RISK ASSESSMENT

(QRA)

At

MANUFACTURING OF SYNTHETIC ORGANIC DYES .

For

FI DYE CHEM

at

Plot no 3 & 11, Sikandar Market
Chandola Dhal , Opp . Chandola petrol pump ,
Danilimda , Ahemadabad,
Gujarat 380 022

Prepared by

Ultra-Tech Environmental Consultancy & Laboratory
(Gazetted By MOEF)
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NOVEMBER 2017

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LIST OF ANNEXURE

SECTION 1: EXECUTIVE SUMMARY

1.1 THE ASSIGNMENT

1.1.1 M/s. FI DYE CHEM located at Plot no 3 & 11, Sikandar Market Chandola Dhal , Opp . Chandola petrol pump , Danilimda , Ahemadabad, Gujarat 380 022. The plot size is m2

1.1.2 The company now proposes a Dyes manufacturing Plant at this plot. The proposed product mix will be as follows;

TABLE NO. 1.1: Proposed Product capacity in TPM

Sr. no.	Product name	Capacity TPM
1	Reactive Blue P3R	20
2	Reactive Blue MX7R	5
3	Reactive Black B	10
4	Reactive Blue 49	10
5	Reactive Green HE4BD	10
	Total	55

1.1.3 Mr. Subhash Bonde of M/s. Bonde Technical Services, Thane is "EIA Functional Expert – Risk Assessment and Hazard Management (RH)" , Accredited by NABET undertook this study in compliance with requirements of EIA report preparation which is prepared by M/s. Ultra –Tech Environmental Consultancy & Laboratory , Accredited by NABET. undertook this QRA study towards compliance of TOR requirements of EIA report .

1.2 SCOPE OF WORK

The scope of the report covers the proposed site activities of manufacturing. The battery limits of this study are restricted to the installations indicated over the proposed site plan.

1.3 METHODOLOGY

Methodology followed in preparation of this report is as per Technical EIA Guidance Manual for Synthetic Organic Chemicals , prepared for the Ministry of Environment and Forests Government of India.

The major steps are as outlined below;

- Hazard Identification.
- Failure Frequency Analysis.
- Consequence Analysis.
- Impact Assessment.
- Protective System & Hazard Analysis.
- Risk Mitigation Measures.
- DMP.

1.4 IDENTIFICATION OF HAZARDS

1.4.1 Hazardous chemicals

MSDS for all the materials are studied. Identification of hazards of the using NFPA 704 M is considered . (in absence of relevant safety data the materials are considered and need to be handled as if hazardous material)

Storage and handling of following chemicals carry There is significant Flammability and Toxicity hazard due to Formaldehyde and Reactivity Hazard due to Cyanuric Chloride .

1.4.2 Hazardous processes /operations

The unit processes such as Dizotisation –coupling , condensation and reduction are identified as hazardous processes

1.4.3 Hazardous operations

The unit operation such as filtration , washing , size reduction , drying are identified as hazardous operations.

1.5 Inventory Analysis

Inventory analysis revels that the inventory of Hazardous chemicals such as Toxic chemicals and flammable chemicals of various groups does not exceeds the threshold specified quantity specified in Schedule II Column 3 of "The the MSIHC Rules, 1989". Thus the site is not classified as a Major Accident Hazards (MAH) Installation

1.6 Relative ranking

1.6.1 MOND Index Assessment

The MOND Index assessment is carried out as per MOND INDEX Manual 1993.As per Mond index assessment for the formaldehyde storage is having " Low "as over all hazard rating. **It is reasonable to assume that a unit assessed at this level can be operated in a satisfactory manner** by providing adequate off setting measures, giving full regard to the hazards indicated by the assessment It should be noted that the assessment depends heavily upon the maintenance of the hardware and of the management procedures; neglect of either will lead to loss of protection and the rating will rise.

1.6.2 DOW F&E Index

Identification of hazardous units and segments of plants and storage units based on "**relative ranking technique**," such as DOW Fire and Explosion Index is used. As per

DOW Toxicity hazard index assessment Hydrochloric acid as well as Formaldehyde storage installation category as II.

1.7 HAZOP STUDY

1.7.1 **Methodology**

The methodology used as per Hazard Identification and Hazard Analysis Techniques of Hazard Identification And Risk Analysis – Code Of Practice IS 15656: 2006.

1.7.2 NODES

NODE 1	Product Reactive Blue P3R
NODE 2	Product Reactive Blue MX7R
NODE 3	Product Reactive Black B
NODE 4	Product Reactive Blue 49
NODE 5	Product Reactive Green HE4BD

1.7.3 Identification of Hazards is carried out by HAZOP Study . Each Hazard is evaluated on 1 to 5 scale of severity and Probability leading to risk level of the scale 1 to 25 . Events / accident scenarios identified in HAZOP Study having risk rating in 16 to 25 range are listed in following table .

TOP TEN identified hazards in HAZOP study

1 Cyanuric chloride toxic gas release during charging of the batch .

2 Scrubber failure releasing toxic gases at vent of the scrubber

3 Reactivity and compatibility hazards at storage of raw materials

4 Hazardous Solid waste especially Iron sludge storage and transport containing residual material .

5 Health hazard due to emissions in Formaldehyde handling at work place.

6 Environmental risk - POCP of formaldehyde handling .

7 Fire tender and Emergency vehicles movement at back side gate may be affected due to reduced width .

8 Organic contaminated water generated during fire fighting operations may enter the storm drain .

9 Presence of heavy metals like chromium in effluent .

10 Hydrochloric acid spill and emission of hydrogen chloride gas at work place .

1.8 CONSEQUENCE ANALYSIS

1.8.1 Consequences zones have been calculated using software ALOHA , PHAST and also software based on the "TNO Yellow Book". Method for calculation of the Physical Effects of the escape of Dangerous Material (Liquid & Gases) Published by the Directorate General of Labour, Ministry of Social Affair, Netherlands(1979).

1.8.2 The worst possible accident scenerios considered are as follows

a) Large Spill of Hydrochloric acid and dispersion of hydrogen chloride gas down wind.

b) Release of Formaldehyde .

1.8.3 Vulnerable Zone

ALOHA modelling of the vulnerable zones are superimposed on satellite site maps called **MARPLOT** are enclosed in section 3 for estimation of impact.

Large Spill of Hydrochloric acid and dispersion of hydrogen chloride gas down wind.

1.9 FREQUENCY ANALYSIS

1.9.1 Event Tree

Event trees begin with an initiating event and work toward a final result. This approach is inductive. The method provides information on how a failure can occur and the probability of occurrence. Frequency of the incident is estimated by Event Tree.

1.9.2 Initiating event frequency

Initiating event frequency/yr for the study are considered from Ref: Table 11.3, Chemical process safety fundametals with apptications ; Dainel A Crowl / Joseph L.Second edition,

1.9.3 The estimated event frequency of Large Spill of Hydrochloric acid and dispersion of hydrogen chloride gas down wind. Hydrochloric acid followed by Hydrogen chloride gas dispersion downwind is 1.0×10^{-4} per year.

1.10 IMPACT ASSESSMENT

1.10.1 Large Spill of Hydrochloric acid 30% and dispersion of hydrogen chloride gas down wind is low frequency event . Evacuation up to 10 m down wind will be affected and need immediate evacuation .

1.10.2 The population in the vulnerable zone being trained industrial workers are likely to take safe shelter with in 5 minutes avoiding any fatality.

1.10.3 It is pertinent to note that Hydrogen Chloride gas can react with water and/or water vapor/moisture . This can affect the release rate and downwind dispersion. The resultant air born Hydrochloric acid mist is likely ..

1.11 RISK ASSESSMENT

1.11.1 Individual risk

Individual risk is defined by AIChE/ CCPS as risk to a person in the vicinity of a hazard. This includes the nature of the injury to the individual, the likelihood of the injury occurring and the time period over which the injury might occur.

It is estimated that at assembly point individual risk of fatality is insignificant however the location may require evacuation depending upon meteorological conditions prevailing at that time .

1.11.2 Societal risk

Societal risk is a measure of risk to a group of people . It is most often expressed in terms of the frequency distribution of the multiple casualty events (F-N curve)

In the present case any fatality unlikely for the population in surroundings the site and there is no situation point above the criterion line in F-N curve indicating insignificant societal risk.

1.12 RISK MITIGATION MEASURES

To address the residual risk issues risk mitigation measures are suggested which includes preventive as well as protective measures to achieve reasonable acceptable risk level .

1. Provide Closed arrangement for charging of Cyanuric Chloride to reactor .

2. Hydrogen chloride leak detector at plant and Cyanuric chloride store .

3. Storage of raw materials at store considering the compatibility and reactivity hazards at store.

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4. Hydrogen Chloride gas liberated in cyanuration reactor can be scrubbed by water in multiple scrubbers to get 30 % hydrochloric acid from the first scrubber .

5. Portable Fire Extinguishers.

6. Formaldehyde handling
   a) Provide SOP for Formaldehyde storage and handling operations with thrust on medical surveillance, hazard communication to employees, PPE, Spill procedures confirming to OSHA Formaldehyde standard 29 CFR 1910.1048.
   b) Provide scrubber and connect all vents releasing formaldehyde to scrubber.

7. Safety Shower & Eye Wash Fountains and Personnel Protective Equipment (PPE)

8. Suitable arrangement at storm drain to avoid any organic contaminated water/ spill/ fire water going out of the site.

9 Effective washing of the sludge to make it free of retained product .

10. "DMP" based on MCLS Analysis for the site with dove tailing data for "Offsite Disaster Control Plan".

A practical working document DMP for site as per the format specified under "The the MSIHC Rules, 1989" is prepared .Emergency organization, roles and responsibilities are detailed in the plan.

1.13 We thank the staff and the management for positive approach shown and excellent co-operation extended throughout the studies to complete the studies in scheduled time frame.

SECTION 2: HAZARD IDENTIFICATION

Preliminary hazard analysis
Table no. 2.1: Layout Hazards

Layout Hazard	Pre Construction phase	Construction phase	Operation phase	Post Operation /De commissioning /demolish
Organic contaminated water generated during fire fighting operations , sprinkler operation , spill / floor washing may enter storm water drain .		√	√	√
Reactivity and compatability of hazards at storage installations , ETP in case of accidental mix up of materials .	-		√	√
Fire tender and Emergency vehicles movement at back side gate may be affected due to reduced width .			√	√

In addition to above Annexure no. 4 lists additional detailed Hazards covering following aspects for life time of the project considering following aspects

- Natural calamities
- Physical hazards
- Biohazards
- Electrical hazard
- Hazardous substances and wastes
- Mechanical hazards
- Frequent causes of accidents during construction Activity
- Ergonomics & psychosocial hazards
- General Hazards

FLAMMABILITY HAZARD

Table no. 2.2: Flammability hazards

Sr. No.	Name	CAS	LEL	UEL	Flash Point	Boiling Point	NFPA Hazard Index		
			%	%	0c	0c	N_h	N_f	N_r
1	Formaldehyde 37%	50-00-0	7	73	83	98	3	4	0
2	Formaldehyde 37% methanol free	50-00-0	NA	NA	83	98	3	2	0
3	Resorcinol	108-46-3	1.4	-	127	280	3	1	0
4	Hydrochloric Acid	7647-01-0	NA	NA	NA	101-103	3	0	0
	Bichromate	10588-81-9	NA	NA	NA	NA	NA	NA	NA
6	Cyanuric Chloride	108-77-0	NA	NA	NA	NA	NA	NA	NA
7	Vinyl Sulfone	77-77-0	NA	NA	102	234	NA	NA	NA
8	*Metanilic acid	121-47-1	NA	NA	NA	NA	NA	NA	NA
9	Sodium Nitrite	7632-00-0	NA	NA	NA	Decompose	NA	NA	NA
10	*Sulfanilic Acid	121-57-3	NA	NA	-	-			

*Sulfonic acids: BDSA – Benzidine 2,2'di sulfonic acid CAS 117-61-3, PA2SA - Para Anisidine -2 sulfonic acid etc .

NFPA 704 M Hazard Index, Scale 1 to 4.

The Highest NFPA flammability Hazard (Nf) Rating is 3 for 3 chemicals

TOXICITY HAZARD

Table no. 2.3: Toxicity Hazards

Sr. No.	Name	NFPA Hazard Index	TLV	STEL	IDLH	Oral LD50	Dermal LD50	Inhal. LC50
		Nh	Ppm	Ppm	Ppm	mg/kg.	mg/kg.	mg/m3
1	Resorcinol	3	10	20	NA	301	3360	NA
2	Formaldehyde	3	0.3	NA	20	100	270 ul/kg	203
3	Hydrochloric Acid	3	5	NA	NA	900	-	3124
4	Bichromate	NA	NA	NA	15 mg/m3 As Cr (VI)	NA	NA	NA
5	Sodium Nitrite	NA	NA	NA		175	NA	NA
6	Vinyl Sulfone	NA	NA	NA		32	NA	NA

NFPA 704 M Hazard Index, Scale 1 to 4.

The Highest NFPA Health Hazard Rating is 3

Source: MSDS

2.5 INVENTORY ANALYSIS

2.5.1 INVENTORY

TABLE NO. 1.2: Product wise Raw material consumption in Kg/T of product

Sr. no.	Product → Raw material ↓	Reactive Blue P3R	Reactive Blue MX7R	Reactive Black B	Reactive Blue 49	Reactive Green HE4BD
1	BDSA	51.0			76.0	
2	Bichromate	219	219		219	
3	Cyanuric Chloride	73.0			123.0	
4	Formaldehyde					183.0
5	H acid			51.4		
6	Hydrochloric Acid			38.00		472.0
7	IBAMSA	219	219		219	
8	Iron powder	256	256		256	
9	Metanilic acid	121.9	121.9		121.9	
10	Nadapsa	135	135		135	
11	$NaHCO_3$			42.0		
12	PA2SA	134	134		134	
13	Resorcinol					139.0
14	Salt	97.56	97.56		97.56	
15	Soda Ash					236.0
16	Sodium Nitrite			23.4		136.0
17	Sulfanilic Acid					333.0
18	VS			95.2		
19	Water	731.0	731.0		731.0	

Table no. 2.5: Inventory

Sr. No.	**Name**	**Maximum Quantity Stored T**	**Mode of Storage**	**Consumption TPM**	**Inventory level for number of days**
1	Iron powder	8.960	Bags	8.960	30 days
2	Bichromate	7.665	Bags	7.665	30 days
3	IBAMSA	7.665	Bags	7.665	30 days
4	Hydrochloric Acid	5.100	Carboys	5.100	30 days
5	NADAPSA	4.725	Bags	4.725	30 days
6	PA2SA	4.690	Bags	4.690	30 days
7	Metanilic acid	4.267	Bags	4.267	30 days
8	Salt	3.415	Bags	3.415	30 days
9	Sulfanilic Acid	3.330	Bags	3.330	30 days
10	Cyanuric Chloride	2.690	Drums	2.690	30 days
11	Soda Ash	2.360	Bags	2.360	30 days

Sr. No.	Name	Maximum Quantity Stored T	Mode of Storage	Consumption TPM	Inventory level for number of days
12	Formaldehyde	1.830	Drums	1.830	30 days
13	BDSA	1.780	Bags	1.780	30 days
14	Sodium Nitrite	1.594	Bags	1.594	30 days
15	Resorcinol	1.390	Bags	1.390	30 days
16	Vinyl Sulfone	0.952	carboys	0.952	30 days
17	H acid	0.514	Bags	0.514	30 days
18	Sodium bi carbonate	0.420	Bags	0.420	30 days

TABLE NO. 2.6: HAZARDOUS CHEMICALS CLASSIFICATION

Group		Material	Max. Storage Capacity	Threshold Qty. Mt. **
2	Toxic chemicals	Formaldehyde Conc. > 90 %.	Nil *	5
5.3	Very Highly Flammable Liquids.	Chemicals having flash point ≤ 230 C & boiling point < 350 C	Nil	1500
5.5	Highly Flammable Liquids.	Chemicals having 230 C < flash point ≤ 600C	LDO /HSD	2500
5.6	Flammable Liquids.	Chemicals having 600C < flash point < 900 C	NIL	5000

*Not applicable as 37 % solution is used

The site is not Major Accident Hazards Installation (MAH)

**Criteria used: "Manufacture Storage and Import of Hazardous Chemicals Rules, 1989".

2.6 Relative ranking

2.6.1 DOW F&E Index

Identification of hazardous units and segments of plants and storage units based on "Relative Ranking Technique," such as Fire and Explosion Index. F & EI, is a method universally adopted for classifying/ categorizing/ indexing of chemicals based on their reactivity and instability. The assessment is carried out as per the Dow's Fire and Explosion Index hazard Classification Guide 7 th edition , 1994 . Work sheet enclosed in annexure 2.

Table No. 2.7: DOW F & E INDEX

Sr. No.	Installation	DOW F&E Index	The Degree Of Hazard	Toxicity Index	Toxicity Category
2	Hydrochloric acid	2	Light	7.3	II
3	Formaldehyde 37%	2	Light	7.3	II

2.6.2 MOND index assessment

The MOND Index is a rapid hazard assessment method for use on chemical plant or in plant design. The use of this technique puts the hazard of a plant on a numerical scale, where the comparative pictures of all subdivisions of the plant form emerge. The assessment is carried out as per MOND INDEX Manual 1993. Work sheet enclosed in annexure 3.

TABLE NO. 2.8: MOND INDEX ASSESSMENT

Sr. No.	Installation	Equivalent DOW Index	Fire Index	Internal Explosion Index	Aerial Explosion Index	Over All Hazard Rating
1	Formaldehyde 37%	25	Light 0.45	Moderate 3.0	Light 0.23	Low 30

Formaldehyde storage area Hazard index is Low due to less inventory.It is reasonable to assume that a unit assessed at this level after off setting measures can be operated in a satisfactory manner by providing adequate off setting measures, giving full regard to the hazards indicated by the assessment however it depends heavily upon the maintenance of the hardware and of the management procedures; neglect of either will lead to loss of protection and the rating will rise to the above estimated value .

2.7 COMPATIBILITY/ REACTIVITY HAZARD

2.7.1 Hazardous RM Storage Area

TABLE NO. 2.9: COMPATABILITY /REACTIVITY HAZARD MATRIX

	Chemicals Mixing With →	1	2	3	4	5	6	7	8
1	4-Aminobenzene Sulfonic Acid								
2	Cyanuric Chloride	N							
3	Divinyl Sulfone	N	N	SR					
4	Formaldehyde, Solutions (Flammable)	N	N	N					
5	Formaldehyde, Solutions (Formalin) (Corrosive)	N	N	N	N	SR			
6	Hydrochloric Acid, Solution	N	N	N	N	N			
7	Sodium Nitrite	N	N	N	N	N	N		
8	Water	C	N	C	Y	C	C	Y	

CHART LEGEND

Y	Compatible	-	No hazardous reactivity issues expected
N	Incompatible	-	Hazardous reactivity issues expected
C	Caution	-	May be hazardous under certain conditions
SR	Self reactive	-	Potentially self reactive e.g. polymerizable

Reactivity and compatability hazard work sheet enclosed under HAZOP Study annexure no 6.

Risk mitigation

Store chemicals considering the compatibility and reactivity hazards for separation at store

2.7.2 Transformation products

Table No. 2.10:Transformation If Any Which Could Occur

SR. NO.	NAME	Hazards due to gases released decpmposition , transformation during fire condition
1	Cyanuric chloride	Rapid hydrolysis in presence of water containing solvent , acid catalysed reactions release of hydrogen chloride gas
2	Hydrochloric acid	When heated to decomposition, emits toxic hydrogen chloride fumes and will react with water or steam to produce heat and toxic and corrosive fumes. Thermal oxidative decomposition produces toxic chlorine fumes and explosive hydrogen gas.
3	Formaldehyde	May form carbon dioxide, carbon monoxide, and formaldehyde when heated to decomposition.
4	Sodium nitrite	Contact with oxidizable substances may cause extremely violent combustion
5	Resorcinol	Reacts with strong oxidants ammonia and amino compounds causing fire and explosion hazard.
6	Vinyl sulfone	Polymerizable
7	Bi chromate	Toxic Chromium oxide fumes may be formed in fire

Risk mitigation

a) Store chemicals considering the compatibility and reactivity hazards for segregations at store.
b) Smoke detector at store

2.8 HAZOP STUDY

2.8.1 The methodology used as per Hazard Identification and Hazard Analysis Techniques of Hazard Identification And Risk Analysis – Code Of Practice IS 15656: 2006.

2.8.2 Manufacturing Process description , flow chart and material balance are available enclosed In EIA report

2.8.3 product wise unit processes &operations

TABLE NO. 2.11.:PRODUCT WISE UNIT PROCESSES & OPERATIONS

Sr. no.	Product name	Reactive Blue P3R	Reactive Blue MX7R	Reactive Black B	Reactive Blue 49	Reactive Green HE4BD
1	Condensation					√
2	Coupling	√		√	√	√
3	Diazotization	√		√	√	√
4	Filtration	√	√		√	√
5	Iron acid reduction	√	√		√	√
6	Packing	√	√	√	√	√
7	Spray Drying	√	√		√	
8	Spray drying /	√	√		√	
9	Washing	√	√		√	√

2.8.4 Identification of hazards by HAZOP study is carried out for following nodes , the thrust area being the environmental issues in the proposed activities. The HAZOP Study carried out under batch wise modes following NODES

Table No. 2.12: **NODES FOR HAZOP STUDY**

NODE 1 Product Reactive Blue P3R

NODE 2 Product Reactive Blue MX7R

NODE 3 Product Reactive Black B

NODE 4 Product Reactive Blue 49

NODE 5 Product Reactive Green HE4BD

2.8.5 HAZOP worksheets are enclosed as annexure 6 .

2.8.6 Hazard are identified and risk evaluated for each identified hazard on the scale 1 to 25 using the hazard rating matrix given in table 2.12

Table No. 2.13: HAZARD RATING MATRIX.

	SEVERITY					
PROBABILITY		Very High (5)	High. (4)	Moderate (3)	Slight (2)	Nil. (1)
	Very Likely. (5)	25	20	15	10	05
	Likely. (4)	20	16	12	08	04
	Quite Possible (3)	15	12	09	06	03
	Possible. (2)	10	08	06	04	02
	Not Likely. (1)	05	04	03	02	01

2.8.6 HAZARDS

Identified hazards/ events having risk rating in 16 to 25 range are highlighted in the table no . 2. 13

Table No. 2.14: IDENTIFIED HAZARDs

Sr.No	Hazard
1	Cyanuric chloride toxic gas release during charging of the batch .
2	Scrubber failure releasing toxic gases at vent of the scrubber
3	Reactivity and compatibility hazards at storage of raw materials
4	Hazardous Solid waste especially Iron sludge storage and transport containing residual material .
5	Health hazard due to emissions in Formaldehyde handling at work place.
6	Environmental risk - POCP of formaldehyde handling .
7	Fire tender and Emergency vehicles movement at back side gate may be affected due to reduced width .
8	Organic contaminated water generated during fire fighting operations may enter the storm drain .
9	Presence of heavy metals like chromium in effluent .
10	Hydrochloric acid spill and emission of hydrogen chloride gas at work place .

SECTION 3 CONSEQUENCE ANALYSIS

3.1 INTRODUCTION

1	Large Spill of Hydrochloric acid and dispersion of hydrogen chloride gas down wind.
2	Release of Formaldehyde .

These accident scenarios are divided in two categories considering the consequence seriousness and occurrence frequency.

- MAXIMUM CREDIBLE LOSS SCENARIO (MCLS).
- WORST POSSIBLE SCENARIO.

MAXIMUM CREDIBLE LOSS SCENARIO (MCLS)

Maximum Credible Loss Scenario (MCLS) is one of the methodologies evolved to access the events in realistic and practical way. An MCLS can be described as the worst "credible" accident or as an accident with a maximum damage distance, which is still believed to be probable. The analysis, however, does not include a quantification of the probability of occurrence of an accident. The MCLS aims at identifying undesirable and hazardous events causing the Maximum damage to human beings environment around the industry under the consideration.

Leak from hose/ piping failure are quite probable events. Such accidental release is considered as MCLS.

WORST POSSIBLE SCENARIO

Worst Case Scenario/ MCA (Maximum Credible Accident) Accident Scenario accidental release of Hydrochloric acid and dispersion downwind is considered as Worst Case Scenario/ MCA (Maximum Credible Accident).

Table No. 3.1 A: Affect distance (dispersion)

Sr.		**Downwind Affect Distance (m)**					
No.	Accident Scenario	Toxic vapor cloud				Flammable vapor cloud LEL	
		PAC 3	PAC 2	PAC 1	IDLH	60 %	10 %
1	Hydrogen chloride dispersion	38	84	308	55	NA	NA

Table No. 3.1 B : Affect distance (VCE & Pool Fire scenarios)

Sr.		**Downwind Affect Distance (m)**					
No.	Accident Scenario	Blast Over Pressure psi			Thermal radiation (KW/m2)		
		8	3.5	1.0	10	5	2
2	Formaldehyde pool fire.	NA	NA	NA	<10	<10	<10

NOTE:

1. **ATMOSPHERIC DATA**

Wind	from West at 1.5 m/s	Stability Class	F	Cloud cover	5 tenth
No Inversion		Relative Humidity	50 %	Air temperature	30 °C

2. Consequences zones have been calculated using software ALOHA and also software based on the "TNO Yellow Book". Method for calculation of the Physical Effects of the escape of Dangerous Material (Liquid & Gases) Published by the Directorate General of Labour, Ministry of Social Affair, Netherlands(1979).

3. Apart from the maximum credible releases, the conservative approach appears in adoption of atmospheric conditions, used in the dispersion calculation. In general, the assumptions/ conditions will result in the largest damage distances. Hence, it must be remembered that this analysis will be pessimistic & conservative in approach & is only a planning tool. Its use should not be extended without understanding its limitations.

4. DISCLAIMER:

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SECTION 4: IMPACT ASSESSMENT.

4.1 TOXIC GAS RELEASE

4.1.1 Hydrogen chloride gas release from Hydrochloric acid spill

Hydrogen Chloride (HCl) is a colorless, corrosive, toxic gas with a pungent, irritating odor. HCl is miscible in water. HCl is an irritant to eyes, skin, and mucous membranes. HCl has a low threshold limit value (TLV) and is detectable by odor at concentrations lower than those necessary to cause physical harm or impairment. The most serious hazard presented by Hydrogen chloride is exposure to a large release from which escape is impossible. Following Table describes various health effects of Hydrogen Chloride exposure.

MARPLOT : **Hydrogen chloride gas release**

VULNERABLE ZONE PAC conc.

EVENT FREQUENCY: 9.2 ò 10^{-4} per Year

VULNERABLE ZONE PAC 1 Conc.

EVENT FREQUENCY: 9.2 ò 10^{-4} per Year

VULNERABLE ZONE IDLH conc .

EVENT FREQUENCY: 9.2 ò 10^{-4} per Year

HEALTH EFFECTS OF HYDROGEN CHLORIDE EXPOSURE.

CONCENTRATION	CONCENTRATION SYMPTOMS OF EXPOSURE
< 1 ppm	Odor Threshold.
10 - 50 ppm	Irritation of the eyes and mucous membranes, which can be tolerated or several hours.
50 - 100 ppm	Immediate irritation of the throat, which may be tolerated for an hour.
1000 - 1300 ppm	A dangerous health hazard, even for short periods of time.

NOTE: Exposure to concentrations in excess of 1300 ppm may cause laryngeal spasms, resulting in death.

PROBABILITY OF FATALITY OF HYDROGEN CHLORIDE EXPOSURE.

EXPOSURE TIME [minutes]	PROBIT	MORTALITY RATE* [percent]	HCl Concentration [ppm]
5	2.67	1	3,465
	5.00	50	11,110
	7.33	99	35,616

* Percent of exposed population fatally affected.

It is estimated that Hydrogen chloride gas dispersion up to 30 m downwind persons need to be evacuated as ERPG 3 concentration is likely.

It is pertinent to note that Hydrogen chloride can react with water and/or water vapor/moisture. This can affect the evaporation rate and downwind dispersion. The resultant gas as air born Hydrochloric acid mist is likely.

Following figure shows the water bodies locations from site

4.1.2 Formaldehyde (containing methanol) spill

Effects of formaldehyde in humans after short-term exposure

Concentration	**range or average(mg/m3)**	**Time range or average Health effects in general population**
0.03	Repeated exposure	Odour detection threshold (10th percentile) *a*
0.18	Repeated exposure	Odour detection threshold (50th percentile) *a*
0.6	Repeated exposure	Odour detection threshold (90th percentile) *a*
0.1 – 3.1	Single and repeated exposure	Throat and nose irritation threshold
0.6–1.2	Single and repeated exposure	Eye irritation threshold
0.5 – 2	3–5 hours	Decreased nasal mucus flow rate
2.4	40 minutes on 2 successive days with 10 minutes of moderate exercise on second day	Post-exposure (up to 24 hours) headache
2.5 – 3.7	– *b*	Biting sensation in eyes and nose
3.7	Single and repeated exposure	Decreased pulmonary function only at heavy exercise
5 – 6.2	30 minutes	Tolerable for 30 minutes with lachrymation
12 – 25	– *b*	Strong lachrymation, lasting for 1 hour
37 – 60	– *b*	Pulmonary oedema, pneumonia, danger to life
60 – 125	– *b*	Death

4.2 THERMAL RADIATION

FATAL THERMAL RADIATION EXPOSURE LEVELS

RADIATION LEVEL KW/m^2	SECONDS EXPOSURE FOR A % FATALITY LEVELS		
	1 %	50 %	99 %
1.6	500	1300	3200
4.0	150	370	930
12.5	30	80	200
37.5	8	20	50

EFFECTS OF THERMAL RADIATION ON UNPROTECTED SKIN

RADIATION LEVEL (KW/m^2)	DURATION PERIOD SECONDS BEFORE	
	Pain is Felt	Blistering Starts
22	02.0	03.0
18	02.5	04.3
11	05.0	08.5
08	08.0	13.5
05	16.0	25.0
2.5	40.0	65.0
Below 2.5	Prolonged exposure can.	be tolerated.

It is estimated that thermal radiation of 10 kw/m2 are likely < 10 m from pool fire and person failed to take shelter within 90 second is 1% probability of fetality .

4.3 OVER PRESSURE IMPACT

EFFECT OF BLAST PRESSURE WAVE

OVER PRESSURE (bar)	EFFECTS
0.01	Shattering of glass windows. Failure of panels.
0.03	Shattering of asbestos siding.
0.1	Collapse of steel framing panels.
0.3	Shearing of brick walls (8-12 inches)

No significant explosion anticipated .

SECTION 5 FAILURE FREQUENCY ANALYSIS.

5.1 Flange gasket failure/ gland failure. An accident/ event for gasket leakage/ failure can be termed as “quite probable”. The hole size in a gasket failure may be that due to complete section between bolt holes or something much smaller. The hole size for a complete section failure of a gasket is usually calculated.

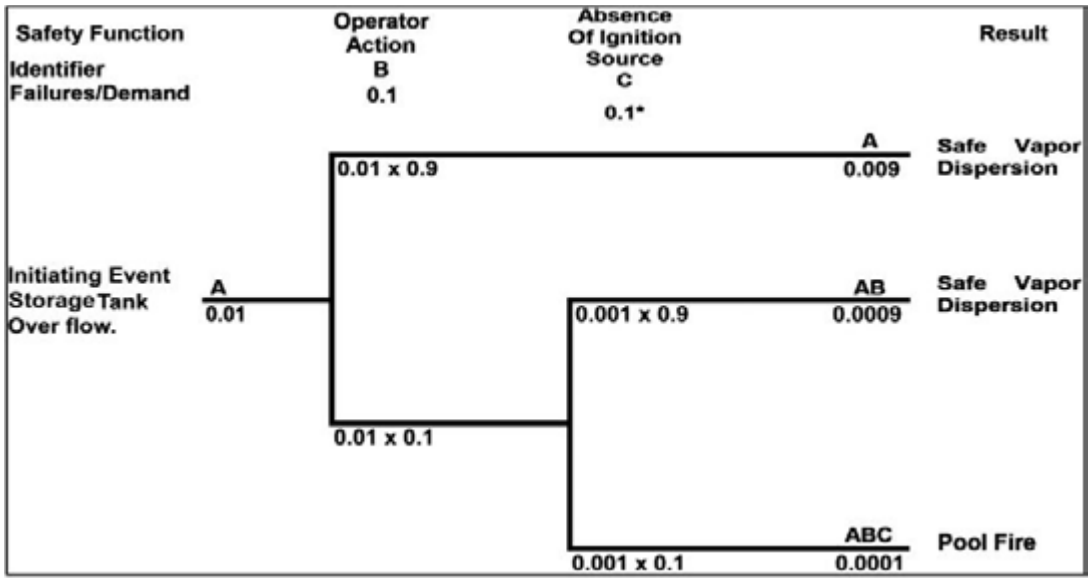
5.2 Failure of transfer line. The possible route of hazardous material going out of containment in open atmosphere is the rupture of a transfer line. The case of guillotine type failure of tanker unloading hose / transfer line or bottom nozzle undergoing guillotine type of failure also are rather low. Failure frequency as per published literature for such lines is low and such events can be considered, “foreseeable”.

5.3 Accidental spill of flammable solvent and uncontrolled spreading pool followed by fire is considered as Worst Possible Scenario. It is to be noted that loss caused due to this event is very high but the probability is low; however, in case of neglect of maintenance or natural calamities such as earthquake the possibility exists. Such events are unlikely to happen and are not credible. Failure frequency of catastrophic rupture of such pressure vessel is very low i.e. 3 per million per year.

5.4 EVENT TREE

Event trees begin with an initiating event and work toward a final result. This approach is inductive. The method provides information on how a failure can occur and the probability of occurrence. Frequency of the incident is estimated by Event Tree.

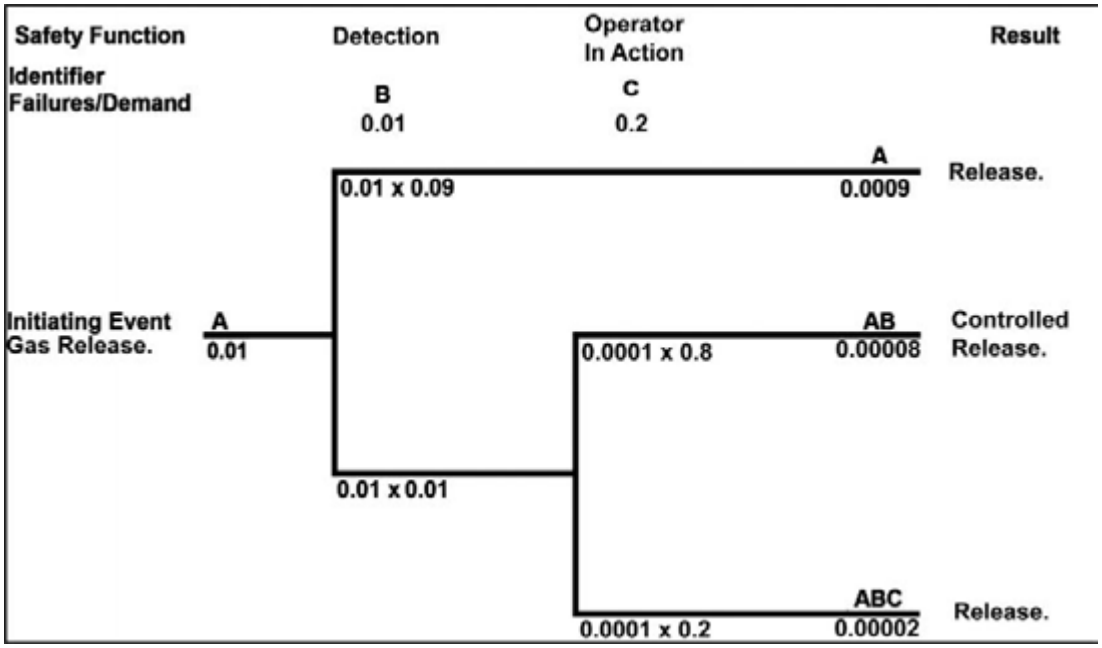
Event Tree-Formaldehyde (Containing Methanol) spill



Pool fire frequency = 0.0001;

*0.1 if distance to 50 % LFL falls inside electrically classified area.other wise 0.5

Event Tree – Non Flammable Toxiv Gas – Hydrogen Chloride Release



Toxic Cloud Release Frequency = 0.0009 + 0.00002
= 9.2×10^{-4}.

1.11.2 Frequency of the incident estimated by Event Tree.

S.N.	EVENT	EVENT FREQUENCY/ YR
1	Hydrogen chloride dispersion	9.2×10^{-4}
2	Formaldehyde pool fire.	1.0×10^{-4}

SECTION 6 :RISK ESTIMATION.

6.1 INDIVIDUAL RISK

Individual Risk (IR) = $(1/N) \sum Ii \times fi$

where
N = number of persons (75 nos.)
i Incident identification number
I, = impact of Incident i
fi = frequency of the i incident

S.N.	Incident	Level of concern	Status at Assembly Point	Fatality %
1	Hydrogen chloride release	32 65 ppm for 5 minutes	At worker room Outside 3540 ppm Inside 1240 ppm At Assembly Outside 176 ppm Inside 61.8 ppm	0
2	Formaldehyde (containing Methanol) pool fire	10 kw m2 therma; radiations	Not reached at assembly poing	1*

*Unless take shelter within 90 seconds from pool fire edge .

It is estimated that Individual risk to worker(5 nos, assumed) at worker room and assembly point (20 nos. max.) is 1.84 x 10^{-6} /yr and < 1 x 10^{-6} /yr respectively .

A broadly acceptable level of individual risk as per the ALARP (As low as reasonably practicable) concept of HSE, UK is 10^{-6}/ year.

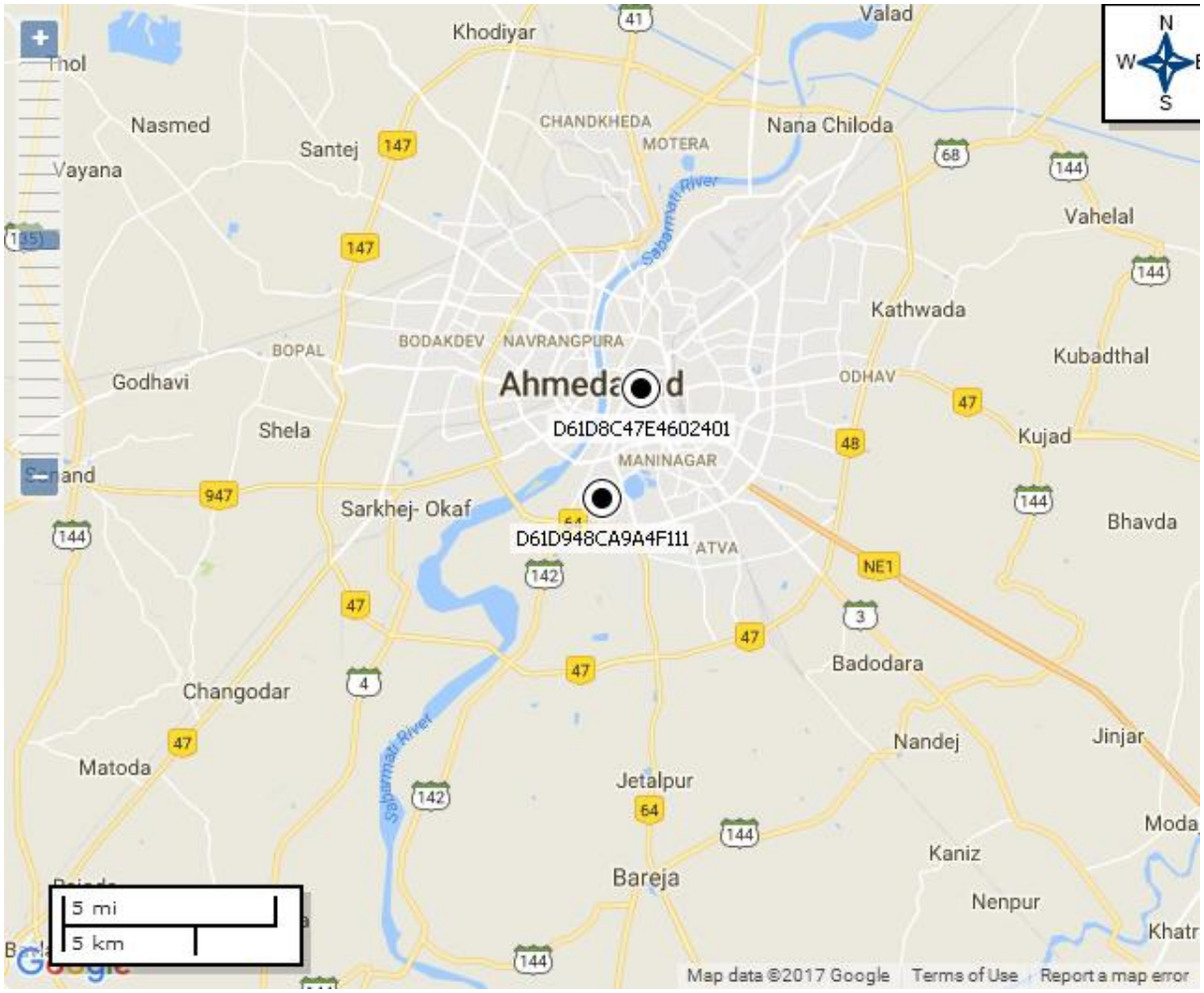
INDIVIDUAL FATALITY CRITERIA

Individual Fatality	Individual Fatality Criteria
1×10^{-4} per yr	This contour remains on-site.
1×10^{-5} per yr	This contour extends into industrial developments only.
1×10^{-6} per yr	This contour extends into commercial and industrial developments only.

Table 6.3 : SOCIETAL RISK

Sr. No.	Event	Event Frequency Per Year	No. Of Fatality	Cumulative Frequency
1	Formaldehyde (containing Methanol) pool fire	1.0×10^{-4}	1	1.00×10^{-4}
2	Hydrogen chloride dispersion	9.2×10^{-4}	0	1.02×10^{-3}

SITE SURROUNDINGS



The population in surrounding is significant .

SECTION 7 : RISK MITIGATION MEASURES.

Following risk mitigation measures are suggested

7. Provide Closed arrangement for charging of Cyanuric Chloride to reactor .

8. Hydrogen chloride leak detector at plant and Cyanuric chloride store .

9. Storage of raw materials at store considering the compatibility and reactivity hazards at store.

.

10. Hydrogen Chloride gas liberated in cyanuration reactor can be scrubbed by water in multiple scrubbers to get 30 % hydrochloric acid from the first scrubber .

11. Fire protection system .

12. Formaldehyde handling

c) Provide SOP for Formaldehyde storage and handling operations with thrust on medical surveillance, hazard communication to employees, PPE, Spill procedures confirming to OSHA Formaldehyde standard 29 CFR 1910.1048.

d) Provide scrubber and connect all vents releasing formaldehyde to scrubber.

7. Safety Shower & Eye Wash Fountains and Personnel Protective Equipment (PPE)

8. Suitable arrangement at storm drain to avoid any organic contaminated water/ spill/ fire water going out of the site.

9 Effective washing of the sludge to make it free of retained product .

10. “DMP” based on MCLS Analysis for the site with dove tailing data for "Offsite Disaster Control Plan".

1.15 We thank the staff and the management for positive approach shown and excellent co-operation extended throughout the studies to complete the studies in scheduled time frame.

ANNEXURE 1 DOW F & E INDEX WORKSHEETS

PLANT:			TANK FARM.	
MATERIALS AND PROCESS:			HYDROCHLORIC ACID.	
MATERIAL FACTOR:			1	
			PENALTY FACTOR RANGE	PENALTY FACTOR USED
1.	GENERAL PROCESS HAZARDS			
	Base Factor.		1.0	1.0
A.	Exothermic Chemical Reactions.		0.30 to 1.25	00
B.	Endothermic Process.		0.20 to 0.40	00
C.	Material Handling & Transfer.		0.25 to 1.05	0.0
D.	Enclosed or Indoor Process Unit.		0.25 to 0.90	00
E.	Access.		0.20 to 0.35	00
F.	Drainage and spill control.		0.25 to 0.50	0.0
	General Process Hazards Factor (F_1).			1.0
2.	SPECIAL PROCESS HAZARDS			
	Base Factor.		1.0	1.0
A.	Toxic Materials.		0.20 to 0.80	0.6
B.	Sub – Atmospheric Pressure.		0.50	00
C.	Operation in or Near Flammable Range Inerted.		–	–
	1.	Tank Farm Storage Flammable Liquids.	0.0	–
	2.	Process Upset or Purge Failure.	0.3	–
	3.	Always in Flammable Range.	–	–
D.	Dust Explosion.		0.25 to 2.0	00
E.	Pressure Operating atmospheric; Relief Setting -		–	00
F.	Low Temperature.		0.20 to 0.50	00
G.	Quantity of Flammable/ Unstable Material Quantity; 5.1 MT		–	–
	1.	Liquid or Gases in Process.	–	–
	2.	Liquid or gases in Storage.	–	–
	3.	Combustible Solids in Storage.	–	–
H.	Corrosion and Erosion.		0.10 to 0.75	0.1
I.	Leakage – Joint and packing.		0.10 to 1.50	0.1
J.	Use of fired heaters.		–	00
K.	Hot Oil Heat Exchange system		0.15 to 1.15	00
L.	Rotating Equipment.		0.5	00
	Special Process Hazards Factor (F_2)			1.8
Unit Hazards Factor ($F_1 \times F_2 = F_3$).				1.8
Fire and Explosion Index ($F_3 \times$ MF) (F & IE).				2
THE DEGREE OF HAZARD.				LIGHT
RADIUS OF EXPOSURE.				–
DAMAGE FACTOR.				–
AREA OF EXPOSURE.				–
T = [250 + 125 (1 + 1 + 1.8)] = 725.			T	7.3 Cat II.

PLANT:			TANK FARM.	
MATERIALS AND PROCESS:			FORMALDEHYDE 37%.	
MATERIAL FACTOR:			10	
			PENALTY FACTOR RANGE	PENALTY FACTOR USED
1.	GENERAL PROCESS HAZARDS.			
	Base Factor.		1.0	1.0
A.	Exothermic Chemical Reactions.		0.30 to 1.25	00
B.	Endothermic Process.		0.20 to 0.40	00
C.	Material Handling & Transfer.		0.25 to 1.05	0.25
D.	Enclosed or Indoor Process Unit.		0.25 to 0.90	00
E.	Access.		0.20 to 0.35	00
F.	Drainage and Spill Control.		0.25 to 0.50	0.0
	General Process Hazards Factor (F_1).			1.25
2.	SPECIAL PROCESS HAZARDS.			
	Base Factor.		1.0	1.0
A.	Toxic Materials.		0.20 to 0.80	0.4
B.	Sub – Atmospheric Pressure.		0.50	00
C.	Operation in or Near Flammable Range Inerted.		–	–
	1.	Tank Farm Storage Flammable Liquids.	0.0	–
	2.	Process Upset or Purge Failure.	0.3	–
	3.	Always in Flammable Range.	–	–
D.	Dust Explosion.		0.25 to 2.0	00
E.	Pressure Operating atmospheric; Relief Setting.			00
F.	Low Temperature.		0.20 to 0.50	00
G.	Quantity of Flammable/ Unstable Material Quantity 1.8 Kl. MT., Hc -- $\times 10^3$ BTU/Lb.		–	–
	1.	Liquid or Gases in Process.	–	–
	2.	Liquid or gases in Storage.	–	00
	3.	Combustible Solids in Storage.	–	–
H.	Corrosion and Erosion.		0.10 to 0.75	0.1
I.	Leakage – Joint and packing.		0.10 to 1.50	0.1
J.	Use of fired heaters.		–	00
K.	Hot Oil Heat Exchange system > 210 ft.		0.15 to 1.15	00
L.	Rotating Equipment.		0.5	00
	Special Process Hazards Factor (F_2)			1.6
Unit Hazards Factor ($F_1 \times F_2 = F_3$).				2.0
Fire and Explosion Index ($F_3 \times$ MF) (F & IE).				20
THE DEGREE OF HAZARD.				LIGHT
RADIUS OF EXPOSURE.				5.1 meter
DAMAGE FACTOR.				0.13
T = {250 +125×(1 + 1.25 + 1.6)}/100 = 7.31			T	Category II

Annexure 2 MOND index assessment worksheets

MOND INDEX

LOCATION : F I DYE CHEM.
: PLOT NO. 3 & 11, SIKANDAR MARKET, AHMEDABAD.
PLANT : STORE.
MATERIAL : FORMALDEHYDE 37 %.

Components	I	II	III	IV	V	Total
Composition (wt.%) X 100	0.37	0.63	0	0	0	1

	No.	Name	Material Factor
Material Factor	: I	FORMALDEHYDE.	10
	: II	WATER.	0
	: III		0
	: IV		0
	: V		0
Key Material / Mixture	:	FORMALDEHYDE.	
Factor Determined By	:	DOW INDEX.	

SPECIAL MATERIAL HAZARDS

SN.	HAZARD	INITIAL	REMARKS
1	Oxidizing materials.	0	No release of Oxygen.
2	Gives combustible gas with water.	0	Not applicable.
3	Mixing & dispersion characteristics (m).	20	Vapour denser than air.
4	Subject to spontaneous heating.	0	Not applicable
5	May rapidly spontaneously polymerize.	0	Not applicable.
6	Ignition Sensitivity.	0	Not applicable.
7	Subject to explosive decomposition.	0	Not applicable.
8	Subject to gaseous detonation.	0	Not applicable.
9	Condensed phase.	0	Not applicable.
10	Other unusual behaviour.	0	Not applicable.
TOTAL		20	M

GENERAL PROCESS HAZARDS:

SN.	HAZARD	INITIAL	REMARKS
1	Handling and physical changes only.	10	Storage only.
2	Reaction characteristics.	0	Not applicable.
3	Batch reactions.	0	Vapour denser than air.
4	Multiplicity of reaction.	0	Not applicable.
5	Material transfer.	25	Flexible hose used.
6	Transportable containers.	40	Full drum/ carbouy transported.
TOTAL		75	P

SPECIAL PROCESS HAZARDS:

SN.	HAZARD		INITIAL	REMARKS
1	Low pressure (below 15 psia).		0	Vacuum not likely.
2	High pressure (p).		0	Atmospheric press./(50mm WC). (MOND INDEX MANUAL 1993).
3	Low temp. Carbon Steel (10°C to -25°C).		0	Temp. > 10 °C.
4	High temp.	1. Flammable material.	25	Storage temperature 30°C. Stored above flash point.
		2. Material strength.		
5	Corrosion and erosion.		10	Less than 0.5 mm / year.
6	Joints and packing leakage.		20	Flange joints known to give regular leakges of minor nature.
7	Vibration, load cycling etc.		0	Not applicable.
8	Processes/reaction difficult to control.		0	No reaction.
9	Operation in or near flammable range.		0	Not applicable.
10	Greater than average explosion hazard.		0	Not applicable.
11	Dust or mist explosion hazard.		0	Not applicable.
12	High strength oxidants.		0	Only storage i.e./ no process operation.
13	Process ignition sensitivity.		0	Not applicable at storage.
14	Electrostatics hazards.		50	Sensitive to static discharge. Methanol may be present.
TOTAL			**105**	**S**

QUANTITY HAZARDS:

SN.	HAZARD		INITIAL	REMARKS
1	Material total in Tonnes.	**K**	**1.83**	

QUANTITY FACTOR:

SN.	HAZARD		INITIAL	REMARKS
1	Material.	**Q**	**14**	

LAYOUT HAZARDS:

SN.	HAZARD		INITIAL	REMARKS
1	Height in meters.	**H**	**1.2**	
2	Working area (m^2).	**N**	**15**	
3	Structure Design.		0	Base height less than 2 m from ground level.
4	Domino Effect.		0	Unit height 20 m from ground level.
5	Below Ground.		50	bruuied tank

6	Surface Drainage.	0	Curb wall provided, spillage inside working area, routed through catch pit.
7	Other.	0	Control room, canteen, work boundary more than 10 m away. Open plant.
TOTAL		**50**	**L**

ACUTE HEALTH HAZARDS:

SN.	HAZARD	INITIAL	REMARKS
1	Skin Effects	10	Causes irritation to skin.
2	Inhalation Effects	50	VP/ STEL > 10.
TOTAL		**60**	**T**

INDICES COMPUTATION:(INITIAL)

SN.	HAZARD	INITIAL	REMARKS
1	D EQUIVALENT DOW INDEX	25.56	
2	F FIRE INDEX	0.45	Light
3	E INTERNAL EXPLOSION INDEX	3.00	Modrate
4	A AERIAL EXPLOSION INDEX	0.23	Light
5	R OVERALL HAZARD RATING	30.46	Low

ANNEXURE 3: GLOSSARY

Acceptance Criteria (Risk).	:	Defines the level of risk to which an individual is exposed, as either tolerable (negligible risk), intolerable or within the ALARP region.
Consequence	:	This is the severity associated with an event in terms of toxic doses, fire or explosion etc., i.e. the potential effects of a hazardous event.
ERPG	:	The Emergency Response Planning Guidelines. ERPG 1: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odor. ERPG 2: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action. ERPG 3: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.
Frequency	:	This is the number of occurrences of an event expressed per unit time. It is usually expressed as the likelihood of an event occurring within one year.
Hazard	:	A physical situation with the potential for human injury, damage to property, damage to the environment or some combination of these.
Hazardous Scenario	:	The identified isolatable sections and/or those which have been broken down into scenarios for specific items of equipment.
IDLH	:	Immediately Dangerous To Life And Health. The maximum concentration would not cause any escape imparting symptoms or irreversible health effects to a person exposed for 30 minutes.
Individual Risk	:	The frequency at which an individual may be expected to sustain a given level of harm from the realization of specified hazards.
Individual Risk Contours.	:	As IR (Individual Risk) is calculated at a point, calculating the IR at many points allows the plotting of IR contours, these being lines that indicate constant levels of risk. Most commonly used are the 1 chance per million-year contour and the 10 chances per million-year contour.
Individual Risk Of Fatality.	:	Individual risk with “harm” measured in terms of fatality. It is calculated at a particular point for a stationary, unprotected person for 24 hours per day, 365 days per year. Normally measured in chances of fatality per million years.
Individual Risk Of Injury.	:	Similar to individual risk of fatality, however with “harm” measured in terms of injury.
Isolatable Section.	:	A system of pipes or vessels containing the hazardous materials that are bounded by specific isolation points.

Isolation Point.	:	A point in the process, which can be used to isolate one part of the process from the rest of the system.
LEL.	:	Lower Flammability Limit. Expressed as % by volume of flammable gas in air. This is the minimum concentration of gas in air mixture which can ignite. Gas air mixtures below this concentration do not ignite.
Probability.	:	The expression for the likelihood of an occurrence of an event or an event sequence or the likelihood of the success or failure of an event on test or demand. By definition, probability must be expressed as a number between 0 and 1.
Quantitative Risk Assessment.	:	A risk assessment undertaken by combining quantitative evaluations of event frequency and consequence.
Risk.	:	The combination of frequency and consequences, the chance of an event happening that can cause specific consequences.
Reactive dyes		These are defined as coloured compounds possessing a suitable group capable of forming a covalent bond between a carbon atom of the dye ion or molecule and an oxygen, nitrogen or sulphur atom of a hydroxyl, an amino or a mercaptan group respectively of the substrate. It is suitable for dyeing wool and cotton.
TEEL	:	Temporary Emergency Exposure Limits. TEEL-1: Maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing other than mild transient health effects or perceiving a clearly defined objectionable odor. TEEL-2: Maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action. TEEL-3: Maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing life-threatening health effects.
UFL	:	Upper Flammability Limit. Expressed as % by volume of flammable gas in air. This is the maximum concentration of gas in air mixture which can ignite. Gas air mixtures above this concentration do not ignite.
Vapor Cloud Explosion	:	An accidental release of flammable liquid or gas, there is possibility that it may form a cloud which can spread along the wind direction. Delayed ignition of the cloud away from the source of release results in Vapor cloud explosion (flash back) and associated blast / over pressure effects.

ANNEXURE 4: ABBREVIATIONS

AIChE.	American Institute Of Chemical Engineers.
ALARP.	As Low As Reasonably Practicable.
BTU.	British Thermal Unit.
CCPS.	Centre For Chemical Process Safety.
DMP.	Disaster Management Plan
ECC.	Emergency Control Centre.
EIA.	Environmental Impact Assessment.
EMP.	Environment Management Plan.
F & E I.	Fire And Explosion Index.
FIG.	Figure.
HAZOP.	Hazard Operability.
HSD.	High Speed Diesel.
IDLH.	Immediately Dangerous To Life And Health.
IPL.	Independent Protection Layer.
KCal.	Kilocalories.
lb.	Pound.
LOC.	Level Of Concentration.
LOPA.	Layers Of Protection Analysis.
MCA.	Maximum Credible Accident.
MF.	Material Factor.
MIDC.	Maharashtra Industrial Development Corporation.
MoEF.	Ministry Of Environment And Forests.
MSDS.	Material Safety Data Sheet.
MT.	Metric Ton.
NFPA.	National Fire Protection Association.
PFD.	Probability Of Failure On Demand.
PHA.	Preliminary Hazard Analysis.
QRA.	Quantative Risk Assessment.
RH.	Risk Assessment And Hazard Management.
SIF.	Safety Integrated Function.
TEEL.	Temporary Emergency Exposure Limits.
UK.	United Kingdom.

ANNEXURE 5: REFERENCES

1. *Technical EIA Guidance Manual for Synthetic Organic Chemicals, prepared for the Ministry of Environment and Forests Government of India.*

2. *MOND INDEX Manual 1993.*

3. *"TNO Yellow Book". Method for calculation of the Physical Effects of the escape of Dangerous Material (Liquid & Gases) Published by the Directorate General of Labour, Ministry of Social affair, Netherlands (1979).*

4. *Frank P. Lees – Loss Prevention in the Process Industries – Volume I.*

5. *Risk Assessment for Process Industries, Loss Prevention News April - June 2001.*

6. *Techniques for assessing Industrial Hazards (World Bank Technical Paper, ISSN 0253; No. 55).*

7. *Ref. Table 3.8 – Vapor Pressure of Organic Compounds, R. H. Perry, C.C., Chemical Engineers Handbook, 5th Edition (1969) McGrow – Hill Book co. (New York, London).*

8. *Guideline for Quantitative Risk Assessment "Purple Book".*

9. *Fire Protection Manual of TAC: 1982; 9th Edition.*

10. *OSID –STD -116 amended edition – October, 2002.*

11. *The Maharashtra Fire Prevention and Life Safety Measures Act, 2006.*

Annexure 6

HAZOP STUDY

At

MANUFACTURING of synthetic organic Dyes .

For

FI DYE CHEM

at

Plot no 3 & 11, Sikandar Market
Chandola Dhal , Opp . Chandola petrol pump ,
Danilimda , Ahemadabad,
Gujarat 380 022

Prepared by

BONDE TECHNICAL SERVICES
Bonde house , plot no. RM 63,Road no. 20 ,
MIDC res ,. Zone , Dombivli (E), Maharashtra .

NOVEMBER 2017

6.1 Methodology

The methodology used as per Hazard Identification and Hazard Analysis Techniques of

Hazard Identification And Risk Analysis – Code Of Practice IS 15656: 2006.

6.2 Process description, flow chart , material balance and reactions

Process description, flow chart and material balance and reactions are available in the EIA report hence not reproduced here to avoid repetition .

6.3 Compatibility/ reactivity hazard worksheet

Chemicals and Reactive Groups in this Mixture:

1. 4-Aminobenzene Sulfonic Acid
2. Cyanuric Chloride
3. Divinyl Sulfone
4. Formaldehyde, Solution, Flammable
5. Formaldehyde, Solutions (Formalin) (Corrosive)
6. Hydrochloric Acid, Solution
7. Sodium Nitrite
8. Water

4-AMINOBENZENE SULFONIC ACID mixed with itself -
INTRINSIC REACTIVE HAZARDS:
No reaction expected.
--- END OF HAZARDS FOR THIS ITEM ---

CYANURIC CHLORIDE mixed with 4-AMINOBENZENE SULFONIC ACID -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
Reaction liberates gaseous products and may cause pressurization
Reaction products may be corrosive
Reaction products may be toxic
POTENTIAL GASES:
Hydrogen Halide
Nitrogen
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

CYANURIC CHLORIDE mixed with itself -
INTRINSIC REACTIVE HAZARDS:
No reaction expected.
--- END OF HAZARDS FOR THIS ITEM ---

DIVINYL SULFONE mixed with 4-AMINOBENZENE SULFONIC ACID -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
May be hazardous but unknown
Polymerization reaction may become intense and may cause pressurization
Reaction may be particularly intense, violent, or explosive
POTENTIAL GASES:
No gases predicted.
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

DIVINYL SULFONE mixed with CYANURIC CHLORIDE -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
Polymerization reaction may become intense and may cause pressurization
Reaction may be particularly intense, violent, or explosive
POTENTIAL GASES:
No gases predicted.
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

DIVINYL SULFONE mixed with itself -
INTRINSIC REACTIVE HAZARDS:
Potentially self-reactive. See referenced documentation provided in the Chemical Reactivity Worksheet.
--- END OF HAZARDS FOR THIS ITEM ---

FORMALDEHYDE, SOLUTION, FLAMMABLE mixed with 4-AMINOBENZENE SULFONIC ACID -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
Reaction may be particularly intense, violent, or explosive
Reaction products may be corrosive
POTENTIAL GASES:
No gases predicted.
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

FORMALDEHYDE, SOLUTION, FLAMMABLE mixed with CYANURIC CHLORIDE -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
Reaction liberates gaseous products and may cause pressurization
Reaction may be particularly intense, violent, or explosive
Reaction products may be corrosive
Reaction products may be toxic
POTENTIAL GASES:
Acid Fumes
Carbon Dioxide
Hydrogen Chloride
Hydrogen Halide

--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

FORMALDEHYDE, SOLUTION, FLAMMABLE mixed with DIVINYL SULFONE -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
Polymerization reaction may become intense and may cause pressurization
Reaction liberates gaseous products and may cause pressurization
Reaction products may be flammable
Reaction products may be toxic
POTENTIAL GASES:
Carbon Monoxide
Hydrogen
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

FORMALDEHYDE, SOLUTION, FLAMMABLE mixed with itself -
INTRINSIC REACTIVE HAZARDS:
No reaction expected.
--- END OF HAZARDS FOR THIS ITEM ---

FORMALDEHYDE, SOLUTIONS (FORMALIN) (CORROSIVE) mixed with 4-AMINOBENZENE SULFONIC ACID -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
May be hazardous but unknown
Polymerization reaction may become intense and may cause pressurization
Reaction may be particularly intense, violent, or explosive
POTENTIAL GASES:

No gases predicted.
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

FORMALDEHYDE, SOLUTIONS (FORMALIN) (CORROSIVE) mixed with CYANURIC CHLORIDE -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
Polymerization reaction may become intense and may cause pressurization
Reaction may be particularly intense, violent, or explosive
POTENTIAL GASES:
No gases predicted.
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

FORMALDEHYDE, SOLUTIONS (FORMALIN) (CORROSIVE) mixed with DIVINYL SULFONE -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
May be hazardous but unknown
Polymerization reaction may become intense and may cause pressurization
Reaction liberates gaseous products and may cause pressurization
Reaction products may be flammable
Reaction products may be toxic
POTENTIAL GASES:
Carbon Monoxide
Hydrogen
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

FORMALDEHYDE, SOLUTIONS (FORMALIN) (CORROSIVE) mixed with FORMALDEHYDE, SOLUTION, FLAMMABLE -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
Polymerization reaction may become intense and may cause pressurization
POTENTIAL GASES:
No gases predicted.
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

FORMALDEHYDE, SOLUTIONS (FORMALIN) (CORROSIVE) mixed with itself -
INTRINSIC REACTIVE HAZARDS:
Potentially self-reactive. See referenced documentation provided in the Chemical Reactivity Worksheet.

--- END OF HAZARDS FOR THIS ITEM ---

HYDROCHLORIC ACID, SOLUTION mixed with 4-AMINOBENZENE SULFONIC ACID -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
Reaction may be particularly intense, violent, or explosive
Reaction products may be corrosive
Reaction products may be toxic
POTENTIAL GASES:
No gases predicted.
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

HYDROCHLORIC ACID, SOLUTION mixed with CYANURIC CHLORIDE -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
Reaction liberates gaseous products and may cause pressurization
Reaction may be particularly intense, violent, or explosive
Reaction products may be corrosive
Reaction products may be toxic
Reaction products may be unstable above ambient temperatures
POTENTIAL GASES:
Acid Fumes
Carbon Dioxide
Hydrogen Chloride
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

HYDROCHLORIC ACID, SOLUTION mixed with DIVINYL SULFONE -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
Polymerization reaction may become intense and may cause pressurization
Reaction liberates gaseous products and may cause pressurization
Reaction may be particularly intense, violent, or explosive
Reaction products may be flammable
Reaction products may be toxic
POTENTIAL GASES:
Hydrocarbons
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

HYDROCHLORIC ACID, SOLUTION mixed with FORMALDEHYDE, SOLUTION, FLAMMABLE -

PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
Polymerization reaction may become intense and may cause pressurization
Reaction liberates gaseous products and may cause pressurization
Reaction products may be corrosive
POTENTIAL GASES:
Acid Fumes
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

HYDROCHLORIC ACID, SOLUTION mixed with FORMALDEHYDE, SOLUTIONS (FORMALIN) (CORROSIVE) -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
Polymerization reaction may become intense and may cause pressurization
Reaction may be particularly intense, violent, or explosive
POTENTIAL GASES:
No gases predicted.
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

HYDROCHLORIC ACID, SOLUTION mixed with itself -
INTRINSIC REACTIVE HAZARDS:
No reaction expected.
--- END OF HAZARDS FOR THIS ITEM ---

SODIUM NITRITE mixed with 4-AMINOBENZENE SULFONIC ACID -
PREDICTED HAZARDS:
Reaction liberates gaseous products and may cause pressurization
Reaction products may be corrosive
Reaction products may be explosive or sensitive to shock or friction
Reaction products may be toxic
Reaction products may be unstable above ambient temperatures
POTENTIAL GASES:
Nitrogen Oxides
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

SODIUM NITRITE mixed with CYANURIC CHLORIDE -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
Reaction may be particularly intense, violent, or explosive
Reaction products may be explosive or sensitive to shock or friction

POTENTIAL GASES:
No gases predicted.
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

SODIUM NITRITE mixed with DIVINYL SULFONE -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
Polymerization reaction may become intense and may cause pressurization
Reaction products may be explosive or sensitive to shock or friction
POTENTIAL GASES:
No gases predicted.
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

SODIUM NITRITE mixed with FORMALDEHYDE, SOLUTION, FLAMMABLE -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
Reaction products may be explosive or sensitive to shock or friction
POTENTIAL GASES:
No gases predicted.
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

SODIUM NITRITE mixed with FORMALDEHYDE, SOLUTIONS (FORMALIN) (CORROSIVE) -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
Polymerization reaction may become intense and may cause pressurization
Reaction products may be explosive or sensitive to shock or friction
POTENTIAL GASES:
No gases predicted.
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

SODIUM NITRITE mixed with HYDROCHLORIC ACID, SOLUTION -
PREDICTED HAZARDS:
Reaction liberates gaseous products and may cause pressurization
Reaction products may be corrosive
Reaction products may be toxic
Reaction products may be unstable above ambient temperatures
POTENTIAL GASES:
Nitrogen Oxides
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

SODIUM NITRITE mixed with itself -
INTRINSIC REACTIVE HAZARDS:
No reaction expected.
--- END OF HAZARDS FOR THIS ITEM ---

WATER mixed with 4-AMINOBENZENE SULFONIC ACID -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
Reaction products may be corrosive
POTENTIAL GASES:
No gases predicted.
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

WATER mixed with CYANURIC CHLORIDE -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
Reaction liberates gaseous products and may cause pressurization
Reaction may be particularly intense, violent, or explosive
Reaction products may be corrosive
Reaction products may be toxic
POTENTIAL GASES:
Acid Fumes
Carbon Dioxide
Hydrogen Chloride
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

WATER mixed with DIVINYL SULFONE -
PREDICTED HAZARDS:
Polymerization reaction may become intense and may cause pressurization
POTENTIAL GASES:
No gases predicted.
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

WATER mixed with FORMALDEHYDE, SOLUTION, FLAMMABLE -
PREDICTED HAZARDS:
No known hazardous reaction
POTENTIAL GASES:
No gases predicted.
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

WATER mixed with FORMALDEHYDE, SOLUTIONS (FORMALIN) (CORROSIVE) -
PREDICTED HAZARDS:
Polymerization reaction may become intense and may cause pressurization
POTENTIAL GASES:
No gases predicted.
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

WATER mixed with HYDROCHLORIC ACID, SOLUTION -
PREDICTED HAZARDS:
Exothermic reaction at ambient temperatures (releases heat)
Reaction liberates gaseous products and may cause pressurization
Reaction products may be corrosive
POTENTIAL GASES:
Acid Fumes
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

WATER mixed with SODIUM NITRITE -
PREDICTED HAZARDS:
No known hazardous reaction
POTENTIAL GASES:
No gases predicted.
--- END OF HAZARDS FOR THIS MIXTURE PAIR ---

WATER mixed with itself -
INTRINSIC REACTIVE HAZARDS:
No reaction expected.
--- END OF HAZARDS FOR THIS ITEM ---

6.4 Preliminary hazard analysis

		Phase of the project			
Sr. no.	Hazard	**Pre Construction**	**Construction**	**Operation**	**Post Operation / Decommissioning**
Natural Ca	Cyclone		√	√	√
	Earth quake		√	√	√
	Land slide		√	√	√
	Flooding - heavy rain ,		√	√	√
Physical hazards	Noise		√	√	√
	Radiation (UV , radioactive materials)	x	x	x	x
	Extreme temperatures in summer season / winter		√	√	√
	Vibration	x	x	x	x
	Material handling operations.		√	√	√
	Steam pressure piping failure/ boiler drum failure.			√	
	Boiler explosion.			√	
Biohazard s	Epidemics /Communicable diseases by pests ,insects ,rodents		√	√	√
	Animal / snake bites		√	√	√
	Occupational health hazards at industry			√	√
Electrical hazard	Transformer oil fire /explosion		√	√	√
	Lightening strike	√	√	√	√
	fires due to Short circuit		√	√	√
	Power outage to emergency equipments / cable failure		√	√	√
Hazardous substances and wastes	AC , Refrigerators , Air conditioners Units fire/ explosion		√	√	
	Pool fire solvent release		√	√	√
	Release of toxic gas – hydrochloric acid , formaldehyde		√	√	√
	Hazardous waste uncontrolled disposal of iron sludge		√	√	√
	Welding cutting flammable gas cylinders fire /explosion		√		√
	Site decontamination	√	√	√	√
	Smoke in fire , acrid gases in fire		√	√	√
	Vehicles fuel fire	√	√	√	√
Mechanical	Failure of machinery and equipment		√	√	√
	Lack of safety guards in machines		√	√	√
	Poor maintenance of machinery and equipment		√	√	√
	power driven tools , saws , grinders ,d abrasive cutting wheels		√	√	√
	scaffolding –fixed and portable failure		√	√	√
	structural failure		√	√	√
	Truck and transport vehicles		√	√	√

	IDENTIFICATION OF HAZARD. CHECK LIST	Phase of the project			
Sr. no.	Hazard	Pre Construction	Construction	Operation	Post Operation / Decommissioning
Storages & process operatios	Uncontrolled Reaction exotherm leading to explosion			√	√
	Static charge as source of ignition leading to fire			√	√
	Smoldering or fire at pitcoal			√	√
	Release of toxic gases at scrubber vent			√	√
	Dust explosion hazard at powder handling			√	√
	Compatability and reactivity hazard at chemical storage			√	√
	Color on objects in surrounding			√	√
Frequent causes of accidents during construction Activity	Being struck by falling object			√	√
	Caught in or compressed between objects		√	√	√
	Cranes , winches , hoisting and hauling equipments failure		√	√	√
	Dusting packing operations , land development		√	√	√
	Electricity (electrocution)		√	√	√
	Fall from height,		√	√	√
	uncontrolled explosion during demolition /		√		√
	Hit by sharp objects		√		√
	Injuries during Handling heavy objects		√		√
	Lack of PPE , housekeeping practices , safety signs		√	√	√
	Oxygen deficiency in confined spaces			√	√
	Paint/ thinner cleaners, pesticides , waste oil fire		√	√	√
	Poor illumination		√	√	√
	Slipping on wet surfaces		√		√
	Snapping cables , ropes , chains , slings , hooks , chains		√	√	√
	Struck by moving objects	√	√	√	√
	Welding fumes and Radiations		√		√
Ergonomics & psychosocial	Repetitive ,monotonous ,excessive workload , strain injuries		√	√	
	Mental stress , human relations (aggressive behavior , alcohol and drug abuse , violance)		√	√	√
	Poverty , low wages , lack of education		√	√	√
	Long working hours , shift work , temporary employment		√	√	√
	Security threats				
Other	Escalating the designed event during MOCK drill		√	√	√
	No access for fire fighting operations to plant		√	√	√
	Obstruction in fire tender path		√	√	√
	Organic contaminated water generated during fire fighting entering in to storm water drain / water body		√	√	√
	Shortage of fire water supply		√	√	√
	Stampede during evacuation /at assembly point		√	√	√
	Spreading Rumors	√	√	√	√
	Inadequate separation in neighboring installations		√	√	√

6 .5: HAZOP WORK SHEETS

NODE 1 OF 5 : Reactive Blue P3R				**Sub node 1.1 : Storage of materials**					
DESIGN INTENT : Storage of materials									
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
None.	Flow.	More flow of material	dispensing from container human error	Delayed operation	Supervision	3	3	9	Training
More.	Flow.	More flow of material	dispensing from container	Spill hazard	Supervision	3	3	9	Training
Less.	Flow.	Less flow of	dispensing from container human error	Delayed operation	Supervision	3	3	9	Training
Reverse.	Flow.	Reverse flow.	Vapours coming from container while dispensing to container	Emission at work place	Ventilation at work place				
As Well As.	Flow.	As well as flow	VOC , odour from stored materials	Health hazard	Ventilation at the store room	4	4	16	
Other.	Flow.	Static discharge.	Transfer operations	Not significant	Equipments are earthed	2	2	4	
Other than	Flow	Undesired flow	Recycled containers , old labels retained Human error	Depends up on mix up components	Supervision	3	3	9	Training
More.	Temperature.	More temperature at	Summer season	Not significant	Storage under shed	3	3	9	
Less.	Temperature.	Less Temperature.	Winter season	Not significant	Storage under shed				
More.	Pressure.	More Pressure.	Not anticipated	Not significant	Systems Open to atmosphere	2	2	4	
Less.	Pressure.	Less Pressure.	Not anticipated	Not significant	Systems Open to atmosphere	2	2	4	
More	Phase.	More phases.	Gas, liquid phases.	Not significant.		–	–	–	

NODE 1 OF 5 : Reactive Blue P3R			Sub node 1.1 : Storage of materials						
DESIGN INTENT : Storage of materials									
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
As Well As.	Composition	Impurities.	Purity of the materials	In absence of chemical identifiers such as CAS number , DOT hazard label , MSDS , NFPA704 the materials are to be considered as if hazardous chemicals .	Quality checks and Process control	3	3	9	Q 1 What is the Finished products MSDS and colour index
More.	Level.	More Level.	Excessive filling of the container. Abuse in unloading and handling , Despencesing operations	Spill hazard	Supervision	3	3	9	
Less.	Level.	Less Level in container	Left over material in container unused for long time	Unsafe condition	Supervision	3	3	9	Periodic checking of the stock for identification of unused material in stock for long time and safe disposal of the same.

NODE 1 OF 5 :	Reactive Blue P3R	Sub node 1.1 : Storage of materials							
DESIGN INTENT :	Storage of materials								
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
Other.	Hazardous chemicals Handling.	Accidental mix up	Storage of large number of chemicals at store	Reactivity and compatibility hazards at storage of raw materials	Supervision	4	3	12	Storage of raw materials at store considering the compatibility and reactivity hazards at store.
Other.	Hazardous chemicals Handling.	Sulfonic acids	Storage and handling of sulfonic acids.	Emits SOx fumes upon heating to decomposition Have essentially the same corrosive characteristics as dose concentrated sulphuric acid.	Supervision PPE In general un neutralised sulphonic acids are regarded as moderate to highly toxic substances	3	3	9	Sop for storage and safe handling of sulfonic acids
Other.	Hazardous chemicals Handling.	Cyanuric chloride	Storage of Cyanuric chloride Opening of the drum	Toxic gas emission at work place	Ventilation	4	4	16	Hydrogen chloride leak detector at plant and Cyanuric chloride store .
Other.	Hazardous chemicals Handling.	BDSA Benzidine 2,2 di sulfonic acid	BDSA is raw material stored and used at site	Health hazard	Supervision PPE SOP	5	4	20	See note below

Note: Benzidine and its salts are hazardous chemicals and listed in the second schedule of the MSIHC rules 1989, with threshold quantity as 1 kg. Benzidine is known Carcinogen. Any benzene as impurity in raw materials or Weather any Benzidine salts are formed and purge point need attention Any contamination need strict isolation and quality control while processing as well as throughout the life span of the project. It is in the interest of PP as well as the community in surrounding .Similarly Anisidines are also controlled substances. (PA2 SA i.e. para Anisidine -2-Sulfonic Acid)

NODE 1 OF 5 : Reactive Blue P3R Sub node 1.2 : Iron Acid Reduction (Be'champ and Brinmeyr reduction method)									
DESIGN INTENT : Iron Acid Reduction									
Guide Word	Parameter	Deviation	Cause	Consequence	Protection Measures	S	P	R	Action Suggested
None.	Flow.	No flow of at filter	Blockage at filter	Spill hazard during blockage removal	Supervision PPE	3	3	9	
More.	Flow.	More flow of material	Not anticipated	No safety issues anticipated		-	-	-	
Less.	Flow.	Less flow of during filteration	Partial Blockage at filter	Spill hazard during blockage removal	Supervision PPE	3	3	9	
Reverse.	Flow.	Reverse flow.	Vapors and fumes from reactor opening	Emission at work place	Ventilation	3	3	9	
As Well As.	Flow.	As well as flow	Bichromate is one of the raw material	Presence of heavy metals like chromium in effluent is likely	Process control ETP	4	4	16	
Other.	Flow.	Static discharge.	Transfer operations	Not significant	Equipments are earthed	2	2	4	
Other.	Flow.	Spill /emission	Accidental spill of acid	Emission at work place Corrosion	Ventilation	3	3	9	SOP for Acid handling
Other than	Flow	Undesired flow	Accidental mix up Human error	Unsafe condition	SOP. Supervision.	3	3	9	Proper labelling of the containers
More.	Temperature.	More temperature at reactor	Human error	Emission at work place	Ventilation	3	3	9	
Less.	Temperature.	Less Temperature.	Human error	Not significant.	SOP. Supervision.	2	2	4	
More.	Pressure.	More Pressure.	Not anticipated	Not significant	System vented to atmosphere	2	2	4	
Less.	Pressure.	Less Pressure.	Not anticipated	Not significant	System vented to atmosphere				

NODE 1 OF 5 : Reactive Blue P3R Sub node 1.2 : Iron Acid Reduction (Be'champ and Brinmeyr reduction method)									
DESIGN INTENT : Iron Acid Reduction									
Guide Word	Parameter	Deviation	Cause	Consequence	Protection Measures	S	P	R	Action Suggested
More	Phase.	Increase in phases.	Agitation loss (loss of power, mechanical problem etc.). Layer separation.	Unsafe condition.	SOP. Supervision.	3	3	9	
As Well As.	Composition	Impurity profile of raw materials By products Side reaction products Contaminations	Not fully known	potential for Unsafe condition	SOP. Supervision. Final reaction mixture tested for complete reduction	4	4	16	Avoid the build up of excess nitro compound in the reaction mass
As Well As.	Composition	Hydrogen released from Iron- acid	The acid is used for activation of the iron ,Normally only 2-3 % hydrogen is derived from acid but 97to 98 % comes from water	Not significant	Hydrogen consumed in situ formation	3	3	9	
More.	Level.	More Level.	More charging in error	Over flow hazard	Supervision	3	3	9	
Less.	Level.	Less Level.	Less batch charging. Human error.	Thermowell may not dip. Unsafe condition.	SOP. Supervision.	3	3	9	
Other.	Hazardous chemicals Handling.	Hazardous Solid waste	Hazardous Solid waste especially Iron sludge storage and transport containing residual material.	Organic contaminated water generated during fire fighting operations may enter the storm drain.	SOP. Supervision.	4	4	16	Effective washing of the sludge to make it free of retained product.

NODE 1 OF 5 : Reactive Blue P3R			Sub node 1.3 : Diazotisation and coupling						
DESIGN INTENT : Diazotisation and coupling and all other unit operations									
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
None / more/less	Flow.	No flow at spray drying	See note below						
Reverse.	Flow.	Reverse flow at reactor	charging Cyanuric chloride through open manhole	Toxic gas emission at work place	Leak detectors at work place	4	4	16	Closed charging of cyanuric chloride to reactor. Hydrogen chloride leak detector at plant and Cyanuric chloride at plant.
Other.	Flow.	Spill /emission	Accidental spill	Toxic gas emission at work place	Supervision	4	4	16	Work area monitoring of the air born concentration of chemicals in the work area.
As Well As.	Flow.	As well as flow	Salts in spray drying mass	Not significant	Filtration & washing steps	4	4	16	
Other.	Flow.	Static discharge.	Transfer operations	Not significant	Equipments are earthed	2	2	4	
Other.	Flow.	Spill /emission	Accidental spill of acid	Emission at work place Corrosion	Ventilation	3	3	9	SOP for Acid handling
Other than	Flow	Undesired flow	Accidental mix up Human error	Unsafe condition	SOP. Supervision.	3	3	9	Proper labelling of the containers
More.	Temperature.	More temperature at reactor	Human error	Quality issues	SOP. Supervision.	2	2	4	

. Note : spray drying outsourced

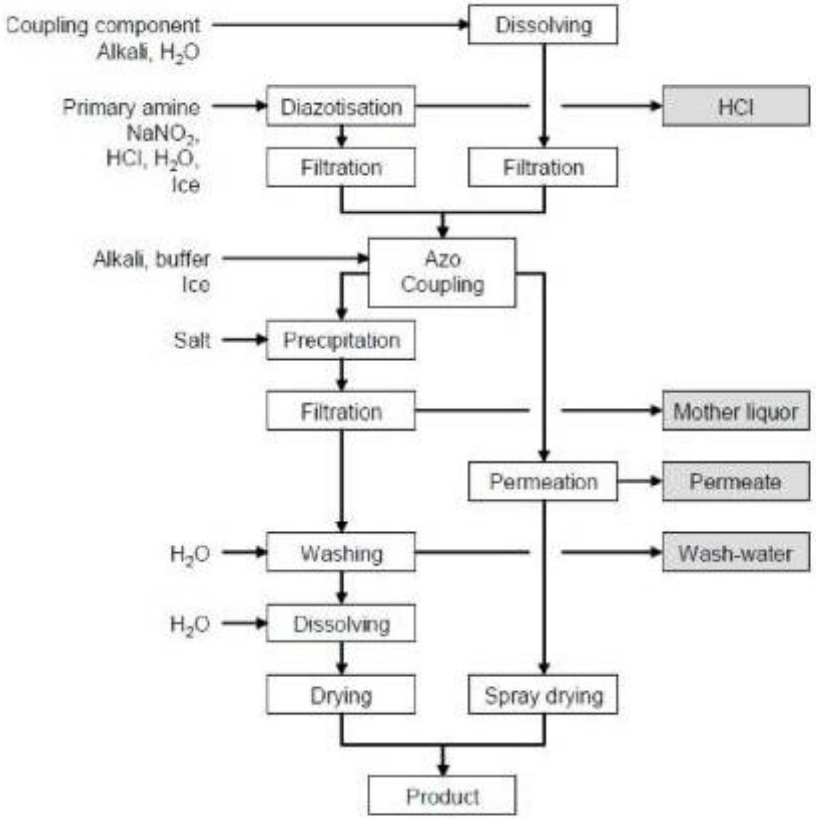


Figure 18: Typical sequence of operations for diazotisation and azo coupling

(Source : Technical EIA Guidance Manual for Synthetic Organic Chemicals, prepared for the Ministry of Environment and Forests Government of India.)

NODE 1 OF 5 :	Reactive Blue P3R	Sub node 1.3 : Diazotisation and coupling							
DESIGN INTENT :	Diazotisation and coupling and all other unit operations								
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
Less.	Temperature.	Less temperature about 0 0 c	Low temperature process requirement.	Freezing not anticipated	SOP. Supervision.	2	2	4	
More.	Pressure.	More Pressure.	Not anticipated	Not significant	System vented to atmosphere	2	2	4	
Less.	Pressure.	Less Pressure.	Not anticipated	Not significant	System vented to atmosphere				
More	Phase.	Increase in phases.	Agitation loss (loss of power, mechanical problem etc.). Layer separation.	Unsafe condition.	SOP. Supervision.	3	3	9	
As Well As.	Composition	Impurity profile of raw materials By products Side reaction products Contaminations	Not fully known	potential for Unsafe condition	SOP. Supervision.	4	4	16	
More.	Level.	More Level.	More charging in error	Over flow hazard	Supervision	3	3	9	
Less.	Level.	Less Level.	Less batch charging. Human error.	Thermowell may not dip. Unsafe condition.	SOP. Supervision.	3	3	9	
Other.	Hazardous chemicals Handling.	Cyanuric Chloride	Cyanuric Chloride It is highly reactive material	potential hazard of Toxic emissions at work place	SOP. Supervision.	3	3	9	Leak detectors at storage place?
Other.	Hazardous chemicals Handling.	Hydrochloric acid	Hydrochloric acid spill	Hydrogen chloride gas release	Safety shower and eye wash fountain PPE	5	4	20	DMP

NODE 2 OF 5 : Reactive Blue MX7R			Sub node 2.1 : Storage of materials						
DESIGN INTENT : Storage of materials									
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
None.	Flow.	More flow of material	dispensing from container human error	Delayed operation	Supervision	3	3	9	Training
More.	Flow.	More flow of material	dispensing from container	Spill hazard	Supervision	3	3	9	Training
Less.	Flow.	Less flow of	dispensing from container human error	Delayed operation	Supervision	3	3	9	Training
Reverse.	Flow.	Reverse flow.	Vapours coming from container while dispensing to container	Emission at work place	Ventilation at work place				
As Well As.	Flow.	As well as flow	VOC , odour from stored materials	Health hazard	Ventilation at the store room	4	4	16	
Other.	Flow.	Static discharge.	Transfer operations	Not significant	Equipments are earthed	2	2	4	
Other than	Flow	Undesired flow	Recycled containers , old labels retained Human error	Depends up on mix up components	Supervision	3	3	9	Training
More.	Temperature.	More temperature at	Summer season	Not significant	Storage under shed	3	3	9	
Less.	Temperature.	Less Temperature.	Winter season	Not significant	Storage under shed				
More.	Pressure.	More Pressure.	Not anticipated	Not significant	Systems Open to atmosphere	2	2	4	
Less.	Pressure.	Less Pressure.	Not anticipated	Not significant	Systems Open to atmosphere	2	2	4	

NODE 2 OF 5 :	Reactive Blue MX7R	Sub node 2.1 : Storage of materials							
DESIGN INTENT :	Storage of materials								
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
More	Phase.	More phases.	Gas, liquid phases.	Not significant.		–	–	–	
As Well As.	Composition	Impurities.	Purity of the materials	In absence of chemical identifiers such as CAS number , DOT hazard label , MSDS , NFPA704 the materials are to be considered as if hazardous chemicals .	Quality checks and Process control	3	3	9	Q 1 What is the Finished products MSDS and colour index Q 2 What is the full name of the material , MSDS and CAS number of 1. NADAPSA 2. IBAMSA
More.	Level.	More Level.	Excessive filling of the container. Abuse in unloading and handling , Despencesing operations	Spill hazard	Supervision	3	3	9	
Less.	Level.	Less Level in container	Left over material in container unused for long time	Unsafe condition	Supervision	3	3	9	Periodic checking of the stock for identification of unused material in stock for long time and safe disposal of the same.

NODE 2 OF 5	**:**	Reactive Blue MX7R	Sub node 2.1 : Storage of materials						
DESIGN INTENT	**:**	Storage of materials							
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
Other.	Hazardous chemicals Handling.	Accidental mix up	Storage of large number of chemicals at store	Reactivity and compatibility hazards at storage of raw materials	Supervision	4	3	12	Storage of raw materials at store considering the compatibility and reactivity hazards at store.
Other.	Hazardous chemicals Handling.	Sulfonic acids	Storage and handling of sulfonic acids.	In general un neutralised sulphonic acids are regarded as moderate to highly toxic substances. Emits SOx fumes upon heating to decomposition Have essentially the same corrosive characteristics as dose concentrated sulphuric acid.	Supervision PPE	3	3	9	Sop for storage and safe handling of sulfonic acids

NODE 2 OF 5 : Reactive Blue MX7R Sub node 2.2 : Iron Acid Reduction (Be'champ and Brinmeyr reduction method)									
DESIGN INTENT : Iron Acid Reduction and all other unit operations									
Guide Word	Parameter	Deviation	Cause	Consequence	Protection Measures	S	P	R	Action Suggested
None.	Flow.	No flow of at filter	Blockage at filter	Spill hazard during blockage removal	Supervision PPE	3	3	9	
More.	Flow.	More flow of material	Not anticipated	No safety issues anticipated		-	-	-	
Less.	Flow.	Less flow of during filteration	Partial Blockage at filter	Spill hazard during blockage removal	Supervision PPE	3	3	9	
Reverse.	Flow.	Reverse flow.	Vapors and fumes from reactor opening	Emission at work place	Ventilation	3	3	9	
As Well As.	Flow.	As well as flow	Bichromate is one of the raw material	Presence of heavy metals like chromium in effluent is likely	Process control ETP	4	4	16	
Other.	Flow.	Static discharge.	Transfer operations	Not significant	Equipments are earthed	2	2	4	
Other.	Flow.	Spill /emission	Accidental spill of acid	Emission at work place Corrosion	Ventilation	3	3	9	SOP for Acid handling
Other than	Flow	Undesired flow	Accidental mix up Human error	Unsafe condition	SOP. Supervision.	3	3	9	Proper labelling of the containers
More.	Temperature.	More temperature at reactor	Human error	Emission at work place	Ventilation	3	3	9	
Less.	Temperature.	Less Temperature.	Human error	Delayed operation	Not significant.	2	2	4	
More.	Pressure.	More Pressure.	Not anticipated	Not significant	System vented to atmosphere	2	2	4	
Less.	Pressure.	Less Pressure.	Not anticipated	Not significant	System vented to atmosphere	2	2	4	

NODE 2 OF 5 : Reactive Blue MX7R Sub node 2.2 : Iron Acid Reduction (Be'champ and Brinmeyr reduction method)									
DESIGN INTENT : Iron Acid Reduction and all other unit operations									
Guide Word	Parameter	Deviation	Cause	Consequence	Protection Measures	S	P	R	Action Suggested
More	Phase.	Increase in phases.	Agitation loss (loss of power, mechanical problem etc.). Layer separation.	Unsafe condition.	SOP. Supervision.	3	3	9	
As Well As.	Composition	Impurity profile of raw materials By products Side reaction products Contaminations	Not fully known	potential for Unsafe condition	SOP. Supervision.	4	4	16	The build up of excess nitro compound must be avoided and the final reaction mixture should be tested for complete reduction .
As Well As.	Composition	Hydrogen released from Iron- acid	The acid is used for activation of the iron ,Normally only 2-3 % hydrogen is derived from acid but 97to 98 % comes from water	Not significant	Hydrogen consumed in situ formation	3	3	9	
More.	Level.	More Level.	More charging in error	Over flow hazard	Supervision	3	3	9	
Less.	Level.	Less Level.	Less batch charging. Human error.	Thermowell may not dip. Unsafe condition.	SOP. Supervision.	3	3	9	
Other.	Hazardous chemicals Handling.	Hazardous Solid waste	Hazardous Solid waste especially Iron sludge storage and transport containing residual material.	Organic contaminated water generated during fire fighting operations may enter the storm drain.	SOP. Supervision.	4	4	16	Effective washing of the sludge to make it free of retained product.
None / more/less	Flow.	No flow at spray drying	See note below						

Note : spray drying outsourced .

NODE 3 OF 5	**:**	Reactive Black B	Sub node 3.1 : Storage of materials						
DESIGN INTENT	**:**	Storage of materials							
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
None.	Flow.	More flow of material	dispensing from container human error	Delayed operation	Supervision	3	3	9	Training
More.	Flow.	More flow of material	dispensing from container	Spill hazard	Supervision	3	3	9	Training
Less.	Flow.	Less flow of	dispensing from container human error	Delayed operation	Supervision	3	3	9	Training
Reverse.	Flow.	Reverse flow.	Vapours coming from container while dispensing to container	Emission at work place	Ventilation at work place				
As Well As.	Flow.	As well as flow	VOC , odour from stored materials	Health hazard	Ventilation at the store room	4	4	16	
Other.	Flow.	Static discharge.	Transfer operations	Not significant	Equipments are earthed	2	2	4	
Other than	Flow	Undesired flow	Recycled containers , old labels retained Human error	Depends up on mix up components	Supervision	3	3	9	Training
More.	Temperature.	More temperature at	Summer season	Not significant	Storage under shed	3	3	9	
Less.	Temperature.	Less Temperature.	Winter season	Not significant	Storage under shed				
More.	Pressure.	More Pressure.	Not anticipated	Not significant	Systems Open to atmosphere	2	2	4	
Less.	Pressure.	Less Pressure.	Not anticipated	Not significant	Systems Open to atmosphere	2	2	4	
More	Phase.	More phases.	Gas, liquid phases.	Not significant.		–	–	–	

NODE 3 OF 5 : Reactive Black B			Sub node 3.1 : Storage of materials						
DESIGN INTENT : Storage of materials									
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
As Well As.	Composition	Impurities.	Purity of the materials	In absence of chemical identifiers such as CAS number , DOT hazard label , MSDS , NFPA704 the materials are to be considered as if hazardous chemicals .					Q 2 What is the MSDS and CAS number of Vinyl Sulfone? Is it (CAS 77-77-0) ?
More.	Level.	More Level.	Excessive filling of the container. Abuse in unloading and handling , Despencesing operations	Spill hazard	Supervision	3	3	9	
Less.	Level.	Less Level in container	Left over material in container unused for long time	Unsafe condition	Supervision	3	3	9	Periodic checking of the stock for identification of unused material in stock for long time and safe disposal of the same.
Other.	Hazardous chemicals Handling.	Accidental mix up	Storage of large number of chemicals at store	Reactivity and compatibility hazards at storage of raw materials	Supervision	4	3	12	Storage of materials considering the compatibility and reactivity hazards at store.

NODE 3 OF 5 :	Reactive Black B	Sub node 3.1 : Storage of materials							
DESIGN INTENT :	Storage of materials								
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
Other.	Hazardous chemicals Handling.	Sulfonic acids	Storage and handling of Sulfonic acids.	In general un neutralised sulphonic acids are regarded as moderate to highly toxic substances. Emits SOx fumes upon heating to decomposition Have essentially the same corrosive characteristics as dose concentrated sulphuric acid.	Supervision PPE	3	3	9	Sop for storage and safe handling of sulfonic acids
Other.	Hazardous chemicals Handling.	Vinyl sulfone	Storage of Vinyl sulfone Opening of the container /drum	Toxic gas emission at work place	Ventilation	4	4	16	
Other.	Hazardous chemicals Handling.	H acid 1 –amino , 8 Naphthol ,3,6 di sulfonic acid	It is raw material stored and used at site	Health hazard Dusting	Supervision PPE SOP	5	4	20	

NODE 3 OF 5	**:**	Reactive Black B	Sub node 3.2 : Diazotisation and coupling						
DESIGN INTENT	**:**	Diazotisation and coupling and all other unit operations							
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
None / more/less	Flow.	No flow at spray drying	See note below						
Reverse.	Flow.	Reverse flow at reactor	Batch charging through open manhole	Toxic gas emission at work place	Leak detectors at work place	4	4	16	
Other.	Flow.	Spill /emission	Accidental spill	Toxic gas emission at work place	Supervision	4	4	16	Work area monitoring of the air born concentration of chemicals in the work area.
As Well As.	Flow.	As well as flow	Salts in spray drying mass	Not significant	Filtration & washing steps	4	4	16	
Other.	Flow.	Static discharge.	Transfer operations	Not significant	Equipments are earthed	2	2	4	
Other.	Flow.	Spill /emission	Accidental spill of acid	Emission at work place Corrosion	Ventilation	3	3	9	SOP for Acid handling
Other than	Flow	Undesired flow	Accidental mix up Human error	Unsafe condition	SOP. Supervision.	3	3	9	Proper labelling of the containers
More.	Temperature.	More temperature at reactor	Human error	Quality issues	SOP. Supervision.	2	2	4	
Less.	Temperature.	Less temperature about 0^{0} c	Low temperature process requirement.	Freezing not anticipated	SOP. Supervision.	2	2	4	

Note : spray drying outsourced .

NODE 3 OF 5 :	Reactive Black B	Sub node 3.2 : Diazotisation and coupling							
DESIGN INTENT :	Diazotisation and coupling and all other unit operations								
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
More.	Pressure.	More Pressure.	Not anticipated	Not significant	System vented to atmosphere	2	2	4	
Less.	Pressure.	Less Pressure.	Not anticipated	Not significant	System vented to atmosphere				
More	Phase.	Increase in phases.	Agitation loss (loss of power, mechanical problem etc.). Layer separation.	Unsafe condition.	SOP. Supervision.	3	3	9	
As Well As.	Composition	Impuritiy profile of raw materials By products Side reaction products Contaminations	Not fully known	potential for Unsafe condition		4	4	16	Q 3 Are the Reactive Black B reactions balanced ?
More.	Level.	More Level.	More charging in error	Over flow hazard	Supervision	3	3	9	
Less.	Level.	Less Level.	Less batch charging. Human error.	Thermowell may not dip. Unsafe condition.	SOP. Supervision.	3	3	9	
Other.	Hazardous chemicals Handling.	Hydrochloric acid	Hydrochloric acid spill	Emission of hydrogen chloride gas at work place. Health hazard due to hydrogen chloride gas release	Safety shower and eye wash fountain PPE	5	4	20	Disaster Control Plan for the site with dove tailing data for Offsite Disaster Control Plan.
Other.	Hazardous chemicals Handling.	H acid 1 –amino , 8 Naphthol ,3,6 di sulfonic acid	It is raw material stored and used at site	Health hazard Dusting	Supervision PPE SOP	5	4	20	

NODE 4 OF 5 : Reactive Blue 49			Sub node 4.1 : Storage of materials						
DESIGN INTENT : Storage of materials									
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
None.	Flow.	More flow of material	dispensing from container human error	Delayed operation	Supervision	3	3	9	Training
More.	Flow.	More flow of material	dispensing from container	Spill hazard	Supervision	3	3	9	Training
Less.	Flow.	Less flow of	dispensing from container human error	Delayed operation	Supervision	3	3	9	Training
Reverse.	Flow.	Reverse flow.	Vapours coming from container while dispensing to container	Emission at work place	Ventilation at work place				
As Well As.	Flow.	As well as flow	VOC , odour from stored materials	Health hazard	Ventilation at the store room	4	4	16	
Other.	Flow.	Static discharge.	Transfer operations	Not significant	Equipments are earthed	2	2	4	
Other than	Flow	Undesired flow	Recycled containers , old labels retained Human error	Depends up on mix up components	Supervision	3	3	9	Training
More.	Temperature.	More temperature	Summer season	Not significant	Storage under shed	3	3	9	
Less.	Temperature.	Less Temperature.	Winter season	Not significant	Storage under shed				
More.	Pressure.	More Pressure.	Not anticipated	Not significant	Systems Open to atmosphere	2	2	4	
Less.	Pressure.	Less Pressure.	Not anticipated	Not significant	Systems Open to atmosphere	2	2	4	
More	Phase.	More phases.	Gas, liquid phases.	Not significant.		–	–	–	

NODE 4 OF 5 : Reactive Blue 49			Sub node 4.1 : Storage of materials						
DESIGN INTENT : Storage of materials									
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
As Well As.	Composition	Impurities.	Purity of the materials	In absence of chemical identifiers such as CAS number , DOT hazard label , MSDS , NFPA704 the materials are to be considered as if hazardous chemicals .	Quality checks and Process control	3	3	9	Q 1 What is the Finished products MSDS and colour index
More.	Level.	More Level.	Excessive filling of the container. Abuse in unloading and handling , Despencesing operations	Spill hazard	Supervision	3	3	9	
Less.	Level.	Less Level in container	Left over material in container unused for long time	Unsafe condition	Supervision	3	3	9	Periodic checking of the stock for identification of unused material in stock for long time and safe disposal of the same.
Other.	Hazardous chemicals Handling.	Accidental mix up	Storage of large number of chemicals at store	Reactivity and compatibility hazards at storage of raw materials	Supervision	4	3	12	Storage of raw materials at store considering the compatibility and reactivity hazards at store.

NODE 4 OF 5 :	Reactive Blue 49	Sub node 4.1 : Storage of materials							
DESIGN INTENT :	Storage of materials								
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
Other.	Hazardous chemicals Handling.	Sulfonic acids	Storage and handling of sulfonic acids.	In general un neutralised sulphonic acids are regarded as moderate to highly toxic substances. Emits SOx fumes upon heating to decomposition Have essentially the same corrosive characteristics as dose concentrated sulphuric acid.	Supervision PPE	3	3	9	Sop for storage and safe handling of sulfonic acids
Other.	Hazardous chemicals Handling.	Cyanuric chloride	Storage of Cyanuric chloride Opening of the drum	Toxic gas emission at work place	Ventilation	4	4	16	Hydrogen chloride leak detector at plant and Cyanuric chloride store .
Other.	Hazardous chemicals Handling.	BDSA Benzidine 2,2 di sulfonic acid	BDSA is raw material stored and used at site	Health hazard	Supervision PPE SOP	5	4	20	See note below

Note: Benzidine and its salts are hazardous chemicals and listed in the second schedule of the MSIHC rules 1989, with threshold quantity as 1 kg. Benzidine is known Carcinogen. Any benzene as impurity in raw materials or Weather any Benzidine salts are formed and purge point need attention Any contamination need strict isolation and quality control while processing as well as throughout the life span of the project. It is in the interest of PP as well as the community in surrounding .Similarly Anisidines are also controlled substances. (PA2 SA i.e. para Anisidine -2-Sulfonic Acid)

NODE 4 OF 5 : Reactive Blue 49 Sub node 4.2 : Iron Acid Reduction (Be'champ and Brinmeyr reduction method)									
DESIGN INTENT : Iron Acid Reduction									
Guide Word	Parameter	Deviation	Cause	Consequence	Protection Measures	S	P	R	Action Suggested
None.	Flow.	No flow of at filter	Blockage at filter	Spill hazard during blockage removal	Supervision PPE	3	3	9	
More.	Flow.	More flow of material	Not anticipated	No safety issues anticipated		-	-	-	
Less.	Flow.	Less flow of during filteration	Partial Blockage at filter	Spill hazard during blockage removal	Supervision PPE	3	3	9	
Reverse.	Flow.	Reverse flow.	Vapors and fumes from reactor opening	Emission at work place	Ventilation	3	3	9	
As Well As.	Flow.	As well as flow	Bichromate is one of the raw material	Presence of heavy metals like chromium in effluent is likely	Process control ETP	4	4	16	
Other.	Flow.	Static discharge.	Transfer operations	Not significant	Equipments are earthed	2	2	4	
Other.	Flow.	Spill /emission	Accidental spill of acid	Emission at work place Corrosion	Ventilation	3	3	9	SOP for Acid handling
Other than	Flow	Undesired flow	Accidental mix up Human error	Unsafe condition	SOP. Supervision.	3	3	9	Proper labelling of the containers
More.	Temperature.	More temperature at reactor	Human error	Emission at work place	Ventilation	3	3	9	
Less.	Temperature.	Less Temperature.	Human error	Delayed operation	Not significant.	2	2	4	
More.	Pressure.	More Pressure.	Not anticipated	Not significant	System vented to atmosphere	2	2	4	
Less.	Pressure.	Less Pressure.	Not anticipated	Not significant	System vented to atmosphere				

NODE 4 OF 5 : Reactive Blue 49 Sub node 4.2 : Iron Acid Reduction (Be'champ and Brinmeyr reduction method)									
DESIGN INTENT : Iron Acid Reduction									
Guide Word	Parameter	Deviation	Cause	Consequence	Protection Measures	S	P	R	Action Suggested
More	Phase.	Increase in phases.	Agitation loss (loss of power, mechanical problem etc.).	Layer separation Unsafe condition.	SOP. Supervision.	3	3	9	
As Well As.	Composition	Impurity profile of raw materials By products Side reaction products Contaminations	Not fully known	potential for Unsafe condition	SOP. Supervision. final reaction mixture tested for complete reduction	4	4	16	Avoid the build up of excess nitro compound in reactor
As Well As.	Composition	Hydrogen released from Iron- acid	The acid is used for activation of the iron ,Normally only 2-3 % hydrogen is derived from acid but 97to 98 % comes from water	Not significant	Hydrogen consumed in situ formation	3	3	9	
More.	Level.	More Level.	More charging in error	Over flow hazard	Supervision	3	3	9	
Less.	Level.	Less Level.	Less batch charging. Human error.	Thermowell may not dip. Unsafe condition.	SOP. Supervision.	3	3	9	
Other.	Hazardous chemicals Handling.	Hazardous Solid waste	Hazardous Solid waste especially Iron sludge storage and transport containing residual material.	Organic contaminated water generated during fire fighting operations may enter the storm drain.	SOP. Supervision.	4	4	16	Effective washing of the sludge to make it free of retained product.

NODE 4 OF 5 : Reactive Blue 49			Sub node 4.3 : Diazotisation and coupling						
DESIGN INTENT : Diazotisation and coupling and all other unit operations									
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
None / more/less	Flow.	No flow at spray drying	See note below						
Reverse.	Flow.	Reverse flow at reactor	charging Cyanuric chloride through open manhole	Toxic gas emission at work place	Leak detectors at work place	4	4	16	Closed charging of cyanuric chloride to reactor. Hydrogen chloride leak detector at plant
Other.	Flow.	Spill /emission	Accidental spill	Toxic gas emission at work place	Supervision	4	4	16	Work area monitoring of the air born concentration of chemicals in the work area.
As Well As.	Flow.	As well as flow	Salts in spray drying mass	Not significant	Filtration & washing steps	4	4	16	
Other.	Flow.	Static discharge.	Transfer operations	Not significant	Equipments are earthed	2	2	4	
Other.	Flow.	Spill /emission	Accidental spill of acid	Emission at work place Corrosion	Ventilation	3	3	9	SOP for Acid handling
Other than	Flow	Undesired flow	Accidental mix up Human error	Unsafe condition	SOP. Supervision.	3	3	9	Proper labelling of the containers
More.	Temperature.	More temperature at reactor	Human error	Quality issues	SOP. Supervision.	2	2	4	
Less.	Temperature.	Less temperature about 0^{0} c	Process requirement.	Freezing not anticipated	SOP. Supervision.	2	2	4	

Note : spray drying outsourced .

NODE 4 OF 5 :	Reactive Blue 49	Sub node 4.3 : Diazotisation and coupling							
DESIGN INTENT :	Diazotisation and coupling and all other unit operations								
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
More.	Pressure.	More Pressure.	Not anticipated	Not significant	System vented to atmosphere	2	2	4	
Less.	Pressure.	Less Pressure.	Not anticipated	Not significant	System vented to atmosphere				
More	Phase.	Increase in phases.	Agitation loss (loss of power, mechanical problem etc.). Layer separation.	Unsafe condition.	SOP. Supervision.	3	3	9	
As Well As.	Composition	Impurity profile of raw materials By products Side reaction products Contaminations	Not fully known	potential for Unsafe condition	SOP. Supervision.	4	4	16	
More.	Level.	More Level.	More charging in error	Over flow hazard	Supervision	3	3	9	
Less.	Level.	Less Level.	Less batch charging. Human error.	Thermowell may not dip. Unsafe condition.	SOP. Supervision.	3	3	9	
Other.	Hazardous chemicals Handling.	Cyanuric Chloride	Cyanuric Chloride It is highly reactive material	potential hazard of Toxic emissions at work place	SOP. Supervision.	3	3	9	Leak detectors at storage place?
Other.	Hazardous chemicals Handling.	Hydrochloric acid	Hydrochloric acid spill	Emission of hydrogen chloride gas at work place. Health hazard	Safety shower and eye wash fountain PPE	5	4	20	Disaster Control Plan for the site with dove tailing data for Offsite Disaster Control Plan.

NODE 5 OF 5 : Reactive Green HE4BD			Sub node 5.1 : Storage of materials						
DESIGN INTENT : Storage of materials									
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
None.	Flow.	More flow of material	dispensing from container human error	Delayed operation	Supervision	3	3	9	Training
More.	Flow.	More flow of material	dispensing from container	Spill hazard	Supervision	3	3	9	Training
Less.	Flow.	Less flow of	dispensing from container human error	Delayed operation	Supervision	3	3	9	Training
Reverse.	Flow.	Reverse flow.	Vapours coming from container while dispensing to container	Emission at work place	Ventilation at work place				
As Well As.	Flow.	As well as flow	VOC , odour from stored materials	Health hazard	Ventilation at the store room	4	4	16	
Other.	Flow.	Static discharge.	Transfer operations	Not significant	Equipments are earthed	2	2	4	
Other than	Flow	Undesired flow	Recycled containers , old labels retained Human error	Depends up on mix up components	Supervision	3	3	9	Training
More.	Temperature.	More temperature at	Summer season	Not significant	Storage under shed	3	3	9	
Less.	Temperature.	Less Temperature.	Winter season	Not significant	Storage under shed				
More.	Pressure.	More Pressure.	Not anticipated	Not significant	Systems Open to atmosphere	2	2	4	
Less.	Pressure.	Less Pressure.	Not anticipated	Not significant	Systems Open to atmosphere	2	2	4	
More	Phase.	More phases.	Gas, liquid phases.	Not significant.		–	–	–	

NODE 5 OF 5 :	Reactive Green HE4BD	Sub node 5.1 : Storage of materials							
DESIGN INTENT :	Storage of materials								
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
As Well As.	Composition	Impurities.	Purity of the materials	In absence of chemical identifiers such as CAS number , DOT hazard label , MSDS , NFPA704 the materials are to be considered as if hazardous chemicals .	Quality checks and Process control	3	3	9	Q 1 What is the Finished products MSDS and colour index
More.	Level.	More Level.	Excessive filling of the container. Abuse in unloading and handling , Despencesing operations	Spill hazard	Supervision	3	3	9	
Less.	Level.	Less Level in container	Left over material in container unused for long time	Unsafe condition	Supervision	3	3	9	Periodic stock checking and corrective action for damaged or unwanted material .
Other.	Hazardous chemicals Handling.	Accidental mix up	Storage of large number of chemicals at store	Reactivity and compatibility hazards at storage of raw materials	Supervision	4	3	12	Storage of raw materials considering the compatibility and reactivity hazards at store.

NODE 5 OF 5 : Reactive Green HE4BD			Sub node 5.1 : Storage of materials						
DESIGN INTENT : Storage of materials									
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
Other.	Hazardous chemicals Handling.	Sulfonic acids	Storage and handling of sulfonic acids.	In general un neutralised sufonic acids are regarded as moderate to highly toxic substances. Emits SOx fumes upon heating to decomposition Have essentially the same corrosive characteristics as dose concentrated sulphuric acid.	Supervision PPE	3	3	9	Sop for storage and safe handling of sulfonic acids
Other.	Hazardous chemicals Handling.	Formaldehyde	Formaldehyde spill	Health hazard due to emissions in Formaldehyde handling at work place. Environmental risk due to POCP of formaldehyde handling .	Safety Shower & Eye Wash Fountains and Personnel Protective Equipment (PPE) Supervision Connection of all vents releasing formaldehyde to scrubber.	5	4	20	Provide SOP for Formaldehyde storage and handling operations with thrust on medical surveillance, hazard communication to employees, PPE, Spill procedures confirming to OSHA Formaldehyde standard 29 CFR 1910.1048.

NODE 5 OF 5 :	Reactive Green HE4BD	Sub node 5.1 : Storage of materials							
DESIGN INTENT :	Storage of materials								
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
As well as	Composition	Purity of formaldehyde Water and methanol content	Normally commercial formaldehyde containts Methanol	Fire hazard	Portable Fire Extinguishers.	4	4	16	Q 4 Is Formaldehyde used free from methanol ?
Other	Emergency	Large spill of Formaldehyde	Accidental spill	Health hazard Fire hazard	Portable Fire Extinguishers.	4	4	16	Disaster Control Plan Provide adequate access for fire fighting to plant and gates suitable for fire tender movements . Suitable arrangement at storm drain to avoid any organic contaminated water/ spill/ fire water going out of the site. Wind direction sock

NODE 5 OF 5 : Reactive Green HE4BD				Sub node 5.2 : Diazotisation and coupling					
DESIGN INTENT : Diazotisation and coupling									
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
Reverse.	Flow.	Reverse flow at reactor	charging through open manhole	Toxic gas emission at work place	Leak detectors at work place	4	4	16	Closed system for charging of batch Avoid opening of manhole for batch charging use charge hole
Other.	Flow.	Spill /emission	Accidental spill	Toxic gas emission at work place	Supervision	4	4	16	Work area monitoring of the air born concentration of chemicals in the work area.
As Well As.	Flow.	As well as flow	Salts in spray drying mass	Not significant	Filtration & washing steps	4	4	16	
Other.	Flow.	Static discharge.	Transfer operations Resorcinol handling	Not significant	Equipments are earthed	2	2	4	Use non-sparking tools and equipment
Other.	Flow.	Spill /emission	Accidental spill of acid	Emission at work place Corrosion	Ventilation	3	3	9	SOP for Acid handling
Other than	Flow	Undesired flow	Accidental mix up Human error	Unsafe condition	SOP. Supervision.	3	3	9	Proper labelling of the containers
More.	Temperature.	More temperature at reactor	Human error	Quality issues	SOP. Supervision.	2	2	4	
Less.	Temperature.	Less temperature about 0^{0} c	Low temperature process requirement.	Freezing not anticipated	SOP. Supervision.	2	2	4	

NODE 5 OF 5 : Reactive Green HE4BD				Sub node 5.2 : Diazotisation and coupling					
DESIGN INTENT : Diazotisation and coupling									
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
More.	Pressure.	More Pressure.	Not anticipated	Not significant	System vented to atmosphere	2	2	4	
Less.	Pressure.	Less Pressure.	Not anticipated	Not significant	System vented to atmosphere				
More	Phase.	Increase in phases.	Agitation loss (loss of power, mechanical problem etc.). Layer separation.	Unsafe condition.	SOP. Supervision.	3	3	9	
As Well As.	Composition	Impurity profile of raw materials By products Side reaction products Contaminations	Not fully known	potential for Unsafe condition	SOP. Supervision.	4	4	16	
More.	Level.	More Level.	More charging in error	Over flow hazard	Supervision	3	3	9	
Less.	Level.	Less Level.	Less batch charging. Human error.	Thermowell may not dip. Unsafe condition.	SOP. Supervision.	3	3	9	
Other.	Hazardous chemicals Handling.	Resorcinol	Reacts with amino compounds	potential hazard of Toxic emissions at work place Fire hazard	SOP. Supervision.	3	3	9	
Other.	Hazardous chemicals Handling.	Hydrochloric acid	Hydrochloric acid spill	Emission of hydrogen chloride gas at work place. Health hazard	Safety shower and eye wash fountain PPE	5	4	20	Disaster Control Plan for the site with dove tailing data for Offsite Disaster Control Plan.

NODE 5 OF 5 : Reactive Green HE4BD			Sub node 5.3 : Condensation						
DESIGN INTENT : Condensation and all other unit operations									
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
None / more/less	Flow.	No flow at spray drying	See note below						
Reverse.	Flow.	Reverse flow at reactor	charging through open manhole	Toxic gas emission at work place	Leak detectors at work place	4	4	16	Closed system for charging of batch Avoid opening of manhole for batch charging use charge hole
As Well As.	Flow.	Generation of effluent.	Waste water streams from process.	The effluent is normally composed of high-boiling components (condensation products / by - products) that often show moderate or poor biodegradability, and low - boiling components (educts) with better biodegradability.	Specific waste water volumes are generally low, ETP provided.	4	3	12	
Other.	Flow.	Static discharge.	As a result of flow, agitation, etc., electrostatic charges can be generated.	Fire hazard	SOP. Supervision.	3	3	9	
Other than	Flow	Undesired flow	Accidental mix up Human error	Unsafe condition	SOP. Supervision.	3	3	9	Proper labelling of the containers

Note : spray drying outsourced .

NODE 5 OF 5 : Reactive Green HE4BD				**Sub node 5.3 : condensation**					
DESIGN INTENT : Condensation and all other unit operations									
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
Other.	Flow.	Spill /emission	Accidental spill	Toxic gas emission at work place	Supervision	4	4	16	Work area monitoring of the air born concentration of chemicals in the work area.
More.	Temperature.	More temperature at reactor	Reaction exotherm – moderate.	Emission at vent.	Reflux condenser provided.	3	3	9	
Less.	Temperature.	Less Temperature.	Not anticipated	Not significant	Supervision.	3	3	**9**	
More.	Pressure.	More Pressure.	In case formaldehyde contain Methanol	Pressurization	Condenser System vented to atmosphere	3	3	9	
Less.	Pressure.	Less Pressure.	Not anticipated	Not significant	System vented to atmosphere	2	2	4	
More	Phase.	Increase in phases.	Agitation loss (loss of power, mechanical problem etc.).	Not significant	Supervision.	3	3	9	
As Well As.	Composition	Impurities.	Not fully known	potential for Unsafe condition	SOP. Supervision.	4	4	16	
More.	Level.	More Level.	More charging in error	Over flow hazard	Supervision	3	3	9	

NODE 5 OF 5	**:**	Reactive Green HE4BD	Sub node 5.3 : condensation						
DESIGN INTENT	**:**	Condensation and all other unit operations							
Guide Word	**Parameter**	**Deviation**	**Cause**	**Consequence**	**Protection Measures**	**S**	**P**	**R**	**Action Suggested**
Less.	Level.	Less Level.	Less batch charging. Human error.	Thermowell may not dip. Unsafe condition.	SOP. Supervision.	3	3	9	
Other.	Hazardous chemicals Handling.	Resorcinol	Containers of this material may be hazardous when empty since they retain product residues (dust, solids)	Health Hazard Inhalation of dust causes irritation to respiratory tract. Toxic effects may follow and include methemoglobinemia, convulsions, and death.	SOP. Supervision.	4	4	16	Maintain Antidotes

Annexure 6: DMP (enclosed separately)