by external agencies For the critical temperature area multiple location indicators are provided		

Cooling system/chilled water plant	Cooling belt damaged & spillage of hot products Release of gases from vents of exit of condenser Escape of Methanol from system vent	Interconnection provided amongst all cooling plants Exit temp and any vapour release monitored online/every batch, additional cooling arrangement (interconnection) available at unit Cold thermic fluid circulation is available to all reactors Diesel engine pump is provided for cooling to belt			
Electrical Installation and equipments					
Lightening arrestor, transformers, cable MCC	Fire hazard for –raw materials & finished product area Methanol storage Reaction Section	Provided at suitable place methanol piping is tested regularly Separate Earting pit is given near facilities Fire smoke detectors are provided various place	Regular testing of fire smoke being tested		
Drive System (flame proof motors for reaction section, cables, starters, junction boxes of motors	Fire hazard due to leak of vapour from agitator shaft seal pump seal etc which can ignite	FLP motors provided for all the reactors MCCB and ELCB are provided at various places			

	due to sparking				
Lighting in plant at: storage /liquid storage tank, reaction section &accessories escape route staircase	Fire hazard due to sparking /hot bulb surface Insufficient lighting can cause accident in working /movement	FPL and adequate lighting provided, Alternate supply from DG set separate feeders for lighting and Auto switch ON mode during mains failure is available	DG PM is done regularly		
DG set 320 and 500 KWA fuel supplies in plant	Sufficient for 8 hours at least when DG set is run at full capacity	Available for 24hrs already			
Earth connection of metering panel transformer, MCC, Individual equipments and stores of liquid materials methanol etc	Fire Hazard /electrical shock/accident is possible	Checked regularly and any problem is attended immediately MCCB and ELCB are provided	Quality checked by third party and attended		
Fire Fighting Facilities					
Overhead water tanks water pumps 2 numbers Fire hydrant piping CO2 cylinders DCP units others facilities to cover electrical/Oil/Methanol reactor fire /Coal fire	Capacity 25kl X 2 numbers at plant overhead and 110KL underground tank Required in important section of premises	Alternate arrangement for power supply available Thermic fluid pump –diesel pump driven for maintaining circulation. Temp controllers installed (and checked regularly) for the fluid heater and limpet			

		heating coils for reactors			
Structural stability Reactor section where additional units will be installed, feeding of RM Accessories for reactors piping, condensers, drive motors for agitator limpet coils for thermic fluid ets	Risk to personal if the structure collapse or process units falls Work platforms around reactors and accessories feeding of Raw materials not collapse for safety of personnel	Existing structure designed fabricated and certificate by structure engineer, this practise will be follow for plant extension capacity also Adequate safety margins will be considered for (future) higher plant capacity /additional process units All structure is designed 2 times or actual requirements considering additional safety risk	Stability certificate copy for existing &proposed additional production		
Layout with increased in production Free space for movement around reactor at Raw materials charging floor Easy maintenance of all units escape route (more than one every floor and ladders /stair case Greenery in plant	Risk to human life if they cannot escape from dangerous situation in case of fire, gas release etc As per environmental regulation	Multiple escape routes available in all sections of the plant at different floors, layout shall be approved through factory inspector In reserved premises, Greenery is maintained.	Copy of approved layout drawing by factory insp. attached		
Operation in Plant	Mishap due to runaway reaction/pre	SOP displayed prominently at reaction	Photos /Display Board		

	ssure build-up, fire due to overheating, excess feeding of raw materials, safety valves not working High temperature product drained and transferred gas released from vent / excess effluent to ETP	section,Raw materials feed System Adequate cooling provision with inter connection of cooling plant ETP designed for excess load	displayed in reactor floor &other input section		
Effluent treatment facilities & air pollution control equipments High COD to be explained by RAN chem. Collection of by-product Methanol (as aqueous solution)	Release of high COD effluent Release of high amount of particulate matter from thermic fluid heating system	Equalisation tank (capacity 5+5m3) being upgraded to 12+12 m3. pH adjustment & settling done. wet sludge sends to drying bed treated effluent recycled to plant Additional facilities for pH adjustment flocculation settling of sludge + bio reactors will be provided Settling sludge -> drying bed -> will be send to CHWTSDF,mandawa) MEPL who is operating land	Bio reactors to reduce COD will be provided. By product Methanol is sent to authorised PCB approved vendor.	Form 13 and acceptance membership BY MEPL to be provided with this report	

		filling authorised by MPCB Cyclone and bag filter provided for arresting particulate matter. Pressure drop monitored across the begs and cleaned regularly Temp of gases at inlet to BF controlled by gas cooler to prevent damaged of bags			
Maintenance practice Work on process units for internal repair (Mechanical) Work on equipment for electrical maintenance	Mishap /Personnel way got injured or affected by Toxic materials Electrical Shock	Work permit system (isolation, safety precaution flushing of residual material before M/T work) Electrical isolation	Typical records RAN Chem	Work with permit	Standard mainten ance manuals /procedu res followed
Pressure relief valve / safety valves Pressure vessel & piping Electrical connections short circuits sparking earth connections Lifting device, chain pulley block, Compressor	High pressure in system can injure persons Electrical shocks/fire can be fatal Failure can injure personnel	Regular inspection done by external agencies Regular inspection done by external and internal agencies	Typical records RAN Chem		

Lift taking up raw materials and other items Instruments for temperature measurement pressure indicators etc	-Do- Can result in major accident due to equipment failure, pipelineleakage, fire due to excess heating				

CHAPTER 7 - HEALTH & SAFETY MEASURES

OCCUPATIONAL HEALTH AND SAFETY

In this plant, where many activities are involved during construction, erection, testing, commissioning, operation and maintenance, the men, materials and machines are the basic inputs. The industrialization generally brings several problems like occupational health and safety. The following occupational health and safety issues are specific to proposed plant activities:

- Physical hazards
- Respiratory hazards
- Electrical hazards
- Noise
- Entrapment hazards
- Fire and explosions

Physical Hazards –

Industry specific physical hazards are discussed below. Potential physical hazards in proposed plant are related to handling heavy mechanical transport (e.g. trucks) and work at heights (e.g. platforms, ladders, and stairs). Heavy Loads / Rolling during construction phase Lifting and moving heavy loads at elevated heights using hydraulic platforms and cranes presents a significant occupational safety hazard. Recommended measures to prevent and control potential worker injury include the following;

• Clear signage in all transport corridors and working areas; • Appropriate design and layout of facilities to avoid crossover of different activities and flow of processes;

• Implementation of specific load handling and lifting procedures, including:

1). Description of load to be lifted (dimensions, weight, position of centre of gravity)

2). Specifications of the lifting crane to be used (maximum lifted load, dimensions)

3). Train staff in the handling of lifting equipments and driving mechanical transport devices

4). The area of operation of fixed handling equipment (e.g. cranes, elevated platforms) should not cross above worker and pre-assembly areas;

5.) Material and product handling should remain within restricted zones under supervision;

6) Regular maintenance and repair of lifting, electrical, and transport equipment should be conducted.

7). Use appropriate PPE (e.g. insulated gloves and shoes, goggles to protect against radiation, and clothing to protect against heat radiation and liquid metal splashes);

8.) Install cooling ventilation to control extreme temperatures;

9). Implement work rotations providing regular work breaks, access to a cool rest area, and drinking water.

RESPIRATORY HAZARDS-

Insulation Materials

Recommended management practices include:

• Damaged or friable material should be repaired or removed while other materials may be monitored and managed insitu. Any handling of insulation materials deemed to contain asbestos or any other hazardous material should only be performed by properly trained and certified contractors and personnel following internationally accepted procedures for their repair or removal;

• Use of asbestos must be avoided in new installations or upgrades;

• An LDPE sheet should be placed under the item to be insulated (e.g. tube or vessel) and under the stock of insulation material to be layered, to prevent surface contamination with fibres.

Gas

During transfer of gas workers may be exposed to gas inhalation hazards. Recommendations to prevent exposure to gas are as follows:

• Design facility ventilation to maximize air circulation. Outlet air shall be filtered before discharge to the atmosphere;

• Exhaust ventilation should be installed at the significant point sources of gas emissions;

• Provide a sealed cabin with filtered air conditioning if an operator is needed in a contaminated area

• Provide separated eating facilities that allow for washing before eating;

• Provide facilities that allow work clothes to be separated from personal clothes, and for washing / showering after work;

• Implement a policy for periodic health checks. Recommendations for respiratory protection include the following:

• Use of filter respirators when exposed to dust;

• For light, metallic dust and gases, fresh-air supplied respirators should be used. Alternatively, a complete facial gas mask (or an “overpressure” helmet) may be used, equipped with electrical ventilation;

Electrical Hazards

Workers may be exposed to electrical hazards due to the presence of heavy-duty electrical equipment in plant.

Noise

Noise level will be high at gas compressors and gas engine. Proper environment management plan has been formulated to control the same

Explosion and Fire Hazards

Firefighting system to control the hazard is discussed in previous sections

SAFETY ORGANIZATION AND ITS ACTIVITIES—

Construction and Erection Phase

A qualified and experienced safety officer will be appointed. The responsibilities of the safety officer include identification of the hazardous conditions and unsafe acts of workers and advise on corrective actions, conduct safety audit, organize training programs and provide professional expert advice on various issues related to occupational safety and health. He is also responsible to ensure compliance of Safety Rules/ Statutory Provisions.

Operation and Maintenance Phase

When the construction is completed the posting of safety officers would be in accordance with the requirement of Factories Act and their duties and responsibilities would be as defined thereof.

Strengthening of HSE and Meeting by Safety and quality circle

In order to fully develop the capabilities of the employees in identification of hazardous processes and improving safety and health, safety and quality circles would be constituted in area of work. The circle normally will meet for about an hour fortnight.

Safety Training - A full-fledged training centre will be set up at the plant. Safety training would be provided by the Safety Officers with the assistance of faculty members called from Corporate Centre, Professional Safety Institutions and Universities. In addition to regular employees, limited contractor labours would also be provided safety training. To create safety awareness safety films would be shown to workers and leaflets would be distributed. Some precautions and remedial measures proposed to be adopted to prevent fires are:

• Compartmentation of cable galleries, use of proper sealing techniques of cable passages and crevices in all directions would help in localizing and identifying the area of occurrence of fire as well as ensure effective automatic and manual firefighting operations;

• Reliable and dependable type of fire detection system with proper zoning and interlocks for alarms are effective protection methods for conveyor galleries;

• Housekeeping of high standard helps in eliminating the causes of fire and regular fire watching system strengthens fire prevention and firefighting; and Proper fire watching by all concerned would be ensured.

• Tie up will be made with emergency services like local fire station, hospitals, emergency van etc during operation phase. The emergency telephone numbers will be displayed at different points within the plant premises and at the entry exit gates.

Do's AND Don'ts CHECKLIST

Do's

- Switch off the lights while leaving the rooms
- Throw the garbage in dustbins
- Follow proper housekeeping
- Wear helmets
- Safety measures and PPE to be used wherever required
- Park vehicles in parking area allotted
- Noise management

Don'ts

- Don't enter high electric load area without prior permission from manager
- Don't waste water, energy
- Don't start maintenance of any equipment without informing the concern department.
- Don't carry out preventive maintenance without adequate PPE. The same shall be displayed at the factory premises.

HEALTH AND SAFETY MONITORING

PLAN All the potential occupational hazardous work places would be monitored regularly. The health of employees working in these areas would be monitored once in a year for early detection of any ailment due to exposure to hazardous chemicals. **First aid centres and medical centre should be provided.** Transportation arrangement should be provided in case of emergency. Medical centre should have permanent FMO (Medical officer) to provide first aid in case of injuries.

CHAPTER 8 - RISK REDUCTION MEASURES

RISK CONTROL MEASURES

• All accidental leakages/spillage of hazardous chemical should be attended immediately to avoid further damage to the plant, human and environment.
• Loading / unloading activities should be conducted by properly trained personnel according to pre-established formal procedures to prevent accidental releases
• Procedures should include all aspects of the delivery or loading operation from arrival to departure, including wheel blocking to avoid vehicle movement, connection of grounding systems, verification of proper hose connection and disconnection, adherence to no-smoking and no-naked light policies for visiting drivers.
• In order to prevent the flammable liquid or vapor from reaching ignition sources, liquid entering the drainage or water systems, to prevent contamination of both land and water courses and to allow the controlled recovery or treatment of the spilled material storage tanks are provided with appropriate secondary containment in form of dikes.
• Overfill protection equipment including level gauges, alarms, and automatic cut-off systems should be provided.
• Periodic inspection for corrosion and structural integrity of storage tanks and components should be carried out and will be subjected to regular maintenance and replacement of equipment (e.g. pipes, seals, connectors, and valves).
• Facilities should be developed for spill prevention and control plan that addresses significant scenarios and magnitudes of releases. The plan is supported by the necessary resources and training.
• Above Ground Storage Tanks (ASTs) should be located in a secured area, protected from potential collisions by vehicles, vandalism, and other hazards.
• Fire buckets filled with dry sand should be provided for spillage control.
• Personal Protective Equipment's like apron, gloves, safety goggles, etc. should be provided and ensured to be worn during spillage emergency.

Burns

One of the most agonizing conditions, the burns can be caused by:
• Thermal burns due to heat
• Chemical
• Electrical

All these burns can be extensive or local over a small portion of body.

The entire hand is 9% of body surface x 2	18%
The entire hip is 18 % each x 2	36%
Chest and abdomen	18%
Back	18%
Head and Neck	9%
Sex area	1%

TOTAL	100%

• One hand represents 9 % of the body surface. The progression in our country is below 30% must survive, 30% to 50% usually survive except in extremes of ages or complications, 50% and above are grave.

Electric Shock

May cause stoppage of breathing and heart and may require urgent cardiopulmonary resuscitation (CPR). In severe electric burns, skin may look very normal but nerves and arteries may be extensively damaged requiring amputation.

Poisoning

Poison is a substance which when taken in sufficiently large does, can cause damage to the body. The poisons are classified as per their physical state:
Solids: Sleeping tablet, opium, cyanide, heavy metals and its salts, strong acids and alkalis etc.
Liquid: Alcohol, pesticides, kerosene.

Gases: Argon monoxide, Methylene trichloride, phosgene, chlorine, ammonia, Hydrogen sulphide, Sulphur dioxide etc. For treatment purpose, they are classified as:

Corrosive– which cause lot of burning in the mouth like acids.
Non-corrosive– No burning such as sleeping tablets, opium. The last classification is very important from the First Aid point of view. In non-corrosive, we make the patient vomit if he is conscious.

Mode of entry of poison in body

Ingestion – through mouth - better to make the patient vomit if non-corrosive. The idea is to stop the poison going in circulation. It is important to make the patient vomit in first 3 hours, in fact as soon as possible.
In case of corrosive liquids, it is better to neutralize the poison by giving milk, eggs, and potato, rice kanji that neutralizes the poison and form a coating on intestinal tract. This can be done only if patient is conscious.

Inhalation through lungs- if breathing stops, give artificial respiration.
Through skin – some poison can enter through skin also.
1. If patient is unconscious, treat him as per unconsciousness. Do not induce vomiting; it may kill the patient instantly.
2. Do not feed anything by mouth.
3. Watch the patient breathing and take him to the hospital preferably taking poison bottle with you.
4. In case of breathing being stopped, immediately start artificial respiration.

Control Measures

Hierarchies of Control:

• Work permit system for hazardous area will be strictly followed.
• The management will prepare the safety manual, safety booklet, etc. for enhancing the safety in the company.
• Various instruction boards, cautionary notices, etc will be displayed at all departments.
• Facility like First Aid boxes, Occupational Health Centre and emergency centre will be made available at the company. External medical arrangements are made available in case of major emergency

OTHER HAZARDS AND ITS CONTROLS

The other hazards possible at site are as given below:

Table: Other Hazards and Its Controls

Name of possible hazard or emergency	Its source & reason	Its effects on person, property & environment	Place of effect	Control measures provided
Building collapse Earthquake	Any natural Calamities Week structure Over loading	Injuries & Fatalities Building damage	. All building & sheds of the company as given in the Fac. layout	Structure stability is by competent person for all structure. No overloading of structures and building
. Electrical Installation failure like Transformer, PCC etc.	Overload Loose contacts Short circuit	Fire Suffocation of persons inside the plant	Electrical transformer switch yard Electrical MCC rooms Power plant	Installation as per electricity rules. Other Controls provided Rubber mat provided Earthing provision

CHAPTER 9 - FIRE FITGHTING SYSTEM

AUTOMATIC FIRE DETECTION AND CONTROL MEASURES

The firefighting system shall be designed as per TAC (Tariff Advisory Committee) guidelines. The plant's fire protection shall consist of structural solutions, fire extinguishing systems and fire alarm systems. The fire extinguishing system shall consist of the fire water system with fire pumps distribution pipelines, hydrants and fire hoses and the portable extinguishers. The fire alarm system is a part of the primary systems and shall take care of the places which are unmanned or do not have any fixed fire extinguishing system.

FIRE WATER / HYDRENT SYSTEM

Fire pumps

There shall be two fire pumps, one electric and one diesel engine driven. The pumps supply water for the fire line and the fixed fire extinguishing systems. Either of these centrifugal pumps can alone deliver the required amount of water. At the rated flow, the pressure produced by the pumps shall be adequate, at least 7 bar by the rated flow, and at a zero flow not exceed 10 bar.

Diesel Engine

Diesel engine shall be equipped with an approved automatic auxiliary starting device having a sufficient capacity for at least six starts of fire pump. The diesel pump shall have a fuel tank containing sufficient fuel to enable the pump to run on full load for at least three hours

Jockey Pumps

An electric motor driven jockey pump of requisite capacity will maintain automatically system pressure in the fire line. If the jockey pump cannot keep the pressure the fire pumps shall come into action automatically by the pressure drop. The fire pumps are stopped manually. Operation of all the fire pumps shall be automatic. Pressure switches located in the fire water main shall sense sudden drop of pressure below set point, due to opening of any hydrant valves, which shall provide the starting signal to the fire pumps. For stopping of the pumps only manual arrangement shall be provided. The run and fault alarms from the fire pumps are led to the control room. The pumps will be located in pump house which shall be constructed by purchaser based on input from supplier.

Fire Water Storage Tank

Water storage capacity in the plant is 150 KL underground and also (50+50) KL above ground. It is sufficient for firefighting even in worst case with prescribe flow rate for tank storage surface cooling as well as for hydrant and monitors with prescribe flow rate as per NBC code.

The water for firefighting shall be stored in the fire water tank. The water capacity of the plant can be supplemented from Dugwell.

Water distribution system

Fire piping shall be of MS Class “C” with supports for above ground lines. For underground piping GI class “C” pipes with necessary fittings will be used. The piping will be externally painted. The codes IS1239/IS 3589 will be followed. All underground pipes shall have catholic protection. Sufficient number of isolation valve shall be provided to isolate the area in case of maintenance. The diameter of the fire pipes shall be sufficient for the effective use of at least two fire hoses. The pipes and hydrants will be so placed that the fire hoses may be easily coupled to them.

Hydrants

Hydrant type Fire Protection System essentially shall consist of a network of piping and hydrant valves- both indoor & outdoor. The distance between any two hydrants will not be more than 45 meters. Each hydrant will be provided with a hose cabinet (mounted alongside the hydrant on a steel column, lockable type) containing two nos. of 15 M long hoses and branch pipes/nozzles. For multi-stored building located alongside engine hall, a wet riser tapped off from the hydrant main, shall be provided for each stair case inside the stair case and on this riser hydrant outlet with first aid hose reel connection shall be provided on each floor. Each hydrant shall be provided with a wall/column mounted on hose cabinet containing two nos. of hose and branch pipe/nozzle. The number and position of the hydrants shall be such that spray from at least two hoses with combined jet and water fog nozzles may reach any part of the hall or auxiliary room and spray from one combined jet and water fog nozzles may reach any part of other places. A hydrant unit inside the power house shall consist of two hose couplings of size DN50, both equipped with a shutoff valve. There will be two couplings beside each other to make it possible to use the water hose and mobile foam unit simultaneously. Some hydrants shall also to be installed on an external wall, to allow the use of hoses outside a building. Fire hoses shall be cotton and nylon jacket seamless woven and rot proofed material equipped with quick couplings and adjustable water fog nozzles. Hose couplings and nozzles throughout the fire line shall be completely interchangeable. Hose couplings shall be made of a copper alloy or other approved material.

Hose length test	15 m
Hose diameter	63 mm
Busting pressure	32 g/cm2

FIGURE: Fire Organisation

FIRE ALARM AND DETECTION SYSTEM –

The fire alarm and detection centre shall be located in the control room. Manual call points shall be installed at critical points and escape routes. Manual alarms shall set off by breaking a glass disk and pressing a button. The fire detection system shall comprise of smoke and heat detectors. The fire detection system shall be installed throughout the power plant and shall at least cover the following areas: engine hall, auxiliary area, and switchgear room, gas receiving cum compression station, offices,

stores, control rooms, workshop, and hazardous areas. The preferable choice of type of indicators shall be as mentioned below.

Process area, Engine hall and auxiliary area –
Following extinguishing and protection system shall be provided all over the process area, engine hall and auxiliary area. Fixed heat or flame detectors used in power plants shall be differential maximum heat detectors with the following activation criteria:
Limit temperature: 58 deg C
Maximum temperature rise: 1000 C per minute

LV/MV Switch gear & switchyard room
Ionization / Optical smoke detectors
Offices, pantry, corridor, toilet and changing rooms
Ionization / Optical smoke detectors
Control room
Ionization / Optical smoke detectors
Workshop
Heat alarm system
Fire Pump House
Ionization / Optical smoke detectors
Security Room
Ionization / Optical smoke detectors
Radiator MCC room
Ionization / Optical smoke detectors

Siren

A siren with minimum range of 300 m in addition to flashing lights & alarm bells shall be provided in DG building.

FIRE EXTINGUISHING EQUIPMENT

Extinguisher, preferably wall mounted type, shall be located such that they are not far from each other at max distance of 15 m but shall be provided near the exit CO2 extinguishers Fire extinguisher contains extinguishing carbon dioxide which under expected conditions of use gives off to prevent fire to get oxygen. CO2 extinguishers are meant to extinguish mainly fire caused by electric devices. Capacity of extinguisher shall be Min. 4.5 kg

Dry powder extinguishers

Dry powder extinguisher contains extinguishing medium which either by itself or under expected conditions of use gives off fine powder to prevent fire to get oxygen. Dry powder extinguishers are suitable for all kinds of fires.
Capacity of one extinguisher: Min. 5 kg
Dry powder type: ABIII-E

Mobile foam units

A mobile foam unit shall consist of a low expansion foam branch pipe, inductor, foam tank and two fire hoses with couplings suitable to connected to the fire main hydrants.
Foam tank capacity: 100 litres
Fire hose diameter: 45 mm Fire
Hose length: 15 m
Foam production capacity: 1.5 m3 /min

Process area, Engine hall and auxiliary area Process area

Mobile foam units Portable CO2 extinguishers on the generator-end and Dry powder extinguishers elsewhere in the hall Switch gear room CO2 extinguisher of wall mounted type

Control room

CO2 extinguisher of wall mounted type

MCC room

CO2 extinguisher of wall mounted type
Workshop Dry powder or portable CO2 extinguishers

Fire Pump House

Dry powder or portable CO2 extinguishers

Pantry

Dry powder or portable CO2 extinguishers

Transformers

Dry powder extinguishers

Security Room

Dry powder extinguishers

Main gate

A sand bucket stand consisting of minimum eight bucket shall be provided near the entrance. In addition, a box consisting of all different type of nozzles & hose shall be provided.

Office, corridor and changing rooms

Portable CO2 extinguisher

CHAPTER 10 - HAZARD IDENTIFICATION AND CONTROL

Hazard identification

Hazard is the characteristic of any system or process which has the potential for accident. Identification of hazards, in presence of any hazardous waste generating units within the project facility is of primary significance in the analysis, quantification and cost-effective control of accidents involving chemicals and process.

Hence, all components of a system/unit need to be thoroughly examined to assess their potential for initiating or propagating an unplanned event/sequence of events, which can be termed as an accident.
Typical methods for hazard identification employed are:

- Identification of major hazardous units based on Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 of Government of India (as amended in 2000)
- Identification of hazardous units and segments of plants and storage units based on relative ranking technique, viz. Fire-Explosion and Toxicity Index (FE&TI).

Hazardous substances may be classified into three main categories namely flammable, unstable and toxic substances. Flammable substances require interaction with air for their hazard to be realized. Under certain circumstances, vapours arising from flammable substances when mixed with air may become explosive, especially in confined spaces. However, if present in sufficient quantity, such clouds may explode in open air also. Unstable substances are liquids or solids, which may decompose with such violence giving rise to blast waves. Besides, toxic substances are dangerous and cause substantial damage to life when released into the atmosphere. The ratings for a large number of chemicals based on flammability, reactivity and toxicity are provided in NFPA Codes 49 and 345 M.

Hazard assessment and evaluation

A preliminary hazard analysis shall be carried out to identify major hazards associated with storages in the facility. This is followed by consequence analysis to quantify these hazards. Finally, the vulnerable zones are plotted for which risk reducing measures are deduced and implemented.

Frequent causes of accidents

- Fire and explosion: explosives, flammable material
- Being struck by falling objects
- Caught in/compressed
- Snapping of cables, ropes, chains, slings
- Handling heavy objects
- Electricity (electrocution)
- Poor illumination
- Falls from height inside industrial units or on the ground
- Struck by moving objects

- Slipping on wet surfaces
- Sharp objects
- Oxygen deficiency in confined spaces
- Lack of personal protective equipment (PPE), housekeeping practices, safety signs
- Hackles, hooks, chains
- Cranes, winches, hoisting and hauling equipment;

Hazardous substances and wastes

- Heavy and toxic metals (lead, mercury, cadmium, copper, zinc, etc.)
- Organometallic substances (tributyltin, etc.)
- Lack of hazard communication (storage, labelling, material safety data sheets)
- Batteries, fire-fighting liquids
- PCBs and PVC (combustion products)
- Welding fumes
- Volatile organic compounds (solvents)
- Inhalation in confined and enclosed spaces
- Physical hazards
- Noise
- Extreme temperatures
- Vibration
- Radiation (UV, radioactive materials)

Physical hazards

- Noise
- Extreme temperatures
- Vibration
- Radiation (UV, radioactive materials)

Mechanical hazards

- Trucks and transport vehicles
- Scaffolding, fixed and portable ladders
- Impact by tools, sharp-edged tools
- Power-driven hand tools, saws, grinders and abrasive cutting wheels
- Failure of machinery and equipment
- Poor maintenance of machinery and equipment
- Lack of safety guards in machines
- Structural failure

Biological hazards

- Toxic marine organisms (If the project facility is located in Coastal Regions)
- Risk of communicable diseases transmitted by pests, vermin, rodents, insects and other animals that may infest the project facility.
- Animal bites

- Vectors of infectious diseases (TB, malaria, dengue fever, hepatitis, respiratory infections, others)

Ergonomic and psychosocial hazards

- Repetitive strain injuries, awkward postures, repetitive and monotonous work, excessive workload
- Long working hours, shift work, night work, temporary employment
- Mental stress, human relations (aggressive behaviour, alcohol and drug abuse, violence)
- Poverty, low wages, minimum age, lack of education and social environment

General concerns

- Lack of safety and health training
- Poor work organization
- Inadequate housing and sanitation
- Inadequate accident prevention and inspection
- Inadequate emergency, first-aid and rescue facilities
- Lack of medical facilities and social protection

As per MSIHC rule 1989 this unit comes under purview of MAH unit pertaining to handling /process of HZ chemical exceeding threshold quantity and hence is the EC process and the requirement of RA/DMP

Risk management protects the health and safety of people and the environment by implementing various measures to control or mitigate risk. Risk management typically includes preparation of a risk management plan that describes the mitigation measures and how each will be implemented. The plan may also establish a monitoring process to ensure that the proposed risk management measures are being implemented consistently and effectively.

The risk assessment and risk management plan forms the basis upon which the Regulatory Agencies decide whether to issue an authorization for environmental release and what conditions to impose. To issue an authorization the Regulators must be satisfied either that the identified risks are acceptable or that they can be managed to protect human health and safety and the environment
A risk assessment is a careful examination of consequences resulting from the undesired events that could cause harm to people or property, so that sufficient precautions can be taken. Workers and others have a right to be protected from harm caused by a failure to take reasonable control measures

OBJECTIVES OF THE RISK ASSESSMENT

As per the requirements stated in the Terms of Reference of the EIA study, the risk assessment study has been undertaken to address the following aspects: To identify and assess those fire and explosion hazard arising from the storage and use of the

fuel in the project that require management in order to comply with regulatory requirements, company policy and business requirements To eliminate or reduce to as low as reasonably practical in terms of risk to human health, risk of injury, risk of damage to plant, equipment and environment, business interruption or loss etc.

THE RISK ASSESSMENT PROCESS

As per MSIHC rule 1989 Major accident hazard [MAH] unit has been defined with criteria for the same. Once the unit falls within this criterion then as per prescribe requirement Risk analysis /assessment need to be carried out for the MAH unit. We therefore carry out risk assessment for this chemical processing plant.
Risk assessment involves the identification of the hazards present and an estimate of the extent of the risks involved, considering whatever precautions are inherent to the process/activity. There are more than one approaches to risk assessment,

For example:

• Look at each activity (not forgetting non-routine activities, e.g., maintenance, breakdowns etc.). That could cause harm or adverse effects;
• Look at hazards and risks in groups e.g. machinery, transport, materials, electrical etc;
• Look at each section e.g. stores, workshop, laboratory, office, etc. The approach should match the circumstances. The actions required for an assessment to be suitable and sufficient and compliant with other legal requirements are summarized in the following five steps:

Step 1 - Identify the hazards
Step 2 - Decide who might be harmed and how
Step 3 - Evaluate the risks and decide on precautions
Step 4 - Record your findings and implement them
Step 5 - Review your assessment and update if necessary

Step 1 - Identify the hazards

There are a number of simple ways in which hazards can be identified. In order to achieve a suitable and sufficient risk assessment it is essential to identify all the hazards associated with an activity.

Step 2 - Decide who might be harmed

Look for who may be harmed by the hazards and how. Include people who may not be in the workplace all the time, e.g. cleaners, visitors, contractors, maintenance personnel, members of the public, etc. If the workplace is shared with others, include them too if there is a chance that they may be harmed in some way by the activities

Step 3 - Evaluate the risks arising from the hazards and decide

what should be done to control them Is there any real chance of harm? Take account of any precautions that are inherent to the process/activity; check against guidelines and consider whether the precautions are adequate and, if not, what further action is

needed. Go through the following questions: Can the hazard be removed altogether (substitution of the hazard or permanent removal of the hazard) If not, how can the risks be controlled so that harm is unlikely (control measures taken in order to minimize/remove the risk).

Step 4 - Record the findings and put into practice the control measures.
The record can be greatly simplified by referring to other documentation, such as manuals, health and safety procedures. These may well already have listed hazards for equipment or processes and the precautions and arrangements for controlling risk. It is not necessary to repeat all that. Similarly, reference can be made to other assessments where they are relevant. If the required other assessment does not exist, then the outcome of this general risk assessment will be to request the appropriate specific assessment. If a workplace is shared, others must be told about any risks the work could cause them, and what is being done to protect them.

Step 5 Review the assessment
from time to time and revise it if necessary Workplace changes, new equipment, substances and procedures could lead to new hazards and risks. If there is any significant change, then the assessment should be revised to take account of the new hazard. In any case, it is good practice for assessments to be reviewed periodically and in some cases, it is a statutory requirement.
However, don't amend assessments for every trivial change, or for every new job that has to be attempted. Walk around the area and look afresh at what can reasonably be foreseen as likely to cause harm. Ask the people who work there what they think. They may come up with hazards which they have noticed in the course of their work and which are not immediately obvious. Accident records, manufacturers' instructions, or data sheets can also help. It is required to review the assessment on periodic intervals so that additional risk arises out of the new facilities or modifications carried out in existing facilities can be identified and taken in to account

HAZARD IDENTIFICATION AND VISUALIZATION OF MCA SCENARIOS

“Risk” is loss per unit time and is the product of the consequence of an event and the frequency of its occurrence. All activities involve some risk. In our everyday life, people engaged in an activity frequently perform their own risk assessment often intuitively. The level of risk deemed to be acceptable is highly subjective, varies from person to person, and depends on many factors. Total avoidance of risk (zero risk) is an unattainable goal. Risk can, however, be reduced through the implementation of control measures, engineering design and good management practices.

The starting point of the risk analysis study is the identification of hazards and selection of scenarios which are then addressed for further analysis.

"Hazard" is a characteristic of a system, Installation or processes that present potential for an accident. It is defined as a chemical or physical condition that has the potential

for causing damage to people, property or the environment. Therefore, all the relevant aspects of petroleum Products storage and handling process have been thoroughly examined to assess their potential for initiating or propagating an unintentional event or sequence of events, which can lead to an accident or disaster. Type, quantity, location & conditions of release of the petroleum Products under various scenarios have been examined in order to estimate its damage potential, area affected, and based on that, the precautionary measures needed to be taken are suggested in Independent Heading – "RECOMMENDATIONS".

Hazard Potential: Deciding Factor

Factors considered to identify and analyze the hazard potential are:

1. Flash point & Boiling point of the petroleum Products
2. Inventory of the petroleum Products
3. Potential for loss from containment
4. Pool size & dyke capacity
5. Potential for availability of ignition sources in the vicinity of leakage or spillage

Apart from the petroleum Products characteristics and process of its handling, size & layout of the Depot are also analyzed in order to assess the hazard potential.

IDENTIFICATION OF HAZARDS

Identification of hazards is of primary significance in the analysis, quantification and cost-effective control of accidents involving Petroleum Products and their Operations. Petroleum Products require sufficient interaction with air or oxygen for their explosive mixture to form and then for occurrence of their hazards associated with them. Under certain circumstances, vapors of the products when mixed with air may be explosive especially in confined spaces. Following methods of hazard identification have been employed in this study:

1. All hazardous materials present on the site, and or transported to and from the site are identified
2. The properties of these hazardous materials are reviewed in order to categories the possible hazards
3. Characterization of major hazardous units based on Manufacture, Storage and Import of Hazardous Chemicals Rules, Government of India, 2000; referred here as MSIHC Rules.
4. Identification of hazardous installations based on relative ranking technique, viz. Dow's Fire Explosion Index and Mond's Toxicity Index (FE & TI)
5. The site facilities and transport systems are examined to identify where the hazardous materials are present and the conditions under which they are contained

The major hazards in petrochemical, chemical plants and installations are due to substances within the Installations that can be released to cause either:

- ✓ Fire
- ✓ Explosion
- ✓ Toxic effect (Poisoning)

DISASTER MANAGEMENT PLAN

A disaster is a catastrophic situation in which suddenly, people are plunged into helplessness and suffering and, as a result, need protection, clothing, shelter, medical & social care and other necessities of life.
The Disaster Management Plan (DMP) is aimed to ensure safety of life, protection of environment, protection of installation, restoration of production and salvage operations in this same order of priorities. For effective implementation of DMP, it should be widely circulated and a personnel training is to be provided through rehearsals/drills.
To tackle the consequences of a major emergency inside the plant or immediate vicinity of the plant, a DMP has to be formulated and this planned emergency document is called DMP.
The objective of the DMP is to make use of the combined resources of the plant and the outside services to achieve the following:

- Effective rescue and medical treatment of casualties
- Safeguard other people
- Minimize damage to property and the environment
- Initially contain and ultimately bring the incident under control
- Identify any casualty
- Provide for the needs of relatives
- Provide authoritative information to the news media
- Secure the safe rehabilitation of affected area
- Preserve relevant records and equipment for the subsequent inquiry into the cause and circumstances of the emergency

In effect, it is to optimize operational efficiency to rescue rehabilitation and render medical help and to restore normalcy.
The DMP should include emergency preparedness plan, emergency response team, emergency communication, emergency responsibilities, emergency facilities, and emergency actions.

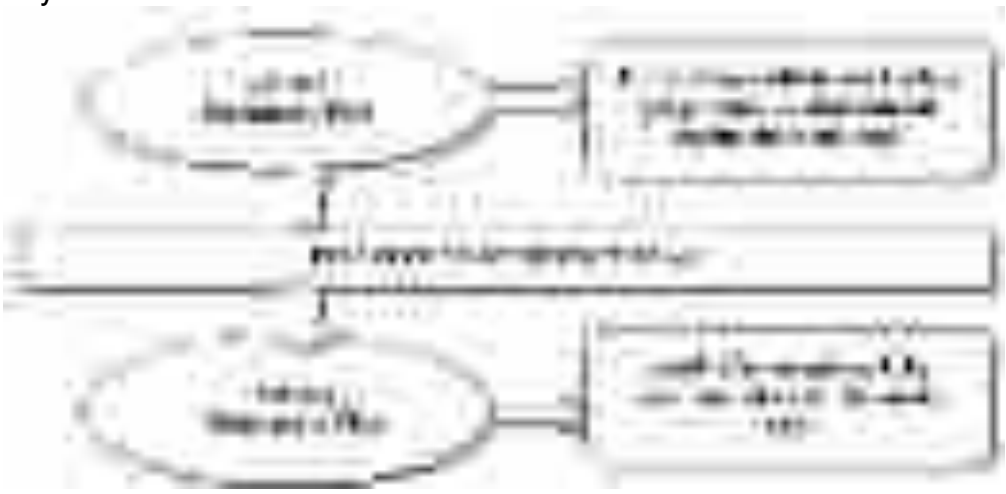


Figure: Disaster Management Plan

EMERGENCY PREPAREDNESS PLAN

Incidents, accidents and contingency preparedness should be accounted during construction and operation process. This shall be a part of Energy Management System. Emergency Preparedness Plan (EPP) should be prepared following the National Environmental Emergency Plan and OSHA guidelines. According to these guidelines, an environmental emergency plan would essentially provide the following information:

- Assignment of duties and responsibilities among the authorities, participating agencies, response team, their coordinators and/or those responsible for the pollution incident
- Relationship with other emergency plans
- A reporting system that ensures rapid notification in the event of a pollution incident
- The establishment of a focal point for coordination and directions connected to the implementation of the plan
- Response operations should always cover these four phases:
    1. Discovery and alarm
    2. Evaluation, notification and plan invocation
    3. Containment and counter measures
    4. Clean-up and disposal
- Identification of expertise and response resources available for assistance for the implementation of plan
- Directions on the necessary emergency provisions applicable to the handling, treatment or disposal of certain pollutants
- Link to the local community for assistance, if necessary
- Support measures, such as procedures for providing public information, carrying out surveillance, issuing post-incident reports, review and updating of the plan, and periodic exercising of the plan.

EMERGENCY RESPONSE

Various units within the project facility are always subjected to accidents and incidents of many a kind. Therefore, a survey of potential incidents and accidents is to be carried out. Based on this, a plan for response to incidents, injuries and emergencies should be prepared. Response to emergencies should ensure that:

- The exposure of workers should be limited as much as possible during the operation
- Contaminated areas should be cleaned and, if necessary disinfected
- Limited impact on the environment at the extent possible.

Written procedures for different types of emergencies should be prepared and the entire workforce should be trained in emergency response. All relevant emergency response equipment should also be readily available.
With regard to dangerous spills, associated clean-up and firefighting operations should be carried out by specially allocated and trained personnel.

RESPONSE TEAM

It is important to setup an Emergency Organization. A senior executive who has control over the affairs of the plant would be heading the Emergency Organization. He would be designated at Site Controller. Manager (Safety) would be designated as the Incident Controller. In case of stores, utilities, open areas, which are not under control of the Production Heads, Senior Executive responsible for maintenance of utilities would be designated as Incident Controller. All the Incident Controllers would be reporting to the Site Controller.

Each Incident Controller organizes a team responsible for controlling the incidence with the personnel under his control. Shift in charge would be the reporting officer, who would bring the incidence to the notice of the Incidence Controller and Site Controller.

Emergency Coordinators would be appointed who would undertake the responsibilities like firefighting, rescue, rehabilitation, transport and provide essential & support services. For this purpose, Security In charge, Personnel Department, Essential services personnel would be engaged. All these personnel would be designated as key personnel.

In each shift, electrical supervisor, electrical fitters, pump house in charge, and other maintenance staff would be drafted for emergency operations. In the event of power or communication system failure, some of staff members in the office/facility would be drafted and their services would be utilized as messengers for quick passing of communications. All these personnel would be declared as essential personnel.

RESPONSE TO INJURIES

Based on a survey of possible injuries, a procedure for response to injuries or exposure to hazardous substances should be established. All staff should have minimum training to such response and the procedure ought to include the following:

- Immediate first aid, such as eye splashing, cleansing of wounds and skin, and bandaging
- Immediate reporting to a responsible designated person
- If possible, retention of the item and details of its source for identification of possible hazards
- Rapid additional medical care from medical personnel
- Medical surveillance
- Recording of the incident
- Investigation, determination and implementation of remedial action

It is vital that incident reporting should be straightforward so that reporting is actually carried out.

EMERGENCY COMMUNICATION

Whoever notices an emergency situation such as fire, growth of fire, leakage, *etc*. would inform his immediate superior and Emergency Control Centre. The person on duty in the Emergency Control Centre, would appraise the Site Controller. Site Controller verifies the situation from the Incident Controller of that area or the Shift In charge and takes a decision about an impending On-site Emergency. This would be communicated to all the Incident Controllers, Emergency Coordinators. Simultaneously, the emergency warning system would be activated on the instructions of the Site Controller.

EMERGENCY RESPONSIBILITIES

The responsibilities of the key personnel should be defined for the following:

- Site controller
- Incident controller
- Emergency coordinator - rescue, fire fighting
- Emergency coordinator-medical, mutual aid, rehabilitation, transport and communication
- Emergency coordinator - essential services
- Employers responsibility

EMERGENCY FACILITIES

- Emergency Control Centre – with access to important personnel, telephone, fax, telex facility, safe contained breathing apparatus, hand tools, emergency shut down procedures, duties and contact details of key personnel and government agencies, emergency equipments, *etc*.
- Assembly Point – with minimum facilities for safety and rescue
- Emergency Power Supply – connected with diesel generator, flame proof emergency lamps, *etc*.
- Fire Fighting Facilities – first aid firefightingequipments, fire alarms, *etc*.

- Location of wind Stock – located at appropriate location to indicate the direction of wind for emergency escape
- Emergency Medical Facilities – Stretchers, gas masks, general first aid, emergency control room, breathing apparatus, other emergency medical equipment, ambulance.

EMERGENCY ACTIONS

- Emergency warning
- Evacuation of personnel
- All clear signal
- Public information and warning
- Coordination with local authorities
- Mutual aid
- Mock drills

MITIGATION MEASURES

The purpose of mitigation is to identify measures that safeguard the environment and the community affected by the proposal. Mitigation is both a creative and practical phase of the EIA process. It seeks to find the best ways and means of avoiding, minimizing and remedying impacts. Mitigation measures must be translated into action in right way and at the right time, if they are to be successful. This process is referred to as impact management and takes place during project implementation. A written plan should be prepared for this purpose and should include a schedule of agreed actions. Opportunities for impact mitigation will occur throughout the project cycle.

CHAPTER 11 - RISK ANALYSIS AND CONSEQUENCE

In this part we have come to the concluding part. We now quantify the maximum damage possible in worst scenario due to hazardous inventory that exceeds threshold quantity. We now have all hazardous chem quantity quality, specification, storage conditions with all prescribe safe conditions as per statutory guidelines and international standards with all instruction, do/don'ts and all safety measure, mitigation in line with prescribe conditions in which it has been mandated.
As we already understood in our previous chapters as to how we can quantify the damage potential of hazardous inventory [raw/finish product] theoretically for all chemicals/substance based on chemical /physical characteristics as well as MSDS of those material provided by manufacturers.

We have identified such hazardous inventories and shall compute damage potential for the sake of designing and preparedness towards mitigation measures in worst scenario. It will also be crucial in planning for disaster management plant onsite as well as offsite for administrative purpose planning mitigation and gross combine planning in line with NDMA guidelines. Onsite emergency plan is document prepares by proponent for preparedness of plant person and management to be readiness in all eventualities in terms on any loss of contentment [LOC] of any quantum. It is also disseminated to each and every stakeholder working in plant. it is expected that all should know how to help administration of plant to put and check any untoward incidences which may escalate due to any or precarious reasons.

RISK QUANTIFICATION

Hazard Identification by fire and explosion index as well as toxicity index calculation:

Fire and Explosion Index (F&EI) is an important technique employed for hazards identification process. Consequence analysis then quantifies the vulnerable zone for a conceived incident. Once vulnerable zone is identified for an incident, measures can be formulated to eliminate or reduce damage to plant and potential injury to personnel. Rapid ranking of hazard of an entire installation, if it is small, or a portion of it, if it is large, is often done to obtain a quick assessment of degree of the risk involved. The Dow Fire and Explosion Index (F&EI) and Toxicity Index (TI) are the most popular methods for Rapid Hazard Ranking. These are based on a formal systematized approach, mostly independent of judgmental factors, for determining the relative magnitude of the hazards in an installation using hazardous (inflammable, explosive and toxic) materials.

The steps involved in the determination of the F&EI and TI are: ·
Selection of a pertinent process unit
1 Determination of the Material Factor (MF)
2 Determination of the Toxicity Factor (Th)
3 Determination of the Supplement to Maximum Allowable Concentration (Ts)
4 Determination of the General Process Hazard Factor (GPH)
5 Determination of the Special Process Hazard Factor (SPH)
6 Determination of the F&EI value · Determination of the TI value
7 Determination of the Exposure Area

Hazardous Material Identification Methodology From the preliminary appraisal of Material Safety Data Sheet, it is observed that,

1) **MEG**
2) **DEG**
3) **Thermic Fluid**

are considered to be hazardous as being inhalant chemical quality and the quantity in which they likely to be stored. Although **Methanol** by-product could have been also considered as hazardous but the at time quantity and quality (diluted) in plant is not threatening as its worst scenario outcome (total loss of contentment) is within 5mtr that too from LOC area, and so also it is underground storage. It is also complied with CCOE /PESO ruling/guideline and hence not vulnerable worth any major threat/risk.

F&EI and TI values have been computed for storage of MEG, and thermic fluid pipeline has been conducted. In general, the higher is the value of material factor (MF), the more inflammable and explosive is the material. Similarly, higher values of toxicity factor (Th) and supplement to maximum allowable concentration (Ts) indicate higher toxicity of the material. The tabulated values of MF, Th and Ts are given in Dows Fire and Explosion Index Hazard Classification Guide. For compounds not listed in Dow reference, MF can be computed from the knowledge of flammability and reactivity classification, Th can be computed from the knowledge of the National Fire Protection Association (NFPA) Index and Ts can be obtained from the knowledge of maximum allowable concentration (MAC) values.

General process hazards (GPH) are computed by adding the penalties applied for the various process factor. Special process hazards (SPH) are computed by adding the penalties applied for the process and natural factors. Both General process hazards and Special process hazards corresponding to various process and natural factors are used with MF to compute F&EI value and with Th and Ts to compute TI value.

F&EI Computation
F&EI value computed for TPS and CTT from GPH and SPH values using the following formula

F&EI = MF x [1 + GPH (total)] x [1 + SPH (total)]

Toxicity Index (TI)

Toxicity index (TI) is computed from toxicity factor (Th) and supplement to maximum allowable concentrations (Ts) using the following relationship:

TI = (Th + Ts) x [1 + GPH (total) + SPH (total)]/100

Calculation for F&EI as well as TI is given in *table shown below* for MEG and Thermic fluid.

FIRE AND EXPLOSION INDEX FOR THERMIC FLUID				
Material Factor			4	Nf=1, Nr=0 (more than 200 deg F FP)
1	**GPH**	**Panalty factor range**	**Panalty factor used**	**Remark**
	Base factor	1.00	1.00	Base factor
A	Exothermic reaction	0.3-1.25	0.00	No reaction
B	Endothermic process	0.2-0.4	0.00	NA
C	Material handling and transfer	0.2-1.05	0.25	NFPA 1
D	Enclosed or Indoor process unit	0.25-0.9	0.30	Enclosed unit with operation above flash point with liquid less than 1000 gallon
E	Access	0.2-0.35	0.00	Two side easy access so NA
F	Drainage & spill control	0.25-0.5	0.50	Operation above FP and all other equipment exposed
	General process Hazard factor F1		**2.05**	
2	**SPH**	**Panalty factor range**	**Panalty factor used**	
	Base factor	1.00	1.00	
A	Toxic material	0.2-0.8	0.20	Nh=1
B	Sub atmospheric pressure (<500 mmhg)	0.5	0.00	NA
C	Operation in or near flamable range			
1	Tank farm storage flammable liquid	0.5		
2	Process upset or purge failure	0.3		
3	Always in flammable range	0.8	0.8	Circulation is in flammable range
D	Dust Explosion	0.25-2.0	0	NA
E	pressure	0.86-1.5	0	NA
F	Low temperature	0.2-0.3	0	NA
G	Quantity of flammable / unstable material		0	Not applicable as FP above 140 deg F
1	Liquid or gases in process	0.2-3		NA
2	Liquid or gases in storage	0.1-1.6		

3	Combustible solid in storage, dust in process	0.2-4		
H	Corrosion&Erosion	0.1-0.75	0.2	Corrosion rate between 0.127 and 0.254 mm per year
I	Leakage joint and packing	0.1-1.5	0.3	Leakage near pumps
J	Use of fired equipment	0.1-1	0.8	Leakage above flash point and leakage within 50 ft of fireed equipment
K	Hot oil heat exchange system	0.15-1.15	0.15	Above flash point with quantity less than 5000 gallon
L	Rotating equipment	0.5	0.5	Considering rotating
				equipment of 75 HP
	Special process Hazard F2		**3.95**	
	Process unit hazard factor(F1×F2) =F3		8.10	
	Fire and Explosion Index(F3×MF)		**32.39**	
TOXICITY INDEX				
	Toxicity number Th		50	Nh=1
	Penalty factor Ts		50	TLV more than 50 ppm
	Toxicity Index		**5.00**	

FIRE AND EXPLOSION INDEX FOR MEG				
Material Factor			4	Nf=1, Nr=0
1	**GPH**	**Penalty factor range**	**Penalty factor used**	**Remark**
	Base factor	1.00	1.00	Base factor
A	Exothermic reaction	0.3-1.25	0.00	No reaction
B	Endothermic process	0.2-0.4	0.00	NA
C	Material handling and transfer	0.2-1.05	0.25	Nf=1, Nr=0
D	Enclosed or Indoor process unit	0.25-0.9	0.00	Not Enclosed
E	Access	0.2-0.35	0.00	Two side easy access so NA
F	Drainage & spill control	0.25-0.5	0.00	Proper dike design so NA
	General process Hazard factor F1		**1.25**	
2	**SPH**	**Penalty factor range**	**Penalty factor used**	
	Base factor	1.00	1.00	
A	Toxic material	0.2-0.8	0.20	Nh=1

B	Sub atmospheric pressure (<500 mmhg)	0.5	0.00	NA
C	Operation in or near flammable range			
1	Tank farm storage flammable liquid	0.5	0.5	
2	Process upset or purge failure	0.3		
3	Always in flammable range	0.8		
D	Dust Explosion	0.25-2.0	0	NA
E	pressure	0.86-1.5	0	NA
F	Low temperature	0.2-0.3	0	NA
G	Quantity of flammable / unstable material			
1	Liquid or gases in process	0.2-3	0	NA
2	Liquid or gases in storage	0.1-1.6	0.4	
3	Combustible solid in storage, dust in process	0.2-4		
H	Corrosion&Erosion	0.1-0.75	0.1	<0.005 in per year
I	Leakage joint and packing	0.1-1.5	0.1	possibility of minor leakage
J	Use of fired equipment	0.1-1	0	NA
K	Hot oil heat exchange system	0.15-1.15	0	NA
L	Rotating equipment	0.5	0	NA
	Special process Hazard F2		**2.30**	
	Process unit hazard factor(F1×F2)=F3		2.88	
	Fire and Explosion Index(F3×MF)		**11.50**	
Toxicity Index				
	Toxicity number Th		50	Nh=1
	Penalty factor Ts		50	TLV more than 50 ppm
	Toxicity Index		**2.55**	

CONCLUSION FOR FIRE & EXPLOSION INDEX		
SR	**Rating**	**Applicable Fire and Explosion index range**
1	1-60	Light
2	61-96	Moderate
3	97-127	Intermediate
4	128-158	Heavy
5	>159	Sever

CONCLUSION FOR TOXICITY INDEX		
SR	**Range**	**Toxicity index Applicable**
1	1-5	Light
2	6-9	Moderate
3	above 10	High

HAZARDS RATING - MONO ETHYLENE GLYCOL

Hazardous in case of ingestion. Slightly hazardous in case of skin contact (irritant, permeator), of eye contact (irritant), of inhalation. Severe over-exposure can result in death.

Potential Chronic Health Effects

CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH. MUTAGENIC EFFECTS: Mutagenic For mammalian somatic cells. Non-mutagenic for bacteria and/or yeast. TERATOGENIC EFFECTS: Not Section: First Aid Measures.

Eye Contact

Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention if irritation occurs.

Skin Contact

Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops. Cold water may be used. Serious Skin Contact: Not available.

Inhalation

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately. Serious Inhalation: Not available.

Ingestion

Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Fire and Explosion Data

Flammability of the Product: May be combustible at high temperature.
Auto-Ignition Temperature: 398°C (748.4°F)
Flash Points: CLOSED CUP: 111°C (231.8°F).
Flammable Limits: LOWER: 3.2%

Products of Combustion
These products are carbon oxides (CO, CO2). Fire Hazards in Presence of Various Substances: Slightly flammable to flammable in presence of open flames and sparks, of heat. Non-flammable in presence of shocks. Explosion Hazards in Presence of Various Substances: Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.

HAZARD RATING - THERMIC FLUID

1. EYE: Flush eyes with plenty of water.
2. SKIN: Wash off in flowing cool water or shower.
3. INHALATION: Remove to fresh air if effects occur. Consult with a physician.
4. INGESTION: If swallowed induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Consult medical personnel. Seek medical attention immediately.
5. FIRE FIGHTING MEASURES
• FLASH POINT 232°F, 111°C
• METHOD Tag Closed Cup
• AUTOIGNITION TEMPERATURE: 748°F, 398°C

Flammable Limits
LFL 3.2 VOL. % IN AIR (ethylene glycol)

Products of Combustion
Combustion may produce carbon, carbon monoxide, carbon dioxide and water. Unidentified organic compounds may be formed during combustion.
FLAMMABILITY: Dense smoke can be emitted when burned without sufficient oxygen.

Extinguishing Media
Water fog, carbon dioxide, dry chemical, or foam can be utilized. For large fires, alcohol resistant foams are preferred if available. General-purpose synthetic foams or protein may function, but much less effectively. Water may be used to flush spills away from fire exposures and to dilute spills to non-flammable mixtures. If possible, contain fire run-off water. For large-scale fires, direct water stream may cause violent frothing, but fine water spray may help control situation.

Fire Fighting Instructions
Keep people away. Isolate fire area and deny unnecessary entry. When using water spray, boil over may occur when product temperature reaches the Boiling point of water (tank type scenarios – not spills).

CONSEQUENCE ANALYSIS

Sudden release of Flammable / Toxic material can result in a number of accident situations. Scenario Selection In risk analysis studies, low frequency high outcome

events as well as high frequency low outcome events can be distinguished. Here for emergency planning we have only considered low frequency high outcome events. While estimating consequence only passive control measures were considered. Following are the potential Loss of Containment scenarios envisaged for the facility.

1) Catastrophic failure of MEG storage tank
2) Catastrophic failure of Furnace oil storage tank.
3) Rupture of thermic fluid pipe line.

Sudden release of Flammable / Toxic material can result in a number of accident situations. As large number of failure cases can lead to the same type of consequences, representative failure cases are selected for this analysis. The failure cases are based on conservative assumptions and engineering judgment. Typically, failure models are considered for 100% pipe diameter/ catastrophic rupture of vessels for rupture based on the guidelines of CPR 18 E.

SCENARIOS DUE TO MEG LEAKAGE / STORAGE

From the primary scenario of flammable material release we have considered following secondary scenarios.

Full Bore Failure- Thermal Radiation Threat Zone

Typically, failure models were developed after considering full bore failure of the pipe i.e. 100% pipe diameter/storage failure. Considering it will form a pool and shall result into fire under favourable condition and hence are the calculations.

Pool fire – Thermal Radiation Threat Zone

This will arise due to leak / rupture of oil line/vessels. Immediate ignition of the released vapour leads to jet fire; else the vapor gets diluted easily below LFL concentration due to initial turbulence created by high momentum.
Having considered worst scenario (total loss of contentment), If found favourable conditions, fire source/ignition etc. that results into fire,although very remote chances due to chemical properties of MEG. Following chemical characteristic of MEG are as under which defines the extent of damage in the form of radiation.
1)Boiling point 196’ C
2)Specific heat 2102J/kg.C
3)Heat of vaporisation 841935 J/kg
4)Heat of combustion16988870 J/kg
Using these values for estimation of radiation we get following inference

DISTANCE from POOL	Radiation strength KW/m2	Effect
1 M	3.7	Sufficient to cause pain if not covered within 20 secs
2 M	2.6	Discomfort and uneasiness
5 M	1.1	No discomfort if exposed for less than 60 sec.

CALCULATION MODEL: HEAT RADIATION --
-MEG

AMBIENT TEMPERATURE = 40
(°C)
DIAMETER POOL = 10 (M)
INTENSITY OF RADIATION = 13.0 (KW/M²)
RELATIVE HUMIDITY = 55
(%)
THE THERMAL LOAD IS CALCULATED FROM THE EDGE OF
THE POOL

DISTANCE THERMAL LOAD
Q(KW/M²)
(M) Q HOR. Q VERT. Q
MAX.
0.5 4.6 5.9
7.5
1.0 3.7 5.1
6.4
1.5 3.1 4.6
5.5
2.0 2.6 4.1
4.9
2.5 2.2 3.7
4.3
5.0 1.1 2.4
2.6
10.0 0.3 1.1
1.2
15.0 0.1 0.6
0.6
20.0 0.1 0.4
0.4
45.0 0.0 0.1
0.1
70.0 0.0 0.0
0.0
95.0 0.0 0.0
0.0

Result- Even in worst scenario of total LOC and result into fire the radiation cause shall not be dangerous and easily manageable with safety gears and PPE.

SCENARIOS DUE TO DEG LEAKAGE / STORAGE

Having considered worst scenario (total loss of contentment),if found favourable conditions, fire source/ignition etc that results into fire, although very remote chances

due to chemical properties of DEG. Following chemical characteristic of DEG are as under which defines the extent of damage in the form of radiation.
1)Boiling point 245' C
2)Specific heat 2302 J/Kg.C
3)Heat of vaporisation 417677 J/kg
4)Heat of combustion 22370000 J/kg
Using these valuesfor estimation of radiationwe get following inference

DISTANCE from POOL	Radiation strength KW/m2	Effect
1 M	6.6	Second degree burn after 20 second
2 M	4.8	Blister on skin after mnt
5 M	2.4	Slight discomfort uneasiness

Result- Even in worst scenario of total LOC and result into fire the radiation cause shall not be dangerous and easily manageable with safety gears and PPE

CALCULATION MODEL: HEAT RADIATION ---Diethyl Glycol

AMBIENT TEMPERATURE = 40 (°C)
DIAMETER POOL = 10 (M)
INTENSITY OF RADIATION = 22.6 (KW/M²)
RELATIVE HUMIDITY = 55 (%)
THE THERMAL LOAD IS CALCULATED FROM THE EDGE OF THE POOL

DISTANCE (M)	THERMAL LOAD Q(KW/M²) Q HOR.	Q VERT.	Q MAX.
0.5	8.1	10.3	13.1
1.0	6.6	9.0	11.2
1.5	5.6	8.0	9.8
2.0	4.8	7.2	8.7
2.5	4.2	6.6	7.8
5.0	2.4	4.4	5.0
10.0	0.9	2.3	2.5
15.0	0.4	1.4	1.4
20.0	0.2	0.9	0.9
45.0	0.0	0.2	0.2
70.0	0.0	0.1	0.1
95.0	0.0	0.0	0.0

25.0	Minimum energy required to ignite wood, at infinitely long exposure (non-piloted)	50% Lethality in 1 min. and Significant injury in 10 sec.
19.0	Maximum thermal radiation intensity allowed on thermally unprotected equipment	-----
12.5	Minimum energy required for piloted ignition of wood, melting plastic tubing etc.	1% lethality in 1 min.
9.5	----	Pain threshold reached after 15 seconds
6.4	------	Pain threshold reached after 8 seconds. Second Degree burns after 20 seconds.
4.5	-------	Sufficient to cause pain to personnel if unable to reach cover within 20 seconds, however blistering of skin (first degree burns) is likely
2.0	PVC insulated cables damaged	----
1.6	-----	Will cause no discomfort to long exposure. Pain threshold reached after 60 seconds
0.7	-----	Equivalent to solar radiation. Exposed skin reddens and burns on prolonged exposure

Source: Reference Green book "Methods for Determination of Possible Damage", TNO, Netherlands; World Bank (1988); Technical Report No. 55: Techniques for Assessing Industrial Hazards; D.C.: The World Bank

The level of damage caused is a function of duration of exposure as well as heat flux. This is true both for the effects on buildings and Installation equipment as well as personnel. However, the variation in likely exposure time is much more marked with personnel due to possibility of findings shelter.

The following table gives the relationship between exposure time and heat flux against the fatality probability factors. Fatality Probability due to thermal radiation:

Percentage of Fatality	10%	50%	99%
Heat Flux (KW/m^2)	**Times in Seconds**		
1.6	500	1300	3200
4.0	150	370	930
12.5	30	80	200
37.5	8	20	50

In general, it might be possible to take to a "shelter" within 30-60 seconds. As can be seen from above table, the change between very low to very high fatality probabilities occurs between flux levels of 12.5 kw/m^2 and 37.5 kw/m^2.

For transient fires like fire ball, the steady state heat flux levels cannot be used to estimate the damage. The degree of thermal radiation in terms of total incident thermal energy dose levels are relevant as shown in table below:

Physiological effect of Threshold Thermal Dose:

Thermal Threshold Dose (KJ/m^2)	Effects
37.5	3rd Degree Burns
25.0	2nd Degree Burns
12.5	1st Degree Burns
6.5	Threshold of Pain or blistering of skin

SCENARIOS DUE TO THERMIC FLUID LEAKAGE / STORAGE

The storage and transfer of liquid materials like oil creates the potential for leaks or accidentally releases from tanks, pipes, hoses, and pumps during loading and unloading of products. The effect and intensity of the spill/leak on person working depends upon the chemicals, quantity leaked and body parts affected. Due to this risk, there is a risk of minor/major chemical hazards, burns, skin/eye irritation, etc.

Pool fire - Thermal radiation threat zone

Scenarios due to rupture of thermic fluid circulation line

Having considered worst scenario (total loss of contentment), if found favourable conditions, fire source/ignition etc. that results into fire, although very remote chances due to chemical properties of thermic fluid. Following chemical characteristic of Thermic fluid are as under which defines the extent of damage in the form of radiation.

1) Boiling point 350' C
2) Specific heat 2900 J/kg

3) Heat of vaporisation 977000 J/kg
4) Heat of combustion42400000J/kg
Using these values for estimation of radiation using software we get following inference

DISTANCE from POOL	Radiation strength KW/m2	Effect
1 M	12.2	1% lethality in 1 min.
2 M	8.8	Second degree burn in 20 secs
5 M	4.3	Blister of skin likely
10M	1.6	Discomfort after 60 seconds
15M	.7	Equivalent to solar radiation, skin reddened

Result- Even in worst scenario of total LOC and result into fire the radiation cause shall not be much harmful unless protected by safety gears/PPE and easily manageable.

Further there will not be any other scenario like VCE due to inherent quality of thermic fluid.

CALCULATION MODEL : HEAT RADIATION ---Thermic Fluid

AMBIENT TEMPERATURE = 40 (°C)
DIAMETER POOL = 10 (M)
INTENSITY OF RADIATION = 41.5 (KW/M²)
RELATIVE HUMIDITY = 55 (%)
THE THERMAL LOAD IS CALCULATED FROM THE EDGE OF THE POOL

DISTANCE (M)	THERMAL LOAD Q(KW/M²) Q HOR.	Q VERT.	Q MAX.
0.5	15.0	18.8	24.1
1.0	12.2	16.5	20.5
1.5	10.3	14.7	17.9
2.0	8.8	13.2	15.9
2.5	7.7	12.0	14.3
5.0	4.3	8.1	9.1
10.0	1.6	4.2	4.5
15.0	0.7	2.5	2.6
20.0	0.3	1.6	1.6
45.0	0.0	0.4	0.4
70.0	0.0	0.2	0.2

95.0 0.0 0.1 0.1

TYPICAL CAUSES AND CONSEQUENCES OF STORAGE FAILURE

Figure: Typical Causes and Consequences of Storage Failure

Root Cause Analysis For Pool Fire Around Tank

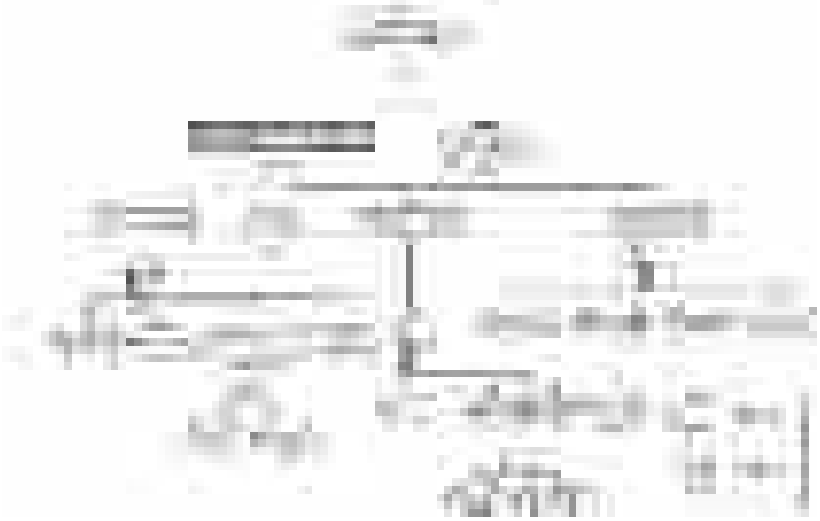
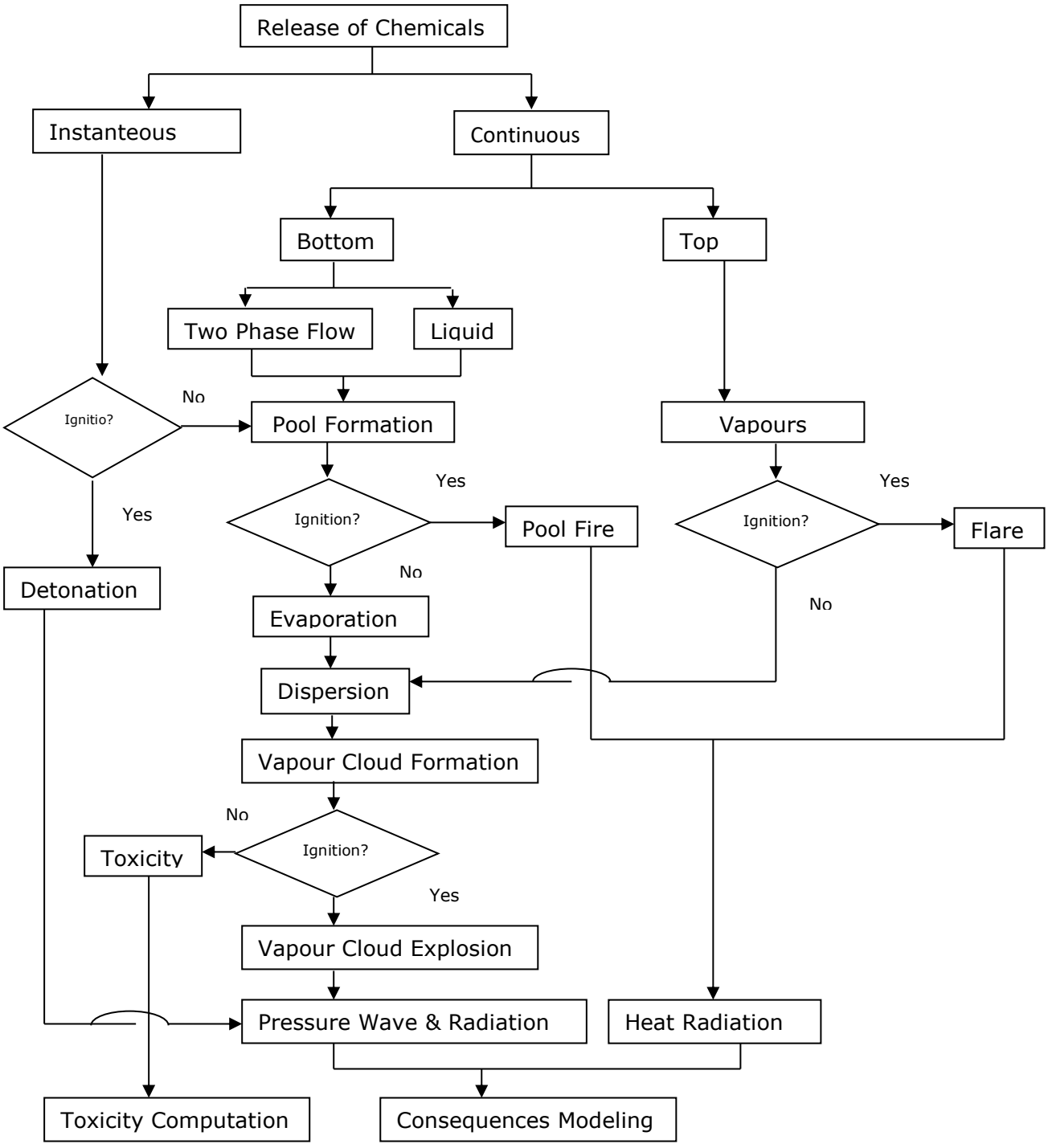


Figure: Root cause analysis for pool fire around tank

CONSEQUENCE ANALYSIS DUE TO LOSS OF CONTAINMENT



Flow chart: consequence analysis due to loss of containment

DISASTER MANAGEMENT PLAN

Emergencies may occur due to many reasons. It may occur due to natural causes like earthquake, cyclone, flood etc. It may occur due to malfunction of standard working systems or practices. There can be no set criteria for assessing the gravity

of a disaster in the abstract since this depends to a large extent on the physical, economic and social environment in which it occurs. What would be consider a major disaster in a developing country, will be equipped to cope with the problems involved, may not mean more than a temporary emergency elsewhere. However, all disasters bring in their wake similar consequences that call for immediate action, whether at the local, national or international level, for the rescue and relief of the victims. This includes the search for the dead and injured, medical and social care, removal of the debris, the provision of temporary shelter for the homeless, food, clothing and medical supplies, and the rapid re-establishment of essential services.

Objectives of Disaster Management Plan

The Disaster Management Plan (DMP) is aimed to ensure safety of life, protection of environment, protection of installation, restoration of production and salvage operations in this same order of priorities. For effective implementation of the Disaster Management Plan, it will be widely circulated and personnel training through rehearsals/drills. The Disaster Management Plan would reflect the probable consequential severalties of the undesired event due to deteriorating conditions or through 'Knock on' effects. Further the management will be able to demonstrate that their assessment of the consequences uses good supporting evidence and is based on currently available and reliable information, incident data from internal and external sources and if necessary the reports of outside agencies.

To tackle the consequences of a major emergency inside the factory or immediate vicinity of the factory, a Disaster Management Plan has been formulated and this planned emergency document is called "Disaster Management Plan".

The objective of the Industrial Disaster Management Plan is to make use of the combined resources of the plant and the outside services to achieve the following:

- Effect the rescue and medical treatment of casualties;
- Safeguard other people;
- Minimize damage to property and the environment;
- Initially contain and ultimately bring the incident under control;
- Identify any dead;
- Provide for the needs of relatives;
- Provide authoritative information to the news media;
- Secure the safe rehabilitation of affected area;
- Preserve relevant records and equipment for the subsequent inquiry into the cause and circumstances of the Emergency. In effect, it is to optimize operational efficiency to rescue rehabilitation and render medical help and to restore normalcy.

Major Causes of On-site Emergency

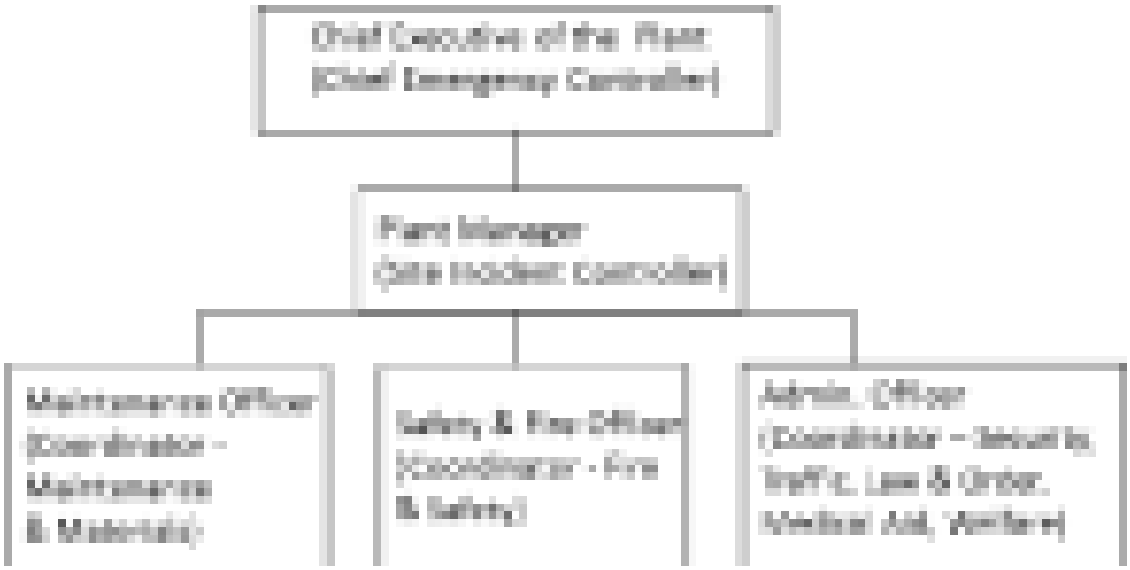
Fire consequences can be disastrous, since they involve huge quantities of fuel either stored or leaked during transportation. Preliminary hazard analysis has provided a basis for consequence estimation. Adequate firefighting systems will be provided and maintained. The detail on firefighting system is discussed in previous section.

Emergency Action Plan

The emergency action plan consists of: First information; Responsibilities of Work Incident Controller; Responsibilities of Chief Incident Controller; Responsibilities for Declaration of Emergency; Responsibilities for Emergency Communication Officer; Responsibilities of key personnel; Responsibilities and action to be taken by essential staff and various teams during emergency; and Responsibilities for All Clear Signal.

Organizational Plan

The Organization Plan is a systematic list of persons in the emergency management team and their functions before, during and after emergency. The disaster management organization shall be capable of quick response at any time of the day or night to meet the emergency condition, both for ON- SITE as well as OFF-SITE. The plan given a detailed chain of command, area of responsibility of each personnel.



It can be seen from Disaster Management Organization that Chief Emergency Coordinator shall take charge of the whole situation and shall guide the various coordinators to contain and control the incident. Various activities are to be carried out by pre- designated key personnel (Coordinators) and their team in quickest possible time.

The names, residential addresses and telephone numbers of key personnel shall be clearly written in Disaster Management Manual as well as widely circulated in ECC, different control rooms. It is to be noted that first few minutes after start of the incident is most vital in prevention of its escalation.

Pre-emergency Actions

The proposed preventive and pre-emptive measures are as follows: -

- Ensure implementation of Disaster Planning.

- Ensure that all drafted for emergency undergo regular training and are prepared for tackling emergency/disaster.
- Ensure that Mock Drills are performed under simulated emergency condition at regular intervals to assess the strength and weaknesses of the response team/plan.
- Ensure awareness among employees through regular training.
- Ensure good liaison with all agencies and industries in the neighbourhood for getting help if situation arises.
- Ensure adequate stock of safety, personal protective appliances in good working condition.
- Ensure awareness amongst public in the neighbouring areas.

Emergency Control Centre

An emergency control centre shall be provided at a safe place from where Chief Emergency Co-coordinator shall function for ON-SITE emergency. The Emergency Control Centre (ECC) shall be provided with following;

- Adequate number personal protective equipment,
- Alarm and communication network (Siren, local as well as P&T Telephone, Public Address system etc.),
- Route map,
- Map of the factory & surrounding areas, evacuation routes, fire hydrant network and other important information
- Fire hydrant
- Copy of detailed Disaster Management Plan, where names, telephone numbers of the response team members and their responsibilities are clearly written as well as names and telephone numbers of key personnel from outside agencies and district authorities, Fire Station, nearby Hospitals and doctors are provided.
- First aid kit,
- Material safety data sheets of chemicals

Medical Services

The doctors in the nearby hospitals should be trained for treatment of personnel affected. Necessary apparatus and drugs should also be available in first aid post and in State Hospitals and also other Nursing Homes nearby. Manager (HR-Welfare) should have good liaison with authorities of nearby hospitals and Nursing Homes as well as doctors outside so that help may be available when required.

Transport and Communication

Ambulance Van will be available inside plant premises. The disaster management cell will have the contact number of nearby hospitals or nursing home with Ambulance facility to call them in case of emergency.

Assembly Point

Assembly points shall be set up near to the likely hazardous event sites where predesignated persons from the disaster response team should assemble and meetthe Site Incident controller. This may be regarded as Site Incident Control Room where Incident Controller will receive instruction and furnish information to the Chief Emergency Co-ordinator. The site incident control room shall be provided with efficient communication system, adequate personal protective equipment, copy of Disaster Management Manual etc.

Emergency Shelter

Emergency shelter places shall be chosen sufficiently away from likely affected site. Employees who are not in the emergency management team shall be asked to take shelter. The place is chosen such that the employees taking shelter are not affected by fire, explosion and release of toxic gases. More than one emergency shelter shall be designated so that proper shelter point can be chosen depending on wind direction and other factors.

Wind Socks

Windsocks shall be provided on the top of tall buildings to indicate the wind direction.

Fire Services Personnel

Fire service shall be manned by trained fire safety personnel. Fire services department shall have adequate number of safety equipment for use during emergency. The list of safety appliances is as follows:

- Gas Mask
- Asbestos Suit
- Fire Proximity Suit
- BA Set
- Electric Gloves (for 15000 volts)
- Hydraulic Tool
- Telephone
- Emergency Ladder, etc.

Safety and Personal Protective Appliances

Safety and personal protective appliances shall be provided in adequate numbers and shall be distributed in different sections according to requirement. A list of such appliances available in the plant is given in the Table.

Table: List of Proposed Safety Equipment

Sl.No	Equipment	Nos.
BREATHING APPARATUS		
01.	Compressed Air	Adequate Nos.
02.	Airline respirator	Adequate Nos.
OTHERS		

01.	Self-contain breathing apparatus (SCBA)	Adequate Nos.
02.	Combustible gas indicator/explosimeter	Adequate Nos.
03.	Gas Detector (Dragger Pump)	Adequate Nos.
04.	Safety Belts	Adequate Nos.
06.	Asbestos Suit	Adequate Nos.
07.	Hand Gloves etc.	Adequate Nos.
08.	Gum Boots	Adequate Nos.
09.	Safety Shoes	Adequate Nos.
10.	Eye Goggles	Adequate Nos.

ONSITE EMERGENCY SAFETY PLAN

Objective
To give clarity in action plan and responsibility, so that fast and appropriate action can be taken in case of emergencies.

Action by First Observer
Any person who notices any accident / fire / emergency in the factory should look around and call the first person he come across.
He shall tell the person what was observed in short and ask him to run towards siren / bell and blow/ring it, shouting “accident or fire” as the case may be, to alert & call everybody on site for help.

He should immediately return back to the accident / incident site & should start taking corrective action to control the incident & help the injured if any. In case he does not see anyone, he should himself raise an alarm by blowing siren/bell

Initial Action by Other Persons

Other persons whom incidence / action was told by first observer, after blowing siren / ringing bell should run back to the accident / incident site for help.
On hearing siren / bell the persons working in different department on site should stop the machine/activity to safety if possible and run and gather near office entrance.

Note – If it is not possible to stop work in safe condition, he should continue to work till it becomes safe to stop & then only leave the place. Refer Department wise safety stopping instructions (Annexure I).

It is expected that the persons in following departments

1) Feeding
2) despatch
3) QC lab

4) processing

should reach the site immediately.

Plant & engineering should leave work place only after ensuring things they are working on is put to safety & inform sic & then only should leave.

CONTROL RESPONSIBILITY

In general shift senior most, person on site while in shift the shift incharge should take charge. In the absence of shift incharge, the senior most supervisor will take control.

ACTION TO BE TAKEN BY CONTROLLER

1. Get the following information about the incident in brief from person raising alarm.
    a) Location of incident
    b) Type of incident
    c) Gravity of incident
    d) Expected injury if any

2. Depending upon the no of person gathered, he should delegate various responsibility to act to person gathered there as follows-
    a) To arrange for First-Aid.
    b) To arrange for emergency vehicle.
    c) To stay near communication system (Phone, Mobile) along with SIC(if available).
    d) Lead & take the team of balance persons to incident site for controlling it by taking remedial action.

3. Person attending communication system should do the following –
    a) Call company's guest house persons i.e. Mr Narapathsingh (9326976870, Mr Tejsingh 9765862011) immediately or send one person to call them.
    b) Contact to RSA and Dhantoli Office. Inform the person on other side about the incident in brief.
    c) Ask him to contact and inform Mr.S.I.Ranka / Mr.Ajayoke / Mr.P.D.Sohale / Mr.RohitKhanduri / Mr.Ajay Malik if they are not available on site.(Minimum two persons). Ask person on other side to stay near communication system for quick communication.
    d) Also try to contact on phone from RAN site. To these persons.
    e) Call Gondkhairy Staff Mr. Deshmukh (8412076232) And Mr. Vanvanshi (9823076793)
    f) In case of major fire ask person at RSA to call Fire Brigade for RAN./ and also to Kalmeshwar \ fire Brigade.
    g) Ask Mr. Ajay Malik to contact Hospital/ Doctor and keep them ready. In case of major accident arrange for ambulance. Ask him to stay at hospital for control & monitor Hospital & Fire brigade.

4. Controller shall judge the gravity of the situation.

In case of minor incident, stop the cause and get the situation under control.

Quick specific response card department wise can be preferred to take control of the incident.

For manpower injury take the steps as required based on criteria mentioned hereunder depending up on the type of injury.

Mr. S.I.Ranka	2524457	9823072312, 9561272312
Mr. P.D.Sohale	2535698	98230-42293
Mr. Oke	930001401	9665082743
Mr. Rohit Khanduri	2230680	9665082745
Mr. Ajay Malik	2520831	98230-15506
Mr. R. Deshpande	2225158	8600622273
Mr. A. Joshi		8600622274
Mr V. Kumbhalkar		8600622275
Mr. Kailash Kolkatwar	2747166	9028065453
Fire Brigede	101	

Types of injuries and its handelling

I. INCASE OF MACHINE / PHYSICAL INJURY

a) Incase of machine injury, stop the machine immediately.
b) Rescue the person trapped if any.
c) Bring him outside in a open place.
d) Give him First–Aid.
e) If necessary send him to doctor in the vehicle arranged.
f) Clear the work area.
g) Check that everything is under control and OK and thereafter resume the factory activities.

II INCASE OF CHEMICAL BURNS / HOT BURN.

a) Take the person to safety shower
b) Uncover the burn area
c) Flush it thoroughly with lot of water minimum 15 minutes on continuous flow.
d) Do not apply any ointment or medicine on the burn
e) Arrange for the Vehicle.
f) Take the person to the hospital (see list of Doctors and hospitals).

III IN CASE OF CHEMICAL / MATERIAL SPILLAGE IN EYES.

a) Hold the person firmly and take him to eye fountain.
b) Wash his eyes thoroughly over the fountain minimum 15 minutes.
c) Arrange for the vehicle and take the person to Hospital for further check Up and treatment

IV. ELECTRICAL SHOCK.

a) Put off the supply immediately from the panel board.
b) Take the person electrocuted to open area.
c) If required help him to breath by giving artificial respiration.
d) Take him to Doctor in the arranged vehicle for further check-up and treatment.

V GAS SUFFOCATION AND POISONING CASE.

a) Remove the person immediately from the Gas affected area to open place in fresh air. NOTE: - in a dense and toxic gas area rescuer must wear self-breathing mask with air cylinder before entering the area.
b) Loosen the clothes of the person if he is wearing tight fitting clothes.
c) If cold keep him warm with blankets, coats, hot water bottles etc.
d) Give him water to drink.
e) If patients breathing is interrupted artificial respiration should be given to improve breathing. Start artificial respiration at once. The first few minutes are vital. The artificial respiration should not be stopped in any case until normal breathing has been restored/not even for giving oxygen. Artificial respiration should continue until stopped on qualified medical advice. People have been revived even after 4 hours.

VI IF PATIENT HAS BECOME UNCONSCIOUS.

a) Lay him with head lower than rest of the body
b) Lower clothing around neck. See that there is plenty of fresh air
c) Sprinkle face and chest with cold water.
d) Put smelling salts of ammonia to the patients nose.
e) Rub; limbs toward body.
f) If breathing is normal there is no need to apply artificial respiration. When patient can take give him hot Tea or Coffee.
g) Rush him immediately to the hospital with escort in vehicle arrange for further treatment.
h) Do not allow any person to enter the Gas affected area.
i) Ask the persons to stand opposite to Wind Direction.
j) Try to stop the source of gas generation.
k) If necessary alert the people in the area which are likely to be affected by gas.

VII IN CASE OF FIRE

DIFFERENT PROCEDURES NEED TO BE FOLLOWED DEPENDING UPON TYPE OF FIRE:

1. ELECTRICAL FIRE

a) Put off the electrical supply to the area from isolation point.
b) Remove the flammable material in the area if any.
c) Do not use water to extinguish fire.
d) Use CO2 or DCP (dry chemical powder) type Fire Extinguisher.

e) Using Fire Extinguisher extinguish the fire.
f) If required bring fire extinguishers from other departments.
g) In case of major fire continue efforts to keep it in control till the Fire Brigade comes into action.

2. CHEMICAL FIRE

a) Put off the electrical supply to the area from isolation point.
b) Use foam type of DCP type fire extinguishers to extinguish fire.
c) Simultaneously remove other flammable material in the vicinity of the area
d) Using fire extinguishers extinguish the fire.
e) If required bring fire extinguishers from other departments.
f) If fire is still uncontrollable, extinguish using water from Fire Hydrant pump.
g) In case of major fire continue firefighting using fire hydrant foam/water system to keep it in control till Fire Brigade comes into action.

As a result of the onsite emergency action if the incident comes under control, there is no need to raise alarm to the people outside the factory. However, if under a situation thing do not come under control and there is likely hood of people outside the factory premises getting affected due to –

1. Toxic fumes getting released.
2. Material getting blasted & pieces thrown out.
3. Incident is likely to spread to area outside the factory, FOLLOW “OFF SITE EMERGENCY PLAN” and in such case SENIOR EXECUTIVE OF THE COMPANY AT SITE (Any one of Mr. Rohit Kanduri / P. D. Sohale) will handle the situation.

Department wise safety stopping instructions

Sr. No.	Department	Person working on	Action to be taken for stopping
1	Feeding		Can go immediately
2	Despatch		Can go immediately
3	Q. C. & Lab	Lab set	1. Stop addition. 2. Stop heating
4	Processing	Pre-crushing	1. Stop feed. 2. Stop machine.
		Grinding	1. Stop grinder feed. 2. Empty grinder & stop it.
		Inspection table	Stop machine immediately cover the filled bag.
5	Engineering	Machine work	1. Stop work
		Boiler	1. Stop fuel addition (wood) to furnace 2. Remove fuel from furnace. 3. Check with controller gravity of accident / incident. 4. If required stop boiler as per Boiler Stopping procedure.
		TFH	1. Stop fuel addition (wood) to furnace. 2. Remove fuel from furnace. 3. Continue TFH circulation. 4. Check with controller gravity of accident / incident 5. If required stop TFH as per TFH stopping procedure.
6	Plant	Reactor	1. Stop addition if it is on. 2. Stop heating. 3. Continue stirring. 4. Other persons can leave except one (Shift in-charge) who should remain in control cabin to monitor temp. & keep watch on Plant and take action as & when required. He should also co-ordinate on mobile & phone.

OFF SITE EMERGENCY PLAN

Scope - Off site emergency is any emergency arising in the factory such as fire, runaway reactions, explosions which are likely to evolve toxic fumes in so much quantity that people residing in and surrounding area are likely to get effected.

Purpose - Off site emergency plan is prepared for clarity of action to be taken, avoid confusion and quick & timely action so that there are minimum injures / casualties.

Control Responsibility – Any one of senior executives of the company ROHIT KHANDURI / P. D. SOHALE in general shift or senior most person on site should take charge. However if the senior executive are not present at site, till they reach the site and take charge as controller, the senior most person on site will take temporary charge as controller and act as per instructions (telephone/mobile) by these executives given to him.

Action Plan – Any Emergency / Accident / Fire occurrence should be handled and controlled by Quick & Prompt action in line with "On Site Emergency Plan"
In case the emergency does not come in control and there are indications that smoke / toxic fumes generated (if any) are likely to spread in surrounding area, the controller should act as follows in addition to the efforts to control & stop generation of fumes.

1. Inform senior executives about Off Site Emergency action requirement and get his clearance for the following action.

2. Creating **Task Force** from persons available on site for handling Off Site Emergency.

3. He shall then do the following -
   Form the group of minimum 3-4 persons from available HOD & Supervisors and allocate them to undertake off site emergency action. They will work as Task force.

Task force to act as follows.

a. Estimation of area likely to be affected which is calculated based on
   i. Wind direction.
   ii. Wind Velocity
   iii. Types of fumes generated.

b. Ask person on communication system mobile / telephone to inform following information in brief to control Authorities.
   i. Type of incident.
   ii. Area likely to be effected.

iii. Type of hazard.
iv. Population density of the area.

Control Authorities.
i. Tehsildar Kalmeshwar.
ii. Factory Inspector Nagpur.
iii. Sarpanch Ashtikala.
iv. Kalmeshwar Police station incharge
v. For electrical MSEB

Note – the senior executives only will talk to these central authority to avoid confusion.

c. Inform to the – Hospitals in local area, estimated casualties / & type of casualty so that they can be ready for handling casualties.

List of Hospitals & Clinic

1 Dr.Potdar Nursing Home - 95-7118-271278 / 271490
2 Indira Gandhi Medical college(IGMC) –95-712-2728626 / 272862
Nagpur
3 Dr. Nandanwar,14th mile 95-7118-238247
4 Govt Medical College Hospital, Nagpur 95-712-2744671 / 72

d. Inform to the factories in vicinity, type of incident so that they can take preventive action in their area.

M/s Minex
M/s Solar Explosives.

e. Arrange for additional vehicle at factory from
i. Additional vehicles present in factory.
ii. Vehicles in nearby factories.
iii. Ask RSA to send vehicles.

f. Go to the area likely to get effected and inform them about
i. First aid precautions against the hazard.
ii. Evacuate & shift to safe area.

g. Contact – Chemical expert for Guidence
i. Mr. S. I. Ranka 0712-2523806
9561272312
ii. Mr. P.D.Sohale 0712-2226679
9823042293
iii. Mr. A.A.Oke 930001401, 9665082743
iv. Mr. Rohit Khanduri 0712- 2230680
9665082745

Recommendations

Plant must display conspicuously outside plant boundary about plant activity being MAH unit Within plant boundary must display location wise depicting area and side specific instruction, more precisely about road map /emergency exit, DO-DON'Ts instruction, operating instruction of key equipments / plants. Plant incharge must ensure and shall not let harmful emission be vented. Must comply with MPCB norms. It is also expected plant management to enter and make/involve other mutual aid members of major nearby factories having similar facilities and their participation in mock drill /learning program may be documented for record.

From the Risk Analysis studies conducted, it would be observed that by and large, the risks are confined within the factory boundary walls in case of fire however not vulnerable to explosion, except in the event of a catastrophic failure of storage tanks of utility gas it will create OFF site emergency situations and required more attention and emergency preparedness for combat such situations.

To minimize the consequential effects of the risk scenarios, following steps are recommended:

- Plant should meet provisions of the Manufacture, storage & Import of Hazardous Chemicals Rules, 1986 & the factories Act, 1948.
- Sprinkler system to be installed at HZ storage area to be made more effective and pressure needs to be maintained.
- Sprinkler opening valve location needs to be in auto mode
- Fire hydrant system for proposed plant to be installed as per TAC/NFPA Norms in each plant location and buildings.
- Dyke wall and collection pit with drain valve needs to be provided as impervious surface storage area
- Tanker unloading procedure needs to be displayed at tanker unloading area.
- Periodic on-Site Emergency Mock Drills and occasional Off-Site Emergency Mock Drills to be conducted, so those staffs are trained and are in a state of preparedness to tackle any emergency.
- Emergency handling facilities to be maintained in tip top condition at all time.
- Safe operating procedure to be prepared for hazardous process and material handling process.
- Safety devices and control instruments to be calibrated once in a year or as per statutory requirement
- Proper colour work as per IS 2379 to plant pipeline and tank, equipments to be done once in a six month to protect from corrosion.
- Permit to work system to be implemented 100 % for hazardous work in the plant.
- Safety manual as per Rule-68 K & P and Public awareness manual as per 41 B & C be prepared and distributed to all employees and nearby public.

- The details of emergency equipments are given in on site emergency Plan along with its quantity. As per our site visit, these was found in order & working condition and sufficient for existing production Activities.
- Manual call points for fire location identification to be installed in plant premises.
- For proposed plant Fire & Safety organization setup to be replanted for batter plant process safety and shall be more rational.
- A HAZOP study to be carried out for all product plant and storage facilities.
- Induction safety course to be prepared and trained all new employees before starting duties in plant.

ANNEXURES

1) Flow Chart of ON-SITE emergency control

2) List of PPEs

SR NO	NAME OF MATERIAL	MAKE
1	DISPOSAL HAND GLOVES (115 I GLOVES THICK)	PLASTI SURGE
2	129 A FACE MASK 2 PLY TIE	PLASTI SURGE
3	ASBESTOS HAND GLOVES 14" (white colour)	
4	LEATHER HAND GLOVES 14" (RED COLOUR)	
5	EAR PLUG 3 MM	
6	SAFTY GOGGALES WHITE (CHEMICAL SPLASH)	
7	RUBBER HAND GLOVES 14" (YELLOW colour)	
8	GUM BOOT (SIZE- 7,8,9 & 10 NOS)	
9	FACE SHIELD HALF (9 X 12)	
10	3M SAFETY HELMET 401-R WHITE (IS - 2925)	
11	3M SAFETY HELMET 401-R BLUE (IS - 2925)	
12	PVC APPRON YELLOW 24 "	
13	SAFETY BELT PN - 16 SINGLE LANYARD PN- 204	KARAM
14	FIRE EXTINGUISHER CYLINDER ABC TYPE CAP. - 4 KG (IS- 15683)	FIRE STONE
15	FIRE EXTINGUISHER CYLINDER ABC TYPE CAP. - 9 KG (IS- 15683)	FIRE FOX
16	FIRE EXTINGUISHER BALL	ELIDE BALL
17	ABC DRY POWDER STORED PRESSURE CEILING MOUNTED FIRE EXTINGUISHER 5 KG	CEASE FIRE

3)HYDRANT LINE DRAWING

4) Work permits

ELECTRICAL WORK FORMAT FOR THE DATE :-		
SR.NO	**WORK DESCRIPTION**	
1	LOCATION	
2	HOUSEKEEPING NEAR WORK PLACE	
3	AVAILIABILITY OF HANDGLOVES & SHOES	
4	ELECTRICAL ISOLATION	
5	WORK DONE BY	
6	SUPERISED BY	
7	COUNTER CHECKED BY	
8	Authorized BY	
9	STARTING TIME	
10	FINISHING TIME	
11	PROPER EARTHING DONE	
12	WORK XCHECKED BY (AFTER FINISHING)	

HEAVY MACHINERY HANDLING FOR THE DATE :-		
SR. NO	**WORK DESCRIPTION**	
1	HOUSE KEEPING	
2	AVAILIBILITY OF WATER	
3	AVAILIABILITY OF FIX EXTINUGUISHER	
4	EQUIPMENT USED FOR / CONDITION	
5	HYDRA	
6	CHAIN PULLY BLOCK	
7	WIRE ROPE	
8	SAFETY BELTS	
9	NYLON ROPE	
10	WORK DONE BY	
11	SUPERRISED BY	
12	COUNTER CHECKED BY	
13	WORK STARTING AT	
14	WORK FINISHING AT	
15	WORK XCHECKED BY (COUNTER CHECKED)	

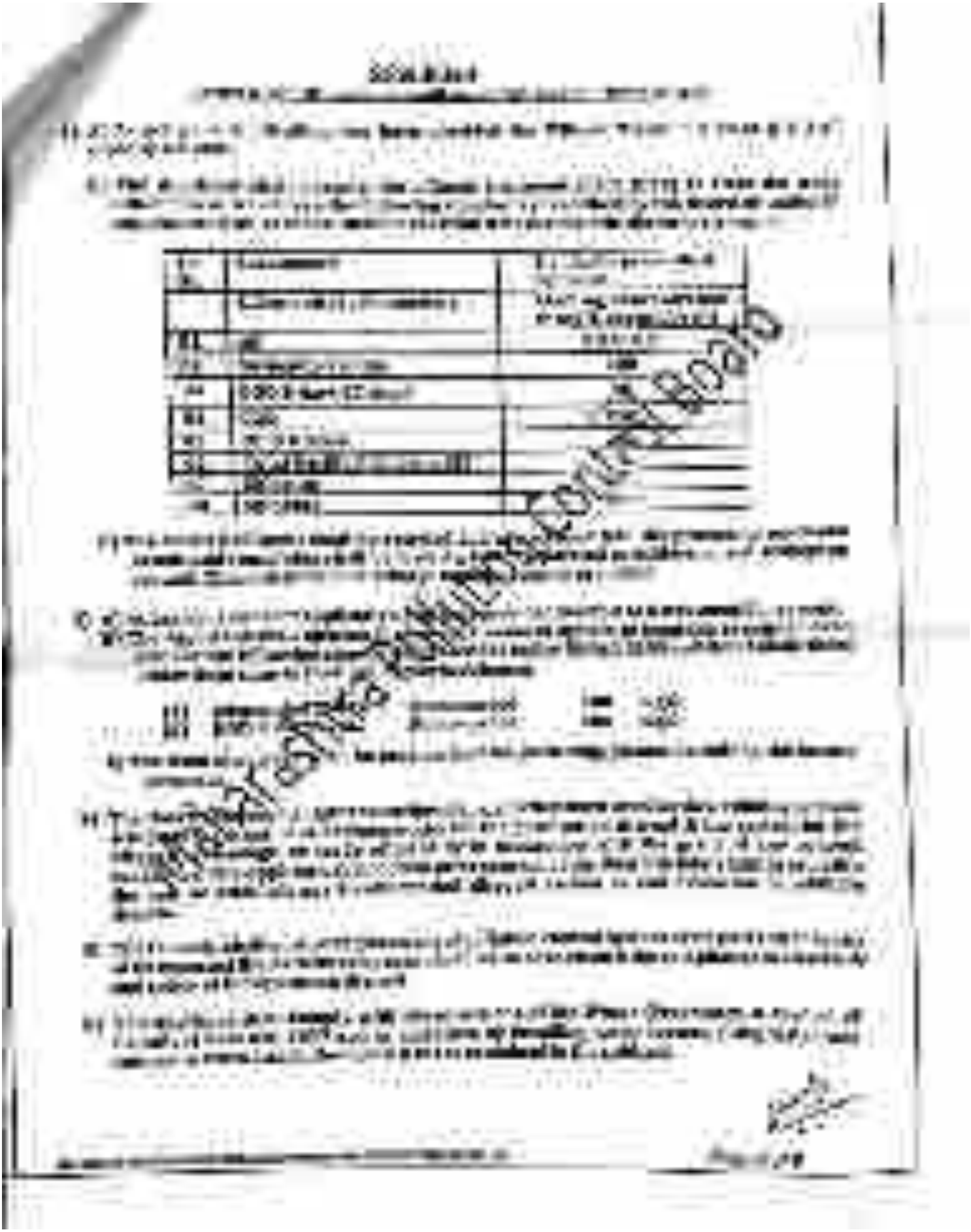
HIGH ALTITUBE FOR THE DATE: -

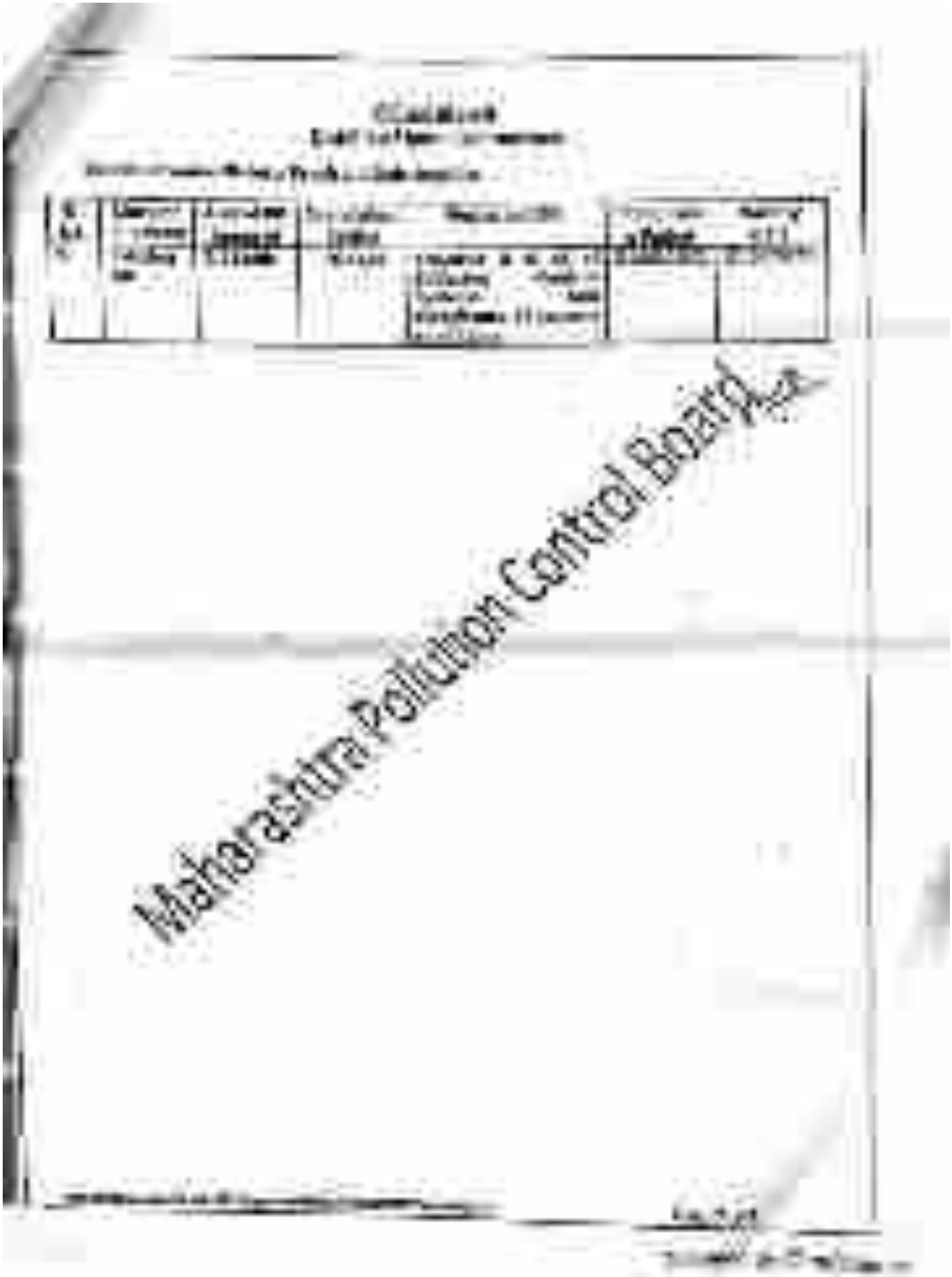
SR .NO	WORK DESCRIPTION	
1	LOCATION	A
2	AVAILABILITY OF EQUIPMENTS	
3	BELTS	
4	HELMET	
5	NYLON ROPE	
6	WORK DONE BY	
7	SUPERISED BY	
8	COUNTER CHECKED BY	
9	Authorized BY	
10	STARTING TIME	
11	FINISHING TIME	
12	WORK XCHECKED BY (COUNTER CHECKED)	

5)Calibration and Test certificates

6) PCB Consent


Maharashtra Pollution Control Board




Maharashtra Pollution Control Board