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# SAFETY REPORT



**INDIAN FARMERS FERTILISER CO-OPERATIVE LIMITED**

**PARADEEP UNIT, Distt. - JAGATSINGHPUR, ODISHA**

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## Chapter- 1

### 1.0 THE NAME AND ADDRESS OF THE PERSON FURNISHING THE INFORMATION

In accordance with Rule 9 (1) of the Orissa Factories (Control of Major Accident Hazard) Rules, 2001, this safety report had been prepared on the guidelines of the format provided under **Schedule- VIII** and submitted to the office of Director Factories & Boilers Odisha on 14-12-2011.

Subsequently; The Safety Report is **updated** In accordance with **Rule 10** of the **Orissa Factories (Control of Major Accident Hazard) Rules, 2001** and submitted on 09.07.2015 Further, the report is updated and being submitted on 27.11.2020 on behalf of the phosphatic fertilizers manufacturing complex of Indian Farmers Fertiliser Co-Operative Ltd. (IFFCO) located at Vill- Musadia, PO-Paradeep at Jagatsinghpur district in the state of Odisha.

The name and address of the person furnishing the information is as follows.

**Name : Shri G.K. Gautam**  
**Director (Technical) & Occupier**

**Address : Indian Farmers Fertiliser Co-Operative Ltd.**  
**Paradeep Unit**  
Vill-Musadia, PO- Paradeep, Distt. -Jagatsinghpur  
Odisha-754142

## Chapter – 2

### 2.0 DESCRIPTION OF THE INDUSTRIAL ACTIVITY

#### 2.(a) SITE DESCRIPTION

##### SITE:

The Indian Farmers Fertiliser Co Operative Limited (IFFCO) was registered as a multi-unit co-operative society, under the co-operative societies act on 3rd November, 1967, IFFCO, a pioneer in the co-operative sector, has been marking a steady progress in the field of Fertiliser production, marketing and rendering services to the farming community.

IFFCO is the federation of more than 35,000 co-operative societies from national to primary level spread over all states and union territories. IFFCO's five modern fertilizer plants, situated in Gujarat state at Kalol and Kandla, in Uttar Pradesh state at Phulpur & Aonla and in Odisha state at Paradeep, having installed annual capacity of 42.42 lakhs MT for Nitrogenous fertilizer and 43.35 lakhs MT for Phosphatic fertilizers.

IFFCO Paradeep unit has an installed annual capacity of 19.2 lakhs MT of complex Phosphatic fertilizer. This unit was earlier owned by Oswal Chemicals and Fertilizers Ltd. (OCFL) & it was taken over by IFFCO w.e.f 1st October, 2005.

##### PLANT:

The Phosphatic Fertilizers manufacturing complex of Indian Farmers Fertiliser Cooperative Ltd. (IFFCO) is located at Musadia village, Paradeep in Odisha state, which is one of the deepest major ports along the east coast.



Paradeep is located at a distance of about 120 km from the state capital Bhubaneswar, on the national highway No NH 5A in Odisha. Paradeep Port facilities are located on the South and South-east side of the Complex. While, Mahanadi River runs along with the North and North-East side of the boundary wall of the complex.

IFFCO Township is located on the North-West of the site near the Plant Gate. The main gate of the complex opens to a 28-meter-wide road leading to the Paradeep town & Port facilities. The major installations located in the vicinity of the complex include those of Paradeep Port Trust, IOCL Refinery, PHB Pipe Line, Paradeep Phosphates Limited, AM & NS India Ltd. and POL terminals of Oil Companies (IOCL, BPCL & HPCL). Paradeep is also accessible by Rail transport.

FEATURE	DETAILS
Longitude	86° 40' 0" E
Latitude	20° 18' 30" N
Village, Tehsil, District, State	At: Musadia, PO: Paradeep, Kujang Tehsil, Jagatsinghpur, Odisha
Max. Temp.	40°C.
Min. Temp.	10°C.
Average Relative Humidity	70-80%
Annual Rainfall	1475 mm
Land Availability	2075.677 acres
Topography	Plain with Sea Coast at 5 Km
Soil Type	Unconsolidated Sand with or without clay, silt
Nearest River	Mahanadi
Bay of Bengal	5 Km
Nearest Highway	NH 5A
Nearest Railway Station	Paradeep
Nearest Railway Junction	Cuttack - 85 Km.
Nearest Village	Musadia - 1 Km
Nearest Industries	Essar Steel -1 Km, Paradeep Phosphates Ltd. - 7 Km
Nearest Air Port	Bhubaneswar-120 Km
Nearest Forest	Hatmundia - 5 Km

Name & Address Of The Factory	IFFCO, Paradeep Unit At- Musadia, PO: Paradeep Tahesil- Kujang Dist- Jagatsinghpur, Odisha Tele fax No.- 06722-224112 License No. JS-54
Name & Designation Of Occupier	Name: Shri G.K. Gautam, Director (Technical) Cell: 9412736650 Telephone No. +91- 11-42592607 E-mail: gkgautam@iffco.in
Name & Designation Of Factory Manager	Name: Shri K.J. Patel (Unit Head, Director) Cell: 9937238366 Telephone No. 06722-224001 E-mail: kjpatel@iffco.in

site.

## 2. (b) CONSTRUCTION DESIGN

The plant largely comprises process reactors, storage tanks, compressors, pumps, pressure vessels, columns, pipelines, material handling equipment and loading / unloading facilities for different raw materials and products, etc. These facilities and equipment have been designed in compliance with well-recognized national and international standards. All the manufacturing areas are provided with AC & Palruf sheet roofs supported on MS columns and are also provided with AC & Palruf sheet enclosures. All the buildings including the administration building, control rooms, substations etc are made of RCC slabs roof and brick masonry walls i.e., class “A” construction. The construction of manufacturing blocks is also as per standards and the supports & other structures have been designed to withstand the cyclonic conditions at the site.

## 2. (c) PROTECTION ZONES, SEPARATION DISTANCES

In view of handling of large quantities of toxic/flammables / combustibles like Ammonia, fuels (HSD & Furnace Oil), Sulphur etc. in some areas, the entire area of the plant has been classified into various zones (0,1 & 2 etc.) in line with the relevant standards. All electric fittings installed in the hazardous zones have been provided with flame proof type enclosures. Dust proof electrical fittings have been installed in the areas with high dust concentrations like sulphur handling yard / areas, etc.

The layout of the plant satisfies the requirements under the Factories Act, Explosive Rules, OISD standards, Indian Petroleum Rules, etc and the separation distances among various facilities (including flares, control rooms, storages, etc.) are in compliance with these standards and guidelines.

## 2. (d) ACCESSIBILITY OF THE PLANT

The Plant is accessible by road as it is located at a distance of about 110 KM from the state capital Bhubaneswar near village Musadia on the national highway NH-5A in Odisha. Besides, Paradeep is also accessible by rail transport. The complex presently has only one gate, which opens to a 28m wide road connecting the sprawling complex to the national highway.

**2. (e) MAXIMUM NUMBER OF PERSONS WORKING ON THE SITE AND PARTICULARLY OF THOSE PERSONS EXPOSED TO THE HAZARDS (MANPOWER)**

The complex, with labour intensive operations, has a total manpower of 4920 including 1207 employees and 3713 casual labours. In view of continuous process, all the plants operate continuously for 24 hours in three shifts on all seven days in a week. Shift 'A' commences at 0600 hours, shift 'B' at 1400 hours while shift 'C' at 2200 hours. The maximum attendance in the plant is expected during the General shift, which operates between 0800 and 1700 hours for six days in a week. Therefore, the plant remains occupied for all 24 hours. Most of the employees reside at the residential township of IFFCO located beside the main gate. The maximum persons inside the plant are likely to be present during the general shift on working days. Besides the permanent employees of the plant in general & morning shifts, these may include the official visitors, drivers of tank trucks & DAP trucks and contract labour.

## Chapter – 3

### 3.0 DESCRIPTION OF THE PROCESS

#### 3.(a) TECHNICAL PURPOSE OF THE INDUSTRIAL ACTIVITY

The phosphatic fertilizers complex is engaged in manufacturing of following materials:

- Sulphuric Acid ( 2 x 3500 MTPD)
- Phosphoric Acid (One unit of 2650 MTPD)
- DAP / NP / NPK Fertilisers ( 3 x 2090 MTPD)

The Sulphuric Acid plant is based on the technology supplied by LURGI GmbH, Germany, while Jacobs Engineering Group Inc., USA are the technology licensors for the Phosphatic Acid and DAP / NPK plants. Besides, the complex has its own captive power plant of 110 MW capacities. This Energy Centre is equipped with two turbo-generators, each of 55 MW capacities.

The basic raw materials used in manufacturing various intermediates and final products are as follows

SL. NO.	NAME OF THE RAW MATERIAL	MODE OF ARRIVAL AT THE PLANT	QUANTITY OF ONE TIME STORAGE PER MONTH MAXIMUM	STORAGE CAPACITY	TYPE OF STORAGE	SIZE OF THE STORAGE AREA
1	Ammonia	Through pipe line from ship, berthed at IFFCO jetty	18,000 MT	20,000 MT	Above Ground Tank	OD- 45 M H- 20.5 M
			18,000 MT	20,000 MT	Above Ground Tank	OD- 45 M H- 20.5 M
			9,000 MT	10,000 MT	Above Ground Tank	OD- 31.4 M H- 20.5 M
			18,000 MT	20,000 MT	Above Ground Tank	OD- 45 M H- 20 M
2	Sulphur	Through belt conveyor from ship, berthed at IFFCO jetty	54,000 MT	60,000 MT	Above Ground Silo	L- 150 Mtrs W- 59 Mtrs H- 14 Mtrs
			43,200 MT	48,000 MT	Above Ground Silo	L- 160 Mtrs W- 40 Mtrs H- 14 Mtrs
3	Rock Phosphate	Through belt conveyor from ship, berthed	68,000 MT	75,000 MT	Above Ground Silo	L- 204 Mtrs W- 37 Mtrs H- 16 Mtrs

		at IFFCO jetty	68,000 MT	75,000 MT	Above Ground Silo	L- 204 Mtrs W- 37 Mtrs H- 16 Mtrs
			90,000 MT	1,00,000 MT	Above Ground Silo	L- 228 Mtrs W- 40.4 Mtrs H- 16 Mtrs
			Under Construction	1,00,000 MT	Above Ground Silo	L- 228 Mtrs W- 40.4 Mtrs H- 16 Mtrs
4	Coal	Through trucks	2,00,000 MT	2,50,000 MT	Open Yard	25,000 Sq. M.
5	Molten Sulphur	Through trucks	233 MT	259MT	Underground pit	L- 18 Mtrs W- 4Mtrs DP- 2Mtrs
6	Potash	Through belt conveyor from ship, berthed at IFFCO jetty	72,000 MT	80,000 MT	Above Ground Silo	L-315Mtrs W-58 Mtrs H-18 Mtrs

Ammonia, sulphur & rock phosphate are received through marine transport mode in ships, which are unloaded at the captive berth of IFFCO at Paradeep port. Liquid ammonia is transferred through an insulated pipeline to the three refrigerated storage tanks (3 x 20,000 MT + 1 x 10,000 MT capacities), which are located at the southern most corner of the complex. While, Rock Phosphate Sulphur are transferred vide a 5 KM long conveyor belt to their respective yards located at the complex.

### 3.(b) BASIC PRINCIPLES OF THE TECHNOLOGICAL PROCESS

The basic principles of various technological processes employed for manufacturing various intermediates and the final product are based on the technology provided by M/s Lurgi GmbH, Germany for Sulphuric Acid Manufacturing Process and M/s M/s-Jacobs Engg. Group, USA for Phosphoric acid Manufacturing process as well as DAP / NP / NPK Fertilizer Manufacturing Process.

### 3. (c) PROCESS AND SAFETY RELATED DATA INDIVIDUAL PROCESS STAGES

#### 3. (c).1 Sulphuric Acid Manufacturing Process

Imported sulphur is stored in Sulphur storage shed. From storage shed it is taken to three sulphur melting tanks. It is melted in the tanks, which are provided with heat from LP steam. The liquid 'Sulphur' is filtered and stored in the molten sulphur storage tank at 145°C. The molten sulphur is pump to the sulphur furnaces of two streams. The required air is supplied to furnace and sulphur is burnt in the Furnace at 1120°C. The resulting SO<sub>2</sub> of combustion gas is cooled down to 420°C in a water tube boiler and saturated steam at 61.2 kg/cm<sup>2</sup>g is generated. These gases pass through the Converters I & II, which contain V<sub>2</sub>O<sub>5</sub>. The part of the SO<sub>3</sub> generated in the converter layers 1 to 3 is absorbed in intermediate absorption tower to form 98.5% Sulphuric acid. This tower is a brick-lined packing tower operated at counter current with an approx. 98.5% Sulphuric acid trickling. To adjust the concentration of the circulated Sulphuric acid, 96% Sulphuric acid from the air-drying tower is added via control valve. Part of the product generated in the intermediate absorber unit is pumped to the final

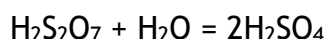
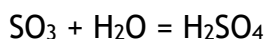
absorber as a function of the level in the pump feed tank where the product is withdrawn from the final absorber. Another part which mainly originates from the exchange volume from the dryer is returned into the drying tower via the level control of the intermediate absorption tower. Two pumps are installed in Pump Tank for acid circulation in Tower.

Candle Filters are installed at the top of the trickling unit to separate acid droplets and mist from the gas downstream of the intermediate absorption tower.

The SO<sub>3</sub> generated in the layer 4 of the Converter is absorbed in the Final absorption tower in an approx. 98.5% sulphuric acid. Final Absorption tower is connected with a pump tank in which two vertical submersible pumps are installed for acid circulation in tower and one pump is installed for taking out the product acid and sending it to the Storage Tank.

Each circulation pump discharge acid is routed through two plate type heat exchangers for cooling acid prior to trickling in acid tower. To adjust this concentration in the final absorption circuit, 96% sulphuric acid from air drying tower is added via a Control Valve.

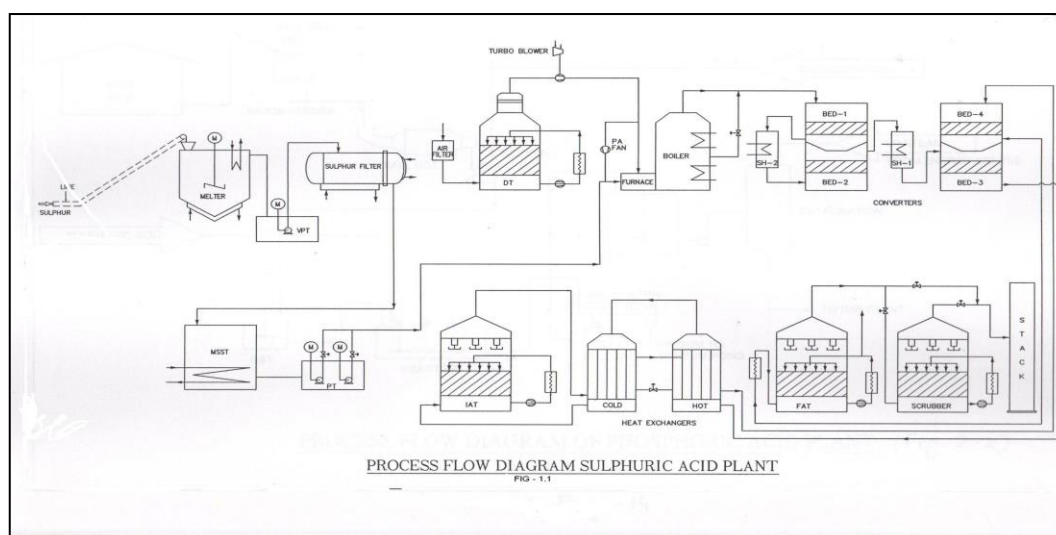
At the top of final absorption tower trickling system candle filters are installed. The gas leaving the candle filter of the final absorption with acid mist concentration of 40 mg. SO<sub>3</sub> per NM<sup>3</sup> gas and SO<sub>2</sub> concentration of < 0.035% is routed through the tail gas stack to the atmosphere.



In each stream generates 185.3 MTPH of superheated steam at 61.2kg/cm<sup>2</sup> and 480°C, which is used to generate 55MW power each and some part of steam used to run Air Blower.

The Plant is equipped with Alkali Scrubber Unit which is designed by FACT Engineering and Design Organization, Kerala. The objective of the scrubber unit is to treat the effluent gas during start up and to control the sulphur dioxide concentration within the prescribed limits. This system guaranties SO<sub>2</sub> concentration in outlet gas during plant start up to maximum of 200 mg / NM<sup>3</sup>

## PROCESS FLOW DIAGRAM OF SULPHURIC ACID PLANT



### **3. (c).2 PROCESS DESCRIPTION OF PHOSPHORIC ACID PLANT**

The Plant is based on wet process dehydrate route.

The main sections in the plant are:

- **Grinding Reaction Section**
- **Filtration Section**
- **Concentration & Fluorine Recovery Section**

#### **Grinding & Reaction:**

The designed plant capacity is 2650 MTPD of 100%  $P_2O_5$ . Rock Phosphate is reclaimed from three Rock silos and is transferred to the four Ball mills with weigh feeders. The slurry from the slurry surge tank at 68% solids is fed to the reaction compartment. This is diluted to facilitate dispersion. The Vacuum cooler circulating pumps circulate slurry through vacuum coolers.

#### **Filtration & Gypsum Disposal:**

In Filtration Unit, there are 7 Belt Filters for separating Phosphoric Acid & Gypsum. The filters pass through four flooded compartments. The vacuum system constitutes five sections. The initial filtrate is cloudy and not clear, it is taken into return acid section of Primary Filtrate Seal Tank. The balance filtrate from the first compartment is 28% product acid, which is taken into product acid section of Primary Filtrate Seal Tank. The other three flooded compartments are used for cake washing with counter current washing.

The washed Gypsum cake contain (~0.5% wt) of water soluble  $P_2O_5$  which is sluiced in the Gypsum Cake Hopper with pond water. This flows by gravity into Gypsum Slurry Tank where it is made into 20% solids slurry by adding additional pond water. This slurry is pumped to Gypsum Pond.

#### **Acid Storage and Clarification:**

The filtered acid from the product acid section containing 2% solids is pumped to weak acid clarifier. It is provided with a rake system, which moves the settled solids to a central bottom discharge cone from which the sludge of 28% solids is pumped to the single tank reactor. The clarified acid with 0.2% solids is fed to Evaporators for concentration. Also 28% acid is transferred to the DAP / NPK plants for use.

#### **Concentration Section:**

28% acid from Evaporator Feed Tanks is fed to the eight Evaporators. Each evaporator is a single stage forced circulation unit constituting of a rubber lined Flashed Chamber. The concentrated acid at a temperature of 85° C overflows from the Flash Chamber to a concentrated Acid pump, which delivers acid to strong acid Clarifier Tank. Vapors

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Phosphoric Acid and Ammonia react in the Pre-Neutraliser (PN) along with scrubber liquor from the scrubbing system. The feed rates of the acid,  $\text{NH}_3$  and Scrubber Liquor are evolved due to the exothermic nature of the reaction is utilized to evaporate considerable quantity of water from Pre-Neutraliser. These fumes along with some ammonia slip pass through the scrubbing system. The reaction slurry of Ammonium Phosphate is pumped vide “Slurry Pump” to Pipe Reactor (PCR) situated in granulator. Further, ammonia is added into Pipe Reactor to ensure the slurry at Mole Ratio 1.90. Slurry from the PCR is sprayed onto the Recycling Material that is passing through Granulator. The Slurry forms layer by layer on the recycling solids. The rolling action inside the Granulator ensures uniform distribution of slurry on the material and well-rounded granules are formed. The granulator wall is provided with flexible rubber panels to minimize build up and lumps formation. The Pipe Reactor can operate as PCR as well as slurry distributor. Different nozzles are used in the above modes. Due to exothermic reaction, the slurry is further heated up in the PCR and while being sprayed in Granulator; large quantity of water is maintained such that 1.4 to 1.5 Mole Ratio is achieved in the Pre-Neutralizer. The heat evaporated with some  $\text{NH}_3$  escaping into fumes. The fumes pass through the scrubbing system. The wet material from Granulator discharges to the Dryer. The air from combustion air fan containing gases from combustion chamber travels co-current with the solids in Dryer. Lifters inside the Dryer, lift the solids and discharge across the hot gases, thereby a better solid-gas contact prevails for efficient drying. At dryer discharge, the large lumps are broken by means of autogenously lifting flights and pass through the grizzly. Solids dried to about 1.5% Moisture at  $90^\circ\text{C}$  temperature are fed to four oversize screens (4 mm size). The +4 mm size fraction is pulverized and fed to Fines Conveyor. The -4 mm size fraction containing product and fines gets collected in a Product Surge Hopper which feeds to the Variable speed Product Screen Feed Conveyor. Speed variation of this conveyor is controlled by Recycle quantity required. The discharge material from variable speed conveyor is elevated by Product Screen Elevator and fed to four Product Screens (2 mm size). The granules in the range of - 4 mm to + 1 mm size from the Product Screens are cooled to  $50^\circ\text{C}$  in a Fluid Bed Cooler (FBC). FBC is supplied by cold air from Air Chiller, which uses liquid  $\text{NH}_3$  for cooling the air. The cold product from cooler is elevated and fed to a double-deck Polishing Screen (4mm & 2mm) where any remaining over size (i.e. +4 mm) and undersize (i.e. -2mm) particles are removed. In case of DAP Product the product after polishing Screen is transported to Bagging Plant for bagging or to Bulk silo for storage.

### **Scrubbing:**

Following are pick-up points for fumes and dust for scrubbers.

Reaction fumes from P.N. and Granulator

- De-dusting air
- Dryer Exit gases

### De-dusting air

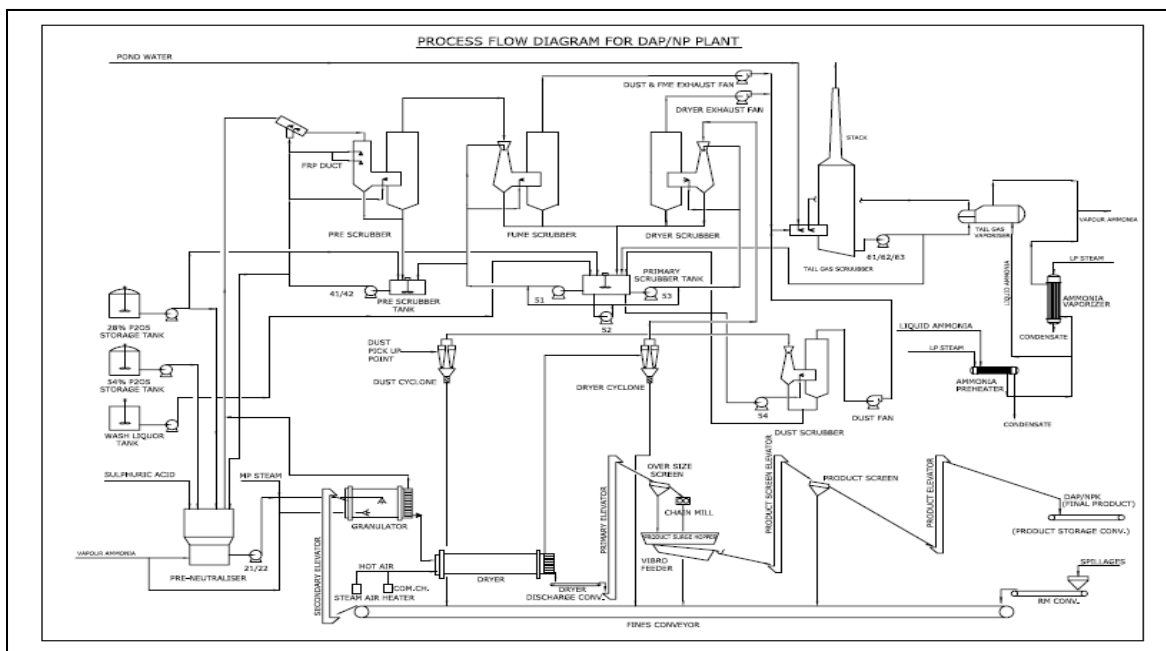
Reaction fumes are scrubbed initially in Pre-Scrubber with a solution of Mono & Di Ammonium Phosphates at 1.4 to 1.5 Mole Ratio. About 50% to 70% of the ammonia in the gases is scrubbed out. The outgoing gases are again scrubbed in the Dust & Fumes Scrubber with diluted mono ammonium phosphate and phosphoric acid and at 0.6 to 0.8 Mole Ratio. Such a two-stage scrubbing system is known as “Dual Mole” Scrubbing system. This system is known to be very efficient for ammonia and fluorine removal. The dust-laden air from various de-dusting points of the plant is fed to Dust Cyclones where 95% of the dust is recovered and fed to Fines Conveyor. The balance of dust with

air is scrubbed in the Dust and Fumes Scrubber along with the reaction fumes passing out from Pre-Scrubber.

## Dryer Exit gases

The Dryer exit gases containing fertilizer dust and  $\text{NH}_3$  fed to Dryer Cyclones, where 95% of the dust is recovered and fed to Fines Conveyor. The remaining dust and air are scrubbed in the Dryer Scrubber with dilute solution of mono-ammonium phosphate and phosphoric acid at 0.6 to 0.8 Mole Ratio same like in Dust and Fumes Scrubber. The supply of scrubber liquor for these two scrubbers is from Primary Scrubber Tank. Dust laden Air from the product cooler containing dust is fed to the cooler cyclones where 95% of the dust is recovered and sent to Fines Conveyor. The balance of dust and air is scrubbed in the Tail Gas scrubber along with the gases out from dust & fumes scrubber and dryer scrubber. The T.G. Scrubber, the gases are scrubbed with re-circulating dilute scrubber solution to remove final traces of ammonia and to reduce fluoride contents further by additional cooling of the scrubber liquor. The cooling effect is enhanced by Tail Gas Vaporizer, which uses liquid ammonia. The final exit gases through stack are maintained well below the Environmental Norms.

## PROCESS FLOW DIAGRAM OF DI-AMMONIUM PHOSPHATE PLANT



## PROCESS DESCRIPTION OF OXYGEN PLANT

The Air at atmospheric pressure is filtered to remove the dust particles. It is then compressed to about 45kg/cm<sup>2</sup> pressure in air compressor unit and then passed through after cooler and to moisture separator, where the moisture condensed in the after cooler is separated. The air then enters to an evaporator coil (Cascade Cooler) where the temperature of compressed air drops to about 20 °C by bubbling dry Nitrogen (from Molecular Sieve dryer/distillation column) in the pool of water. Air at 20 °C exiting from evaporation coil passes into the Chilling coil tank which is having chilled water at 6-10 °C. Here moisture trapped in the air further gets condensed, which is separated in the moisture separator. Air free from moisture passes through the Oil adsorber (Activated carbon and alumina ball vessels). Here Oil Vapour carried over from Air Compressor is removed. To remove CO<sup>2</sup> and left over moisture, oil free air after Oil adsorber is passed to the Molecular

sieve drier vessels. (There are 02 driers, one will be in line for 8 hrs. and one will be in regeneration). Regeneration is done by heating (using electric heater) and cooling (by Outgoing Nitrogen gases from distillation column) Air exiting from the Molecular sieve dryer is again passed through Ceramic filter before entry to Cold Box. Air free from moisture, oil dust is entered to Cold box at 10 °C

Cold Box consists mainly of Heat Exchanger (02 Nos.), Expansion engine, Distillation Column & liquid Oxygen Pump. In the Cold Box Air initially passes through Heat Exchanger no.-1 (a multi coil type heat exchanger). Here the outgoing Oxygen (from Liq. Oxygen Pump) will cool the incoming air and Nitrogen. Outlet Temp. of air exiting from Exchanger-1 will be -100 °C. Outlet Air from Heat exchanger-1 is bifurcated into O<sub>2</sub> streams. The main air streams enter Expansion engine at 40Kg/cm<sup>2</sup> and will be expanded to 5Kg/cm<sup>2</sup> and -150 °C. the rest of the air is passed through heat exchanger No.2 and here it is cooled to about -155 °C by outgoing Oxygen(from Liq. Oxygen Pump) and Nitrogen (from distillation column). This air is then expanded by an expansion valve to form liquid air.

Both the air streams will now enter bottom portion of the Lower column of the cold Box. As the air enters the Lower Column, after the Expansion Engine and after air Expansion Valve (R1) a part of this air condenses into liquid and falls at the bottom of the column. This liquid is about 40% Oxygen and 60% nitrogen and usually called the “Rich Liquid”.

A part of the air in this column evaporates and rises to the top of the column touching the condenser, which is cooler than the Lower Column. As this air touches the condenser, it condenses into liquid on top of the Lower column. This Liquid is generally 99% Nitrogen and being poor in Oxygen, it is called “Poor Liquid”.

Final separation of the O<sub>2</sub> fractions (Oxygen & Nitrogen) is achieved in the Upper Column of the Cold Box. Both the poor Liquid and the Rich Liquid are carried into the Upper Column by 02 Expansion valves and the pressure, drops from 4.5Kg/cm<sup>2</sup> in the lower Column to 0.5 Kg/cm<sup>2</sup> in the Upper Column. This Rich Liquid enters the middle of the Upper Column and as it flows down, Nitrogen evaporates and Oxygen continues as liquid. The Poor liquid(Nitrogen 99%) enters the top of the column and as it flows down the column, it comes in contact with any evaporating oxygen and condenses the same into

liquid, while the Nitrogen itself becomes a gas as it more volatile. This process takes place in each tray of the distillation column.

The entire gaseous Nitrogen is piped out from the top of the column through the Heat Exchangers.

The Liquid Oxygen at the bottom of the column is carried to a Liquid Oxygen Pump from which it is pumped and again passed through the Heat Exchanger where it evaporates into the Gaseous Oxygen, filling the cylinders with gas and giving up its cold to the incoming air.

### **MANUFACTURING PROCESS OF CAPTIVE POWER PLANT (TURBO-GENERATORS)**

The steam turbine is a single cylinder, single shaft, 18 stage condensing type unit supplied by M/s- LMZ Russia. This prime mover continuously converts the energy of high pressure, high temperature steam supplied by the steam generator into shaft work with the low temperature steam exhausted to the condenser. The automatic regulation and protection system is intended for control of the turbine valves in all operating modes of the turbine, and for automatic cut-off of the steam supply to turbine when their maximum permissible limits or any other emergency situations requiring shut down of the machine. The power plant is supported with ABB make dual Channel AVR for better redundancy. The Protection Systems of M/s- ALSTOM and M/s- ABB is an art of technology in itself.

## STEAM GENERATORS:

### AFBC Coal fired Boilers (2 x 110 TPH)

The steam generator is a Bi-drum, natural circulation, water tube balance draft, top supported construction, equipped with Atmospheric Fluidized Bed Combustion system having in-bed evaporator & in-bed super heater coils with under bed fuel feeding system supplied by M/s-Thermax ( India ) Ltd. having an efficiency of 85.4 %. Fluidized bed combustion technology has distinct advantages for burning solid fuels and recovering the energy to produce steam.

The process features a mixture of particles suspended in upward flowing gas streams the combination of which exhibits fluid like properties. Combustion takes place in the bed with high heat transfer to the furnace at low combustion temperatures. Key benefits of this process are fuel flexibility and reduced emissions.

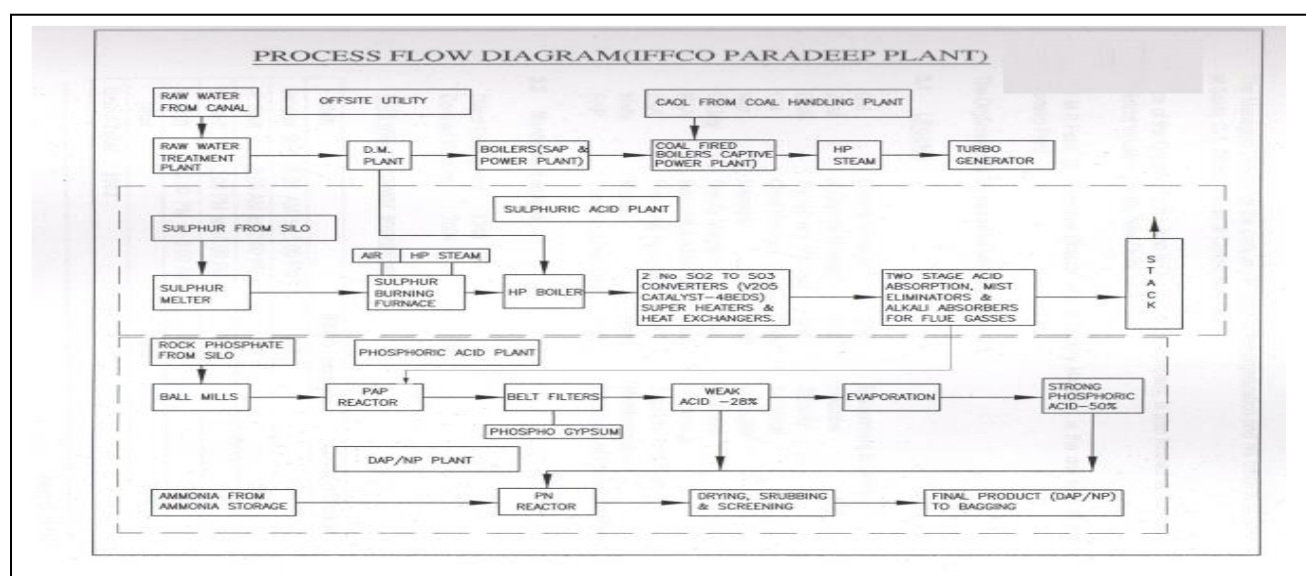
Coal handling plant:

The solid fuel of (-6mm) size for the steam generators is achieved by the coal handling plant having a crushing capacity of 120 MT / Hr.

### BAGGING PLANT

The bulk fertilizer produced taken either directly to the bagging unit or to the storage shed. There are two storage sheds of 20,000 MT capacities each. Fertilizer from storage is reclaimed with the help of reclaiming scrappers and conveyed to Bagging Unit for packaging in the HDPE bags of 50 kg capacity. There are 14 bagging slats each containing one sewing machine. The product is stored in 14 hopper of 50 tonne capacity above each slat. The material from each hopper is taken to feeders where load cells weigh the material for 50 kg and release for packing whenever bag is placed in the position to be filled. After filling the bags are stitched and taken for loading. The railway siding is situated at a distance of 8 km (approx.) where rakes are loaded for dispatch to different parts of the country.

## PROCESS FLOW DIAGRAM



### **3.(e) SAFETY- RELATED TYPE OF UTILITIES**

The safety related types of utilities available in the plant are as follows:

#### **i) Air**

Compressed breathable air is available in cylinders and pipelines at high and low pressure, respectively. This air can be utilized through suitable valves and mask for comfortable breathing in the atmosphere even free of oxygen for carrying out any emergency operation.

#### **ii) Water**

The whole plant is protected by means of a standard fire hydrant system. In addition, the plant has a Fire Station equipped with three Fire Tenders and firefighting team comprising well qualified and experienced fire Engineers, fire Inspector & Firemen. Adequate supply of water (as per standards) is available at the site for operating fire hydrants and monitors to tackle emergency arising out from ammonia leakage / release, fires involving fuels, sulphur, etc. The fire hydrant system is equipped with 310 (equivalent) hydrant outlets and static water storage of 20,000 m<sup>3</sup>. Safety showers and eyewash fountains are also connected with continuous source of water supply.

#### **iii) Electricity**

In addition to normal power supply from the two Steam Turbine Generators (each of 55 MW), the complex can bank on the power supply from the state electricity board. UPS (Uninterrupted Power Supply) unit with battery back-up are provided for instrumentation, fire detection system and critical equipment.

#### **iv) DG Set**

We are having 2.5 Mega Watt DG set for power supply to run the Refrigeration system at Ammonia Storage Area in case of power failure. And thus, we can keep Ammonia Tank pressure within 250-450 mmwc even in case of power failure.

## Chapter - 4

### 4.0 DESCRIPTION OF HAZARDOUS CHEMICALS

#### 4.(a) Chemicals (Quantities, substance data on physical and Chemical properties, safety related data on explosive limits flash point, thermal stability, toxicological data and threshold limit values, lethal concentration):

The list of the hazardous chemicals handled in the complex is as follows:

SL. NO.	NAME	QUANTITY OF ONE TIME STORAGE	STORAGE CAPACITY	TYPE OF STORAGE	SIZE OF THE STORAGE AREA	REMARKS
1	Ammonia	18,000 MT	20,000 MT	Above Ground Tanks (4 Nos.)	OD- 45 M, H- 20.5 M	Qty is stored at ATM pressure & -33°C temp in insulated tanks of ( 3x20,000 MT + 1 x10,000 MT) capacity
		18,000 MT	20,000 MT		OD- 45 M, H- 20.5 M	
		9,000 MT	10,000 MT		OD- 31.4 M, H- 20.5 M	
		18,000 MT	20,000 MT		OD- 45 M, H- 20.5 M	
2	Chlorine	900 KG	930 KG	Tonners (5 Nos.)	OD- 0.75 M, l- 2.108	Raw Water Treatment Plant
		900 KG	930 KG		OD- 0.75 M, l- 2.108	Raw Water Treatment Plant
		900 KG	930 KG		OD- 0.75 M, l- 2.108	SAP Cooling Tower
		900 KG	930 KG		OD- 0.75 M, l- 2.108	EC Cooling Tower
		900 KG	930 KG		OD- 0.75 M, l- 2.108	Ammonia Storage Cooling Tower
3	Sulphur	54,000 MT	60,000 MT	Above Ground Silo 1 No's	L- 150 Mtrs, W- 59 Mtrs, H-14 Mtrs	Stored in Sulphur storage silo
		43,200 MT	48,000 MT	Above Ground Silo 1 No's	L- 160 Mtrs, W- 40 Mtrs, H-14 Mtrs	Stored in Sulphur storage silo
4	Sulphuric Acid	12,000 MT	20,000 MT	Above Ground Tank 6 No's	D- 40 Mtrs H-10 Mtrs	Qty is stored in tanks of ( 2x20,000 MT + 4 x25,000 MT) capacity
		12,000 MT	20,000 MT		D-40 Mtrs H- 10 Mtrs	
		16,000 MT	25,000 MT		D- 40 Mtrs H- 12.2 Mtrs	
		16,000 MT	25,000 MT		D-40 Mtrs H-12.12 Mtrs	
		16,000 MT	25,000 MT		D- 40 Mtrs H- 12.12 Mtrs	
		16,000 MT	25,000 MT		D- 40 Mtrs H- 12.12 Mtrs	
5	Phosphoric Acid	2,600 MT	2,600 MT	1 No of Above Ground Tank	D- 20 Mtrs H- 7.5 Mtrs	Tank is located at Phosphoric acid plant

SL. NO.	NAME	QUANTITY OF ONE TIME STORAGE	STORAGE CAPACITY	TYPE OF STORAGE	SIZE OF THE STORAGE AREA	REMARKS
		12,300 MT	12,300 MT	In 2 no's of Above Ground Tanks	D- 20 Mtrs H- 13.5 Mtrs	Tank is located at Phosphoric acid plant
		7000 MT	7000 MT	1 no of Above Ground Tank	D- 20 Mtrs H- 14.5 Mtrs	Tank is located at Phosphoric acid plant
		25,000 MT	25,000 MT	1 No of Above Ground Tank	D- 40 Mtrs H- 12 Mtrs	Tank is located at Export tank area
		16,600 MT	16,600 MT	1 No of Above Ground Tank	D- 36 Mtrs H- 11 Mtrs	Tank is located at Export tank area
		1400 MT	1400 MT	1 No of Above Ground Tank	D- 12 Mtrs H- 11 Mtrs	Tank is located at Phosphoric acid plant
		22,700 MT	22,700 MT	In 10 No's of Above Ground Tanks	D- 14 Mtrs H- 11.2 Mtrs	Tank is located at Di-Ammonium Phosphate plant
		12700 MT	12700 MT	1 No. of A/G Tank	D- 36 Mtrs H- 10 Mtrs	Tank is located at Phosphoric acid plant
6	Sodium Hydroxide	15 M <sup>3</sup>	15 M <sup>3</sup>	1 No of Above Ground Tank	D- 2.5 Mtrs H- 3 Mtrs	Vertical storage tanks located in Utility & off site
		13 M <sup>3</sup>	13 M <sup>3</sup>	1 No of Above Ground Tank	D- 2.3 Mtrs H- 3.2 Mtrs	Vertical storage tanks located in Utility & off site
		50 M <sup>3</sup>	50 M <sup>3</sup>	1 No of Above Ground Tank	D- 4 Mtrs H- 4 Mtrs	Vertical storage tanks located in Sulphuric acid plant
7	High Speed Diesel	450 KL	502 KL	1 No of Above Ground Tank	D- 8 Mtrs H- 10 Mtrs	Vertical storage tanks located in Utility & off site
8	Furnace oil	810 KL	902 KL	1 No of Above Ground Tank	D- 10 Mtrs H- 11.5 Mtrs	Vertical storage tanks located in Utility & off site
9	Transformer Oil	193 KL	193 KL	In 14 No's of Transformers	Rating 16 MVA to 80 MVA	Filled in transformers
	Transformer Oil	6.3 KL	6.3 KL	DRUM	Each drum 210 Lts	Store
10	Molten Sulphur	233 MT	259 MT	Under Ground pit	L-18 Mtr ,W- 4 Mtrs, DP- 2 Mtrs	Tank is located at Sulphuric Acid Plant

The chemicals handled at IFFCO plant largely include flammables & toxic gases. The NFPA rating & other properties of chemicals handled at the facilities of IFFCO are mentioned in the **Table-4.1a & 4.1b, given below:**

**TABLE – 4.1a  
CHEMICAL PROPERTIES**

Name of Chemical	Ignition temp (°c)	Explosive limits (%)		Flash point (°c)	Boiling point (°c)	IDLH values (ppm)	Chemical Property
		LEL	UEL				
Ammonia	651	16	25	Gas	- 33	300	Soluble in water
Chlorine	-	Non-Combustible		-	- 34	10	Oxidising agent
Sulphur	232	-	-	207	-	-	Burning Sulphur produces toxic Sulphur-Di-oxide gas.
Sulphuric Acid	-	Non-combustible		-	--	-	Highly water reactive
Phosphoric Acid	-	Non-combustible		-	--	-	Soluble in water
Sodium Hydroxide	-	Non-combustible		-	--	-	Water reactive
High Speed Diesel	230 to 250	0.5	5.0	>32	193-293	-	Class-B Flammable
Furnace oil	263	1.0	5.0	66	185-500	-	Class-C Flammable
Transformer Oil	242	0.9	7.0	145	>290	-	Flammable
Oxygen	-	-	--	-	-182.98	-	Oxidizer

**TABLE – 4.1 b  
NFPA Ratings of Chemicals**

Chemical Handled	Health Rating	Flammability	Reactivity
Ammonia	3	1	0
Chlorine	3	0	0
H <sub>2</sub> SO <sub>4</sub>	3	0	2
Caustic soda	3	0	1
Sulphur	2	1	0
Phosphoric Acid	2	0	0
Diesel(HSD)	1	2	0
Furnace Oil	0	2	0
Transformer Oil	1	1	0
Oxygen	3	0	0

From **Table – 4.1b**, the following conclusions are drawn with respect to health, flammable and reactivity criteria.

## 1. Health

The highest health hazard rating is reported for Ammonia (3) and Chlorine (3) gases. These gases are known for their toxic properties and can cause varying degrees of injuries depending on their concentrations. It may, however, be noted that except for liquid ammonia. Chlorine is stored in tonners.

Health hazard rating of acids, Sulphuric acid (3) & Phosphoric acid (2) and base i.e., Caustic Lye (3) are also high. However, these ratings only indicate the highly corrosive nature of these acids / bases. Skin contact with these corrosives can cause chemical burns.

Therefore, the major toxicity hazard at the site could be due to bulk liquid ammonia storage tanks and chlorine tonners. Possible failures involving release of both the gases have been simulated using softwares to estimate the possible impact distances.

## 2. Flammable / Combustible

The only flammable chemicals handled are High Speed Diesel (2) and Furnace Oil (2), Transformer Oil (1) & Sulphur (1). Fuels like High Speed Diesel (HSD) and Furnace Oil, each with a flammability factor of 2, need to be heated moderately above ambient temperature before they could ignite. These flammable liquid fuels, on release, may form a large pool. On an encounter with a source of ignition, there could be a pool fire.

Ammonia (1) in liquid state is difficult to ignite. However, in vapour phase, it can ignite and explode on an encounter with a source of ignition. Sulphur (1) powder, used as the principle raw material for manufacturing sulphuric acid, is an easily ignitable and a highly combustible solid. Sulphur dust and vapours form an explosive mixture with air. Burning sulphur produces toxic sulphur dioxide (SO<sub>2</sub>) gas.

## 3. Reactivity

Sulphuric acid (2) and Caustic Lye (1) are the only reactive chemicals handled at the IFFCO complex.

The reactivity factor of these chemicals is high due to their exothermic reaction on contact with water.

## EXPLANATION OF NFPA CLASSIFICATION

### Classification

Health Hazard	Definition
4	Materials which on very short exposure could cause death or major residual injury even though prompt medical treatment were given.
3	Materials which on short exposure could Cause serious temporary or residual injury even though prompt medical treatment were given.
2	Materials which on intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical treatment is given
1	Materials which on exposure would cause irritation but only minor residual Injury even if no treatment is given
0	Materials which on exposure under fire conditions would offer no hazard Beyond that of ordinary combustible material.

### Flammability

Flammability Hazard	Definition
4	Materials which will rapidly or completely vaporize at atmospheric pressure normal ambient temperature, or which are readily dispersed in air and which will burn readily.
3	Liquids and solids that can be ignited under almost all ambient temperature conditions.
2	Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur.
1	Material that must be preheated before ignition can occur.
0	Materials that will not burn.

### Reactivity

Reactivity Hazard	Definition
4	Materials which in themselves are readily capable of detonation or of explosive decomposition or reaction at normal temperature and pressures.
3	Materials which in themselves are capable of detonation or explosive reaction but require a strong initiating source or which must be heated under confinement before initiation or which react explosively with water.
2	Materials which in themselves are normally unstable & readily undergo violent chemical change but do not detonate. Also materials which may form potentially explosive mixtures with water.
1	Materials which in themselves are normally stable, but which can become unstable at elevated temperature and pressures or which may react with water

	with some release of energy but not violently.
0	Materials which in themselves are normally stable, even under fire exposure conditions, and which are not reactive with water.

## MATERIAL SAFETY DATA SHEET OF CHEMICALS

### 1. AMMONIA

#### (i) CHEMICAL IDENTITY :

Product Name	<b>AMMONIA</b>
Chemical classification	Alkaline, Corrosive
Synonyms	Anhydrous ammonia
Trade Name	Ammonia
Formula	<b>NH<sub>3</sub></b>
C.A.S. Number	7664-41-7
U.N. Number	1005
Shipping name Codes / Label	Ammonia Anhydrous
HAZCHEM Code	2RE

#### (ii) PHYSICAL AND CHEMICAL PROPERTIES :

Physical State	Gas (liquid under pressure)
Appearance	Colourless gas and liquid
Odour	Pungent and irritating odour
Boiling Point ( °C)	- 33.3
Melting / Freezing Point ( °C)	- 77.7
Vapour pressure @ 25°C (mm-Hg)	7600
Vapour Density (air =1)	0.6
Solubility in water @ 30°C	Highly Soluble
Specific Gravity (Water =1)	0.77
pH	11.7
Others	Molecular Weight - 17

#### (iii) FIRE AND EXPLOSIVE HAZARDS DATA :

Explosion /Flammability	Yes
LEL (%)	16 v/v
UEL (%)	25 v/v
Flash Point (°C)	Not Applicable

Auto ignition Temperature (°C)	651
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**(iv) REACTIVE HAZARDS :**

Impact(Hazardous Combustion Products)	Nil
Static Discharge(Hazardous Decomposition Product)	Nil
Reactivity ( Conditions to avoid)	Reactive with chlorine, violent reaction with acids, strong oxidants, halogens, highly soluble in water generating heat.
Hazardous Polymerization	Nil
Incompatibility	Materials to avoid Strong oxidizers, hypo chlorite bleaches, mercury chlorine, nitrogen oxide, halogens, Aluminium, Zinc, Copper etc.

**(v) HEALTH HAZARD DATA:**

Routes of Entry	Eyes, Respiratory tract and skin contact.	
Effects of Exposure / Symptoms	<ul style="list-style-type: none"> <li>Liquid ammonia causes cold burns on contact.</li> <li>400-700 ppm causes upper respiratory tract irritation.</li> <li>1000-2000 ppm causes severe coughing, severe eye, and nose and throat irritation.</li> <li>3000 – 4000 ppm could be fatal after 30 minutes exposure.</li> </ul>	
Permissible Exposure Limit ( PEL)	25 ppm	17 mg/m <sup>3</sup>
Short Term Exposure limit (STEL)	35 ppm	24 mg/m <sup>3</sup>
Threshold Limit Value (TLV)	25 ppm	17 mg/m <sup>3</sup>
Immediately Dangerous to Life and Health (IDLH)	300 ppm	208 mg/m <sup>3</sup>

**(vi) HEALTH HAZARD DATA:**

Routes of Entry	Eyes, Respiratory tract and skin contact.	
Effects of Exposure / Symptoms	<ul style="list-style-type: none"> <li>Liquid ammonia causes cold burns on contact.</li> <li>400-700 ppm causes upper respiratory tract irritation.</li> <li>1000-2000 ppm causes severe coughing, severe eye, nose and throat irritation.</li> </ul>	

	<ul style="list-style-type: none"> <li>3000 – 4000 ppm could be fatal after 30 minutes exposure.</li> </ul>
NFPA Hazard Signal	Health - 03, Flammability - 01. Stability - 0

**(vii) SAFE USAGE DATA**

Protective Equipment Required	Eyes (Specify)	Safety Goggles
	Respiratory (Specify)	Breathing Apparatus Set
	Gloves (Specify)	Hand Gloves
	Clothing (Specify)	Alkali resistant apron/suit
	Others (Specify)	Body protective Suit
Precautions	Handling & Storage	To be stored in recommended vessels.
	Others (Specify)	Handle with the use of PPE only.

**(viii) EMERGENCY RESPONSE DATA**

Fire	Fire Extinguishing Media	Stopping the flow of gas rather than extinguishing the fire is usually the best procedure to follow when escaping gas is burning. Use water spray, fog or alkaline foam.
	Special Procedures	Wear SCBA set while attending ammonia leakages.
	Unusual Hazards	Spills
Exposure	First Aid Measures	Any person affected by ammonia should be taken immediately into fresh air. Eyes should be washed with an abundance of clean water for at least fifteen minutes. Any contaminated cloths with ammonia liquid should be drenched with water & be removed as soon as possible and affected point should be washed with copious amounts of water. Patient should be kept warm. Administer oxygen if available in case of difficulty breathing or give artificial respiration. Must be consulted with doctor.
Spills	Steps to be taken	To be contained and mitigated with alkaline foams for avoiding rapid evaporation.
	Waste Disposal Method	Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable central, state and local regulations.

**(ix) ADDITIONAL INFORMATION :**

Ammonia is used as an intermediate for Di-ammonium Phosphate or Mixed Fertiliser Production at IFFCO Paradeep.

**2. CHLORINE**

**(i) CHEMICAL IDENTITY**

Product Name	<b>CHLORINE</b>
Chemical classification	Acidic nature
Synonyms	Chlorine, Bertholite
Trade Name	Chlorine
Formula	<b>Cl<sub>2</sub></b>
C.A.S. Number	7782-50-5
U.N. Number	1017
Shipping name Codes / Label	Chlorine/ DOT Label : Non Flammable gas, Poison A
HAZCHEM Code	IMO class-2.3
Hazardous waste Identification Number	17

**(ii) PHYSICAL AND CHEMICAL PROPERTIES**

Physical State	Liquid / Gas
Appearance	Green-Yellow Gas
Odour	Pungent
Boiling Point ( °C)	- 34.5
Melting / Freezing Point ( °C)	- 101
Vapour pressure @ 35°C (mm-Hg)	> 1 atm. ( 4800 )
Vapour Density(air =1)	2.50
Solubility in water @ 30°C	Slightly soluble
pH	NA
Others	Molecular Weight - 71

**(iii) FIRE AND EXPLOSIVE HAZARDS DATA**

Explosion /Flammability	Non Flammable
Combustible Liquids	Does not burn but supports combustion
Explosive Material	Reacts explosively or forms explosive compounds with many chemicals
Corrosive Material	Wet Chlorine is corrosive to most of the metals. Chlorine reacts with water to form HCL acid and hypochlorous acid which are highly corrosive.

Oxidiser	Highly oxidizing agent
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#### (iv) REACTIVE HAZARDS

Impact (Hazardous Combustion Products)	Toxic product are generated and combustible burn in Chlorine
Reactivity (Conditions to avoid)	Reaction with alcohol metals, Sulphites, tri-alkylboranes
Incompatibility	Combustible substances, Finely divided metals.

#### (v) HEALTH HAZARD DATA

Routes of Entry	Eyes, Respiratory tract and skin contact.										
Effects of Exposure / Symptoms	Causes eye irritation, sneezing, copious salivation, general excitement and restlessness. High concentration causes respiratory distress and violent coughing. Often with retching. Death may result from suffocation. <ul style="list-style-type: none"> <li>• 30 ppm causes intense coughing fits &amp; burning.</li> <li>• 40 ppm causes cardiac paralysis &amp; bronchitis.</li> <li>• 1000 ppm danger to life even after few deep inhalations</li> </ul>										
LD 50(rat)	NA										
LC 50 (rat)	293 ppm/1 Hour										
Exposure Limit : Permissible Exposure Limit ( PEL) Short Term Exposure Limit(STEL) Threshold Limit Value (TLV) of ACGIH Immediately Dangerous to Life and Health (IDLH) Odour Threshold	<table> <tr> <td>1 ppm</td><td>3 mg/m<sup>3</sup></td></tr> <tr> <td>3 ppm</td><td>9 mg/m<sup>3</sup></td></tr> <tr> <td>1 ppm</td><td>3 mg/m<sup>3</sup></td></tr> <tr> <td>10 ppm</td><td>29 mg/m<sup>3</sup></td></tr> <tr> <td>3.5 ppm</td><td>10.2 mg/m<sup>3</sup></td></tr> </table>	1 ppm	3 mg/m <sup>3</sup>	3 ppm	9 mg/m <sup>3</sup>	1 ppm	3 mg/m <sup>3</sup>	10 ppm	29 mg/m <sup>3</sup>	3.5 ppm	10.2 mg/m <sup>3</sup>
1 ppm	3 mg/m <sup>3</sup>										
3 ppm	9 mg/m <sup>3</sup>										
1 ppm	3 mg/m <sup>3</sup>										
10 ppm	29 mg/m <sup>3</sup>										
3.5 ppm	10.2 mg/m <sup>3</sup>										
NFPA Hazard Signal	Health - 3, Flammability – 0, Stability - 0 Special - OX										
Emergency Treatment	Inhalation: Remove the victim to fresh air area, support respiration, and give oxygen, if necessary. Eyes: Flush with large amounts of water for at least 15 minutes. Seek medical aid immediately.										

#### (vi) SAFE USAGE DATA

Ventilation	General / Mechanical/ Local Exhaust	Well-ventilated area preferably with a hood with forced ventilation. Tonners should always be handled using a lifting clamp, cradle or carrier.
Protective Equipment Required	Eyes (Specify)	Head Mask
	Respiratory (Specify)	SCBA
	Gloves (Specify)	Hand Gloves PVC
	Clothing (Specify)	Rubber over Coat
	Others (Specify)	Gumboots
Precautions	Handling & Storage	Storage in well ventilated areas or outdoors.
	Others (Specify)	Protect against physical damage. Separation from combustible organic or easily oxidisable material. Isolate from Acetylene, Ammonia, Hydrogen, Hydrocarbons, Ether, Turpentine & finely divided material.

**(vii) EMERGENCY RESPONSE DATA**

Fire	Fire Extinguishing Media	Use extinguishing agent suitable to surrounding media. Chlorine itself does not burn.
	Special Procedures	Wear SCBA set while attending chlorine leakages.
	Unusual Hazards	Poisonous gases emitted on burning.
Exposure (Inhalation, skin, eye contact and ingestion)	First Aid Measures	Evacuate the contaminated zone. Call a Doctor. Affected clothing should be removed and skin should be washed thoroughly with water. In case of unconsciousness transport him to a quiet place and keep him warm. Inhale oxygen or give artificial respiration till doctor arrive. Wash thoroughly on contaminated area of the body.
Spills	Steps to be taken	Shut off leaks if without risk. Contain liquid with sand or earth. Prevent the liquid from entering the sewer. Vapours create toxic atmosphere. Knock down vapours with water spray.

	Waste Disposal Method	Neutralize small liquid spillages with soda ash and drain with abundant water. Cover pool with protein foam. So that the release of vapour to atmosphere is low and under control.
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**(viii) ADDITIONAL INFORMATION :**

In case of large gas escapes, the presence of cloud can be marked with ammonia with which it will turn into a mist. Run away from the gas clouds in a direction perpendicular to the wind direction. Avoid liquid chlorine from leaking and body contact. Person with pulmonary diseases should avoid the exposure. A concentration of 3.5 ppm produces a detectable odour. 15 ppm causes immediate irritation of throat. Concentration of 50 ppm is dangerous for even short exposures. 1000 ppm is fatal. Can react to cause fires / explosion on contact with turpentine, illuminating gas, polypropylene, Rubber, Sulfuric acid, Acetaldehyde, Alcohols. Bring the leaking portion of the cylinder to the uppermost position, so that only the gas escapes and not the liquid.

**3. SULPHUR**

**(i) CHEMICAL IDENTITY:**

Product Name	Sulphur
Chemical classification	No-Metallic Element
Synonyms	Brimstone
Trade Name	No
Formula	S
C.A.S. Number	7704-34-9
U.N. Number	1350/2448
Regulated Identification	UN Number 1350
Shipping name	SULPHUR
Codes / Label	Flammable Solid, Class 4.1
HAZCHEM Code	2Z
Hazardous waste Identification Number	17

**(ii) PHYSICAL AND CHEMICAL PROPERTIES :**

Physical State	Solid or Liquid
Appearance	Yellow to reddish brown
Odour	Faint rotten egg
Boiling Point ( °C)	444.6
Melting / Freezing Point ( °C)	113 to 119
Vapour pressure @ 35°C (mm-Hg)	1

Vapour Density (air =1)	-
Evaporation rate @ 30 °C	-
Solubility in water @ 30°C	Not Soluble
Specific Gravity (Water =1)	2.07
pH	Acidic to Neutral
Others	Slightly soluble in alcohol, ether, soluble in benzene

**(iii) FIRE AND EXPLOSIVE HAZARDS DATA :**

Explosion /Flammability	Combustible (Dust can be explosive.)
LEL (%)	35 g/m <sup>3</sup> (For Dust suspended in air)
UEL (%)	1400 g/m <sup>3</sup> (For Dust suspended in air)
Flash Point (°C)	168
Auto ignition Temperature (°C)	230
TDC Flammability (Classification)	-
Combustible Liquids	No
Flammable Material	Yes,
Pyrophoric Material	No
Explosive Material	Yes
Corrosive Material	Yes
Oxidiser	No
Organic Peroxide	No

**(iv) REACTIVE HAZARDS:**

Impact (Hazardous Combustion Products)	Stable (SO <sub>2</sub> , H <sub>2</sub> S)
Static Discharge	Yes
Reactivity ( Conditions to avoid)	Can react violently with Halogens, Carbides, Halogens, Halogenates, Zinc, Tin, Sodium, Lithium, Nickel, Palladium, Phosphorus, Potassium, Iridium.
Hazardous Polymerization	May Not Occur.
Incompatibility	NA

**(v) HEALTH HAZARD DATA:**

Routes of Entry	Inhalation, Ingestion, Eyes & Skin
Effects of Exposure / Symptoms	Can cause eye irritation, may irritate skin. The molten solid may Cause skin burns.
LD 50(rat) (mg / kg of body wt.)	NA

LC 50 (rat) Mg / ¼ hours.	NA
Permissible Exposure Limit ( PEL)	NA
Short Term Exposure Limit(STEL)	NA
Threshold Limit Value (TLV) of ACIGH	NA
NFPA Hazard Signal	Health 2      Flammability 1      Reactivity 0      Special -

#### (vi) SAFE USAGE DATA

Ventilation	General / Mechanical	General
Protective Equipment Required	Eyes (Specify)	Safety goggles or face shield,
	Respiratory (Specify)	Mask for the dust.
	Gloves (Specify)	PVC / Rubber hand gloves
	Clothing (Specify)	-
	Others (Specify)	Gum boot
Precautions	Handling & Storage Others (Specify)	Store in cool, dry well-ventilated separate area away from heat flame and oxidizing materials.

#### (vii) EMERGENCY RESPONSE DATA

Fire	Fire Extinguishing Media	Water Spray, Dry Chemical Powder(DCP), Carbon Dioxide (CO <sub>2</sub> )
	Special Procedures	Use Self Contained Breathing Apparatus (SCBA) set while Fire Fighting
	Unusual Hazards	Burns with blue flame, difficult to see in daylight.
Exposure	First Aid Measures	<b>Eyes:</b> Wash with plenty of water for 15 minutes. <b>Skin:</b> Treat molten sulphur burns with petroleum jelly or mineral oil. Seek medical aid immediately.
Spills	Steps to be taken	Allow the molten liquid to solidify and then sweep and collect. Wash the surface with plenty of water.
	Waste Disposal Method	Seal all waste in vapour tight plastic bags for Disposal.

### 4. SULPHURIC ACID

#### (i) CHEMICAL IDENTITY:

Product Name	<b>Sulphuric Acid</b>
Chemical classification	Inorganic Acid
Synonyms	Oil of Vitriol
Trade Name	Sulphuric Acid
Formula	H <sub>2</sub> SO <sub>4</sub>
C.A.S. Number	7664-93-9
U.N. Number	1830
Regulated Identification	-
Shipping name Codes / Label	Sulphuric Acid Corrosive, Class 8
HAZCHEM Code	2P
Hazardous waste Identification Number	16
Hazardous Ingredients	-

**(ii) PHYSICAL AND CHEMICAL PROPERTIES :**

Physical State	Liquid
Appearance	Colourless Oily
Odour	Odorless
Boiling Point ( °C)	290
Melting / Freezing Point ( °C)	NA
Vapour pressure @ 35°C (mm-Hg)	1
Vapour Density (air =1)	3.4
Evaporation rate @ 30 °C	NA
Solubility in water @ 30°C	Soluble in water with liberating heat
Specific Gravity (Water =1)	1.84
pH	<1

**(iii) FIRE AND EXPLOSIVE HAZARDS DATA :**

Explosion /Flammability	NO
LEL (%)	NA
UEL (%)	NA
Flash Point (°C)	NA
Auto ignition Temperature (°C)	NA
TDC Flammability (Classification)	NA
Combustible Liquids	NO
Flammable Material	NO
Pyrophoric Material	NA
Explosive Material	-
Unstable Material	NO

Corrosive Material	YES
Oxidiser	YES
Organic Peroxide	-

**(iv) REACTIVE HAZARDS:**

Impact (Hazardous Combustion Products)	Emits toxic fumes of SO <sub>2</sub>
Static Discharge(Hazardous Decomposition Product)	Stable
Reactivity ( Conditions to avoid)	Powerful Oxidiser
Hazardous Polymerization	May not occur
Incompatibility	Organic Chlorates, Carbides, Fulminates, Pirates and metals.

**(v) HEALTH HAZARD DATA:**

Routes of Entry	Inhalation, Ingestion, eyes
Effects of Exposure / Symptoms	Inhalation of vapour from hot concentration acid may injure lungs. Swallowing may cause injury or death. Contact to skin or eyes causes severe burns. Dilute solution cause dermatitis. Exposure causes bronchitis.
LD 50(rat) (mg / kg of body wt.)	2140
LC 50 (rat) Mg / ¼ hours.	NA
Permissible Exposure Limit ( PEL)	1 mg/m <sup>3</sup>
Short Term Exposure Limit(STEL)	NA
Threshold Limit Value (TLV) of ACIGH	1 mg/m <sup>3</sup>
Odour Threshold	1 mg/m <sup>3</sup>
NFPA Hazard Signal	Health      Flammability      Reactivity 3                      0                      2 Special -

**(vi) SAFE USAGE DATA**

Ventilation	General / Mechanical / Local Exhaust	Wall ventilated place away from oxidizer.
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Protective Equipment	Eyes (Specify)	Safety goggles, Face shield
	Respiratory (Specify)	Self-contained breathing apparatus or Airline System
Required	Gloves (Specify)	PVC
	Clothing (Specify)	PVC Suit
	Others (Specify)	Rubber Shoes, Safety shower, Eye wash fountain
Precautions	Handling & Storage	Store in cool, well ventilated place away from oxidizes; acids of 98% are to be stored in MS or CI tanks / drums.
	Others (Specify)	Safety Showers, eye wash fountains.

**(vii) EMERGENCY RESPONSE DATA**

Fire	Fire Extinguishing Media	NA
	Special Procedures	Keep containers cool by spraying water if exposed to flame or heat
	Unusual Hazards	Poisonous gases may be produced
Exposure	First Aid Measures	If inhaled, remove the victim to fresh air, provide artificial respiration or oxygen if required. If eyes are affected wash with plenty of water for 15 minutes or more. If skin is affected remove contaminated cloths and shoes & wash the affected area with plenty of water and soap. Seek medical help immediately.
Spills	Steps to be taken	Shut off leaks if without risk. Contain leaking liquid on sand or earth. Do not absorb on saw dust or other combustibles.
	Waste Disposal Method	-

**(viii) ADDITIONAL INFORMATION:**

Sensitivities to Sulphuric acid mists or vapors vary with individuals. Normally 0.125 to 0.5 ppm may be mildly annoying 1.5 to 2.5 ppm may be definitely be unpleasant, 10 to 20 ppm unbearable. Contact with water violent reaction generating much heat and splattering of hot

acid. Attacks many metals. Liberating hydrogen which is flammable & forms explosive mixture with air.

## 5. PHOSPHORIC ACID

### (i) CHEMICAL IDENTITY:

Product Name	<b>PHOSPHORIC ACID</b>
Chemical Classification	Inorganic Acid
Synonyms	Ortho Phosphoric Acid
Trade Name	Phosphoric Acid
Formula	H <sub>3</sub> PO <sub>4</sub>
C.A.S. No	7664-38-2
U. N. No	1805
Shipping Name	Phosphoric Acid
Codes / Label	Corrosive, Class 8
Hazchem Code	2R
Hazardous Waste ID No	16

### (ii) PHYSICAL AND CHEMICAL PROPERTIES:

Physical State	Thick Liquid / Solid
Appearance	Colourless
Odour	Pleasant
Boiling Point ( °C)	130 <sup>0</sup> C
Melting / Freezing Point ( °C)	42.4 <sup>0</sup> C
Vapour pressure @ 35°C (mm-Hg)	0.286
Vapour Density (air =1)	-
Evaporation rate @ 30 °C	-
Solubility in water @ 30°C	Soluble in water
Specific Gravity (Water =1)	1.89 at 25°C
pH	1.5 (0.1 N)
Others	soluble in Alcohol

### (iii) FIRE AND EXPLOSIVE HAZARDS DATA :

Explosion /Flammability	NO
LEL (%)	NA
UEL (%)	NA
Flash Point (°C)	NA
Auto ignition Temperature (°C)	NA
TDC Flammability (Classification)	-
Combustible Liquids	NO
Flammable Material	NO

Pyrophoric Material	NO
Explosive Material	NO
Unstable Material	Stable
Corrosive Material	Yes
Oxidiser	NA
Organic Peroxide	NA

**(iv) REACTIVE HAZARDS :**

Impact(Hazardous Combustion Products)	Stable
Static Discharge(Hazardous Decomposition Product)	NA
Reactivity ( Conditions to avoid)	Reacts with Chlorides + Stainless Steel to form explosive reaction product- Hydrogen gas.
Hazardous Polymerization	Does not occur
Incompatibility	Explosive mixtures with Nitromethane

**(v) HEALTH HAZARD DATA :**

Routes of Entry	Inhalation, Ingestion Eyes & Skin.
Effects of Exposure / Symptoms	Burns on mouth and lips, sour acid taste, severe gastrointestinal irritation, nausea, vomiting, bloody diarrhea, difficulty in swallowing, severe abdominal pains, thirst, academia, difficult breathing, convulsions, collapse, shock and death.
LD 50(rat) (mg / kg of body wt.)	1530 mg / kg
LC 50 (rat) Mg / ¼ hours.	NA
Permissible Exposure Limit ( PEL)	0.25 ppm / 1 mg/m <sup>3</sup>
Short Term Exposure Limit (STEL)	0.75 ppm / 3 mg/m <sup>3</sup>
Threshold Limit Value (TLV) of ACGIH	0.25 ppm / 1 mg/m <sup>3</sup>
Odour Threshold	NA
NFPA Hazard Signal	Health 2      Flammability 0      Reactivity 0      Special

**(vi) SAFE USAGE DATA**

Ventilation	General / Mechanical	Store in well ventilated area away from active material.
Protective Equipment Required	Eyes (Specify)	Provide face shield,
	Respiratory (Specify)	Self-contained breathing apparatus or Airline System
	Gloves (Specify)	Rubber hand gloves,
	Clothing (Specify)	PVC Suit
Precautions	Handling & Storage	Special Procedure: Keep the containers cool by spraying water if exposed to heat or flame.
	Others (Specify)	Flammable gas is produced on contact with metals.

**(vii) EMERGENCY RESPONSE DATA**

Fire	Fire Extinguishing Media	Not Flammable
	Special Procedures	-
	Unusual Hazards	-
Exposure	First Aid Measures	Ingestion: Do not induce vomiting; give water, milk or vegetable oil. Skin & Eyes: Flush with water for at least 15 minutes. Seek medical aid.
Spills	Steps to be taken	Neutralize with alkali and dilute and drench with water.
	Waste Disposal Method	Seal all waste in vapour tight plastic bags for eventuate disposal.

**(viii) ADDITIONAL INFORMATION :**

Poisoning by an unspecified route. Toxic by ingestion and skin contact. Used to Manufacture of fertilizers.

**6. SODIUM HYDROXIDE**

**(i) CHEMICAL IDENTITY:**

Chemical Name	<b>SODIUM HYDROXIDE</b>
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Synonyms	Caustic Soda, Sodium Hydrate, Lye solution, 50 % Liquid (NaOH), Caustic flake, Liquid Caustic.
Formula	NaOH
Chemical Classification	Alkali Hydroxide
Trade Name	-
C.A.S. NO	1310-73-2
U.N. NO	1824
Regulated Identification	-
Shipping Name : Codes / Label	Sodium Hydroxide Corrosive Material
Hazchem No.	NA
Hazardous Waste I.D. No.	NA
Hazardous Ingredients	NA

**(ii) PHYSICAL AND CHEMICAL PROPERTIES:**

Physical State	Liquid
Appearance	Clear Liquid
Odour	Odourless
Boiling Point / Range (°C)	140°C
Melting / Freezing Point (°C)	12°C ( Freezing Point )
Vapour Density ( Air=1)	NA
Specific Gravity (Water = 1)	1.53 at (25°C)
Vapour Pressure @ 35 °C mm Hg	NA
Solubility in water @ 30 °C	Completely soluble in water
pH	13 (0.5 % solution)
Others	Soluble in alcohol, methanol, glycerol & insoluble in acetone and ether.

**(iii) FIRE AND EXPLOSIVE HAZARDS DATA:**

Flammability Yes / No	No
LEL %	NA
UEL %	NA
Flash Point (°C)	NA
Auto-Ignition Temperature °C	NA
TDG Flammability	NA
Explosion sensitivity to impact	NA
Explosion sensitivity to Static Electricity	NA
Hazardous Combustion Products	NA

Hazardous Polymerisation	Hazardous polymerization cannot occur. Violent polymerization can occur when in contact with acrolein or acrylonitrile. Since Sodium Hydroxide readily absorb water and carbon di-oxide from air, keep container tightly closed.
Combustible Liquid	NA
Explosive Material	NA
Corrosive Material	YES
Flammable Material	NA
Pyrophoric Material	NA
Organic peroxide	NA
Oxidizer	NA
Other	Institute pre-placement and periodic medical exams of exposed workers emphasizing the eyes, skin and respiratory tract. Consider a respiratory protection program that includes regular training, maintenance inspection and evaluation. Educate employees to the possible hazards in using sodium hydroxide.

**(iv) REACTIVE HAZARDS:**

Chemical Stability	Sodium hydroxide solution is stable at room temperature in closed container under normal storage and handling conditions.
Incompatibility with other Material	Since it generate large amount of heat when in contact with water, sodium hydroxide may steam and splatter. It reacts with mineral acids to form corresponding salts, and with weak acid gases like hydrogen sulfide, sulfur dioxide and carbon dioxide. Sodium hydroxide can be very corrosive to metals such as aluminum, tin and zinc as well as alloys such as steel and may causes formation of flammable hydrogen gas.
Reactivity	An increase in temperature and pressure occurs in close containers when sodium hydroxide is mixed with acetic anhydride, Gaseous acetic acid, chlorohydrins, chlorosulfonic acid, ethylenesinohydrin, glyoxal, oleum, 36 % HCl, 48.7 % HF, 70 % Nitric acid or 96 % H <sub>2</sub> SO <sub>4</sub> .
Hazardous Reaction Products	Avoid generation of sodium hydroxide mists and contact with water, metals and the chemicals listed above. Hazardous product of decomposition. Thermal oxidative decomposition of sodium hydroxide can produce toxic

	sodium oxide (Na <sub>2</sub> O) and peroxide (Na <sub>2</sub> O <sub>2</sub> ) fumes.
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**(v) HEALTH HAZARD DATA:**

Routes of Entry	Ingestion, Inhalation, skin and eye contact.
Effects of Exposure / Symptoms	Ingestion causes immediate burning of mouth, esophagus and stomach, painful swallowing, excessive salivation, edematous, lips, chins, tongue and pharynx covered with exudates (fluid oozed from swollen tissue), esophageal edema.
Emergency Treatment	Emergency personnel should protect against contamination.
TLV (ACGIH) ppm / mg/ m3	Ceiling : 2 mg/m3
STEL ppm mg / m3	NA
Permissible Exposure Limit Ppm / mg / m3	NA
Odour Threshold ppm mg / m3	NA
LD <sub>50</sub>	2140 mg / Kg
LC <sub>50</sub>	NA
NFPA Hazard Signals	Health Flammability Reactivity Special 3 0 1 -

**(vi) SAFE USAGE DATA:**

Personal Protective Equipment	<p><b>Goggles:</b> - Wear protective chemical safety goggles. Since contact lens use in industry is controversial, establish your own policy.</p> <p><b>Respirator:</b> - Seek professional prior to respirator selection and use. For emergency or non-routine operation (cleaning spills, reactor vessels or storage tanks) wear a SCBA set.</p> <p><b>Warning:</b> Air purifying respirators do not protect workers in oxygen deficient atmospheres.</p> <p><b>Other:</b> - Wear impervious gloves, boots, aprons and gauntlets to prevent any skin contact.</p>
Handling and Storage Precautions	Avoid physical damage to containers. Store in dry, well ventilated area away from water, acids, metals, flammable liquid and organic halogens. Keep containers tightly closed since Sodium Hydroxide can decompose to sodium carbonate and carbon dioxide upon exposure to air. Since corrosion occurs easily above 140°F (60°C) do not store or transport in aluminum or steel containers when temperature near this

	level. Store containers in room equipped with trapped floor drains, curbs or gutters.
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**(vii) EMERGENCY RESPONSE DATA:**

Fire : Fire Extinguishing Media	Although non-combustible, when contact with moisture or water sodium hydroxide, 50% liquid can generate enough heat to ignite surrounding combustibles. Use extinguishing agent suitable for surrounding fire. For small fire, use dry chemical carbon dioxide (CO <sub>2</sub> ) or regular foam. Avoid using water spray since water react with sodium hydroxide to generate substantial heat. If you must use water, be sure it is as cold as possible. For large fires, use fog or regular foam.
Special Procedures	Also, wear fully protective clothing. Structural fire fighters protective clothing provides limited protection. Apply cooling water to sides of fire exposed containers until fire is well out. Do not splatter or splash this material. Stay away from ends of tanks. Be aware of runoff from fire control methods. Do not release to sewers or waterways with water.
Exposure : First Aid Measures	<p><b>Eyes:</b> - Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transport to an emergency medical facility. Do not allow victim to keep his eyes tightly shut. Warning! Although splashed in only one eye, sodium hydroxide may affect the other eye's sight if prompt medical attention is not received. Consult a physician immediately.</p> <p><b>Skin:</b> Quickly remove contaminated clothing. Rinse with flooding amounts of cold water for at least 15 minutes. Be aware that this substance can become very hot when in contact with water. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.</p> <p><b>Inhalation:</b> Remove exposed person to fresh air and support breathing as needed.</p> <p><b>Ingestion:</b> Never give anything by mouth to an unconscious or convulsing person. If ingested, that have conscious and alert person drink 1 to 2</p>

	glasses of water followed by vinegar or fruit juice to neutralize the poison. Do not induce vomiting. After first aid get appropriate in plant, paramedic or community get medical support.
Antidotes / Dosages	N.A.
Spills : Step to be taken	Notify personnel isolate hazard area, deny entry, and stay upwind of spills. Cleanup personnel should protect against vapor inhalation and skin or eye contact. Use water spray to disperse vapor but do not spray directly on spills. Absorb small liquid spills with fly ash or cement powder. Neutralize spill with vinegar or dilute acid. Perlite and cello solvent WP 3H (hydroxy ethyl cellulose) are recommended for vapor suppression and containment of 50% sodium hydroxide solutions. Place material in suitable container (sodium hydroxide corrodes steel at temperature above 60° C) for later disposal. Follow applicable OSHA regulation.
Waste Disposal Method	Contact your supplier or a licensed contractor for detail recommendation. Follow applicable federal, state and local regulations.

**(viii) ADDITIONAL INFORMATION:**

Engineering Controls :	To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control hazardous air borne contaminants and to maintain concentration at the lowest practical level..
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**7. HIGH SPEED DIESEL**

**(i) CHEMICAL IDENTITY:**

Product Name	High Speed Diesel
Chemical classification	Flammable Liquid
Synonyms	Automotive Diesel Oil, Gas Oil
Trade Name	HSD
Formula	A Complex of Hydrocarbon

C.A.S. Number	68476-30-2
U.N. Number	1202
Regulated Identification	UN Number 1202
Shipping name Codes / Label	HSD Class-3 Flammable Liquid
HAZCHEM Code	3Z
Hazardous waste Identification Number	NA
Hazardous Ingredients	-

**(ii) PHYSICAL AND CHEMICAL PROPERTIES :**

Physical State	Liquid
Appearance	Oily Brown to Yellow
Odour	-
Boiling Point ( °C)	110 to 400
Melting / Freezing Point ( °c)	0 - 18
Vapour pressure @ 35°C (mm-Hg)	1
Vapour Density(air =1)	3 to 5
Evaporation rate @ 30 °C	NA
Solubility in water @ 30°C	Insoluble
Specific Gravity (Water =1)	0.840
pH	Not Pertinent
Others	Sulphur content 1 % max.

**(iii) FIRE AND EXPLOSIVE HAZARDS DATA :**

Explosion /Flammability	Yes
LEL (%)	0.5
UEL (%)	5.0
Flash Point (°C)	>32
Auto ignition Temperature (°C)	230 - 250
TDG Flammability (Classification)	Class 3
Combustible Liquids	Yes
Flammable Material	Yes
Pyrophoric Material	NA
Explosive Material	Yes
Corrosive Material	No
Oxidiser	NA
Organic Peroxide	NA

**(iv) REACTIVE HAZARDS:**

Impact (Hazardous Combustion	Stable (Acid/smoke/CO/CO2/NOx)
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Products)	
Static Discharge (Hazardous Decomposition Product)	No (NA)
Reactivity (Conditions to avoid)	Does not react with common materials but may react with oxidizing agents.
Hazardous Polymerization	Does not occur
Incompatibility	Incompatible with Strong oxidizer.

**(v) HEALTH HAZARD DATA:**

Routes of Entry	Inhalation , Ingestion , eyes , skin
Effects of Exposure / Symptoms	Inhalation : Dizziness , Headache Ingestion: Nausea and vomiting, irritation of mouth, and gastro intestinal tract may follow. Rapidly developing potentially fatal chemical pneumatics. Skin and Eye Contact: Irritation will remove natural fat from skin. Prolonged or repeated contact should be avoided; otherwise skin chapping, cracking or possible contact dermatitis may result. Dry skin, erythema, oil acne and oil folliculate & warty growth may occur which may become skin cancer.
LD 50 (rat) (mg / kg of body wt.)	5g/kg
LC 50 (rat) Mg / ¼ hours.	NA
Permissible Exposure Limit ( PEL)	300 ppm
Short Term Exposure Limit(STEL)	500 ppm
Threshold Limit Value (TLV) of ACGH	300 ppm
Odour Threshold	300 ppm
NFPA Hazard Signal	Health      Flammability      Stability      Special 1                      2                      0                      -

**(vi) SAFE USAGE DATA**

Ventilation	General / Mechanical	Provide proper ventilation for environment to be below TWA
Protective	Eyes (Specify)	Goggles
Equipment	Respiratory (Specify)	Gas Mask
Required	Gloves (Specify)	Hand Gloves
	Clothing (Specify)	PVC suit
	Others (Specify)	-

Precautions	Handling & Storage	<p>Avoid contact with liquid or vapours.</p> <p>Use flame proof equipment's only.</p> <p>Stay upwind while gauging / sampling / handling.</p> <p>Do not wash / clean hands with the product.</p> <p>Earth all equipment's &amp; pipelines properly.</p> <p>Stored in an enclosed vessel in a cool, well ventilated area away from heat &amp; flame. Gas free the tank before entering / cleaning.</p> <p>Change oil soaked clothing promptly.</p> <p>No smoking or open flames</p> <p>Provide adequate ventilation at work site.</p>
	Others (Specify)	Safety Showers, Eye wash

**(vii) EMERGENCY RESPONSE DATA**

Fire	Fire Extinguishing Media	Foam, DCP, CO <sub>2</sub>
	Special Procedures	Keep containers cool by spraying water if exposed to flame or heat.
	Unusual Hazards	Flashback may occur along vapour trail.
Exposure	First Aid Measures	<p>If inhaled removed victim to fresh air, if not breathing, give artificial respiration. If unconscious but breathing, place in unconscious (recovery) position. Give external cardiac massage if necessary. If ingested don't induce vomiting. Remove contaminated clothing, Wash all the affected skin thoroughly with soap and water. Irrigate affected eyes with copious amount of water. Administration of medical paraffin may reduce absorption through digestive tract. Gastric lavage should be done only after end tracheal intubation in view of respiration, which may cause serious chemical pneumonitis for which antibiotic and corticosteroid therapy may be indicated.</p>

Spills	Steps to be taken	Eliminate all sources of ignition. Ventilate the area. Stop leaks if no risk involved. Collect leaking product into closed container. Contain / absorb spillage in sand / earth bund. Use water sprays to disperse / dilute the vapours if necessary. Prevent run-off from entering into sewers.
	Waste Disposal Method	Collect all the waste in vapour tight plastic bags for eventual disposal.

## 8. FUEL OIL

### (i) CHEMICAL IDENTITY:

Chemical Name	<b>FUEL OIL</b>
Synonyms	Furnace Oil, Residual Fuel Oil
Formula	A complex mixture of Hydrocarbons
Chemical Classification	Low Sulphur Heavy Stock
Trade Name	LSHS
C.A.S. No.	68476 – 33.5
U.N. No.	1223
Regulated Identification	UN No-1223
Shipping Name :	Class C
Codes / Label	Flammable Liquid.
Hazchem No.	2PE
Hazardous Waste I.D. No.	NA
Hazardous Ingredients	NA

### (ii) PHYSICAL AND CHEMICAL PROPERTIES:

Physical State	Thick Liquid
Appearance	Tar Odour
Odour	Brown to black colour
Boiling Point / Range (°C)	185-500
Melting / Freezing Point (°C)	- 4 to 13°C ( Freezing Point )
Vapour Density ( Air=1)	3 to 5
Specific Gravity (Water = 1)	Liquid : 0.95 (approx.) at 20°C

Vapour Pressure ( mm)	Not Pertinent
Solubility in water @ 20 °C	Insoluble
pH	Data Not Available
Others	NA

**(iii) FIRE AND EXPLOSIVE HAZARDS DATA:**

Flammability Yes / No	Yes
LEL %	1
UEL %	5
Flash Point (°C)	66°
Auto-Ignition Temperature °C	263°C
TDG Flammability	Not Pertinent
Explosion sensitivity to impact	Data Not Available
Explosion sensitivity to Static Electricity	Data Not Available
Hazardous Combustion Products	Data Not Available
Combustible Liquid	Yes

**(iv) REACTIVE HAZARDS:**

Chemical Stability	Yes, Stable
Incompatibility with other Material	No
Reactivity	No reaction with water and other common materials.
Hazardous Reaction Products	Data not available.

**(v) HEALTH HAZARD DATA :**

Routes of Entry	Ingestion, Aspiration, skin and eye contact.
Effects of Exposure / Symptoms	<b>Ingestion:</b> Do not induce lavage or vomiting, <b>Aspiration:</b> Treatment probably not required, delayed development of pulmonary irritation can be detected by serial chest x-rays. Consider prophylactic antibiotic regime if condition warrants. <b>Eyes:</b> Wash with copious quantity of water.

	<b>Skin:</b> Wipe off and wash with soap and water.
TLV (ACGIH) ppm / mg/ m3	NA
STEL ppm mg / m3	NA
Permissible Exposure Limit Ppm / mg / m3	NA
Odour Threshold ppm mg / m3	Data Not Available
LD <sub>50</sub>	Data Not Available
LC <sub>50</sub>	Data Not Available
NFPA Hazard Signals	Health Flammability Reactivity Special 0 2 0

**(vi) SAFE USAGE DATA:**

Personal Protective Equipment	Eyes (Specify): Safety Goggle/Face shield. Respiratory (Specify): Emergency Life Saving Apparatus (ELSA) / Self Contained Breathing Apparatus (SCBA). Gloves (Specify) : Asbestos / PVC
Handling and Storage Precautions	Store in a cool, clean, well ventilated & fire proof storage area. Keep away from heat, sparks, open flame & incompatible materials (strong oxidizing agents). Protect container against damage.

**(vii) EMERGENCY RESPONSE DATA:**

<b>Fire :</b> <b>Fire Extinguishing Media</b>	Aqueous Film Forming Foam, Dry Chemical Powder & Carbon Dioxide
<b>Special Procedures</b>	Water Spray To Be Used To Cool Containers If Exposed To Fire
<b>Exposure :</b> <b>First Aid Measures</b>	<b>Eyes:</b> - Wash with copious quantity of water. <b>Skin:</b> Remove contaminated clothing & wash affected skin with soap & water. <b>Inhalation:</b> Remove victim to fresh air. If not breathing, give artificial respiration. <b>Ingestion:</b> If unconscious, do not induce vomiting. Obtain medical attention immediately.
<b>Antidotes / Dosages</b>	No specific anti dotes. Treat symptomatically.
<b>Spills :</b> <b>Step to be taken</b>	Stop leak, if safe to do so. Contain spillage absorb in sand or earth for disposal. Flush small spillage with plenty of water.

**(viii) ADDITIONAL INFORMATION:**

<b>Engineering Controls :</b>	Tanks & unloading installation are in the open & well ventilated area. Mechanical unloading & transportation is to be done. No manual handling is involved.
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**9. TRANSFORMER OIL**

**(i) CHEMICAL IDENTITY:**

Product Name	<b>Transformer Oil</b>
Chemical classification	Petroleum Hydrocarbon
Synonyms	Insulating Oil for transformers
Trade Name	-
Formula	-
C.A.S. Number	64742-53-6
U.N. Number	-
Regulated Identification	-
Shipping name Codes / Label	-
HAZCHEM Code	-
Hazardous waste Identification Number	-
Hazardous Ingredients	Non-Hazardous substance. Non- Dangerous Goods

**(ii) PHYSICAL AND CHEMICAL PROPERTIES :**

Physical State	Liquid
Appearance	Yellow : Pale colour
Odour	Odourless
Boiling Point ( °C)	>290
Melting / Freezing Point ( °C)	NA
Vapour pressure @ 35°C (mm-Hg)	NA
Vapour Density(air =1)	NA
Evaporation rate @ 30 °C	NA
Solubility in water @ 30°C	Insoluble in water.
Specific Gravity (Water =1)	0.88
pH	NA

**(iii) FIRE AND EXPLOSIVE HAZARDS DATA :**

Explosion /Flammability	Flammable
LEL (%)	0.9
UEL(%)	7.0
Flash Point (°C)	145
Auto ignition Temperature (°C)	242
TDC Flammability (Classification)	-
Combustible Liquids	Yes
Flammable Material	Yes
Pyrophoric Material	NA
Explosive Material	NA
Unstable Material	NA
Corrosive Material	NA
Oxidiser	NA
Organic Peroxide	NA

**(iv) REACTIVE HAZARDS:**

Impact(Hazardous Combustion Products)	NA
Static Discharge(Hazardous Decomposition Product)	NA
Reactivity ( Conditions to avoid)	NA
Hazardous Polymerization	NA
Incompatibility	NA

**(v) HEALTH HAZARD DATA:**

Routes of Entry	Ingestion, Inhalation, Skin contact, Eye contact.
Effects of Exposure / Symptoms	Ingestion: No significant health hazard identified. Inhalation: No significant health hazard identified. Eyes contact: No significant health hazard identified. Skin contact: Prolonged or repeated contact can defat the skin and lead to irritation and / or Dermatitis.
LD 50(rat) (mg / kg of body wt.)	NA
LC 50 (rat) Mg / ¼ hours.	NA
Permissible Exposure Limit ( PEL)	5 mg/m <sup>3</sup>

Short Term Exposure Limit(STEL)	NA			
Threshold Limit Value (TLV) of ACIGH	5 mg/m <sup>3</sup>			
Odour Threshold	NA			
NFPA Hazard Signal	Health 1	Flammability 1	Stability -	Special

**(vi) SAFE USAGE DATA**

Ventilation	General / Mechanical	-
Protective Equipment	Eyes (Specify)	Safety goggles
	Respiratory (Specify)	Avoid breathing of vapors, mist or spray. Use respirator with organic vapor filters or dust/mist filters.
Required	Gloves (Specify)	Wear protective hand gloves, Chemical resistant or Nitrile hand gloves.
	Clothing (Specify)	Protective apron / suit.
	Others (Specify)	-
Precautions	Handling & Storage	Store and use only in containers designed for its use. Keep away from heat and sun light. Store in a dry, cool and well ventilated area.
	Others (Specify)	Wash hands, fore arms and face thoroughly after handling.

**(vii) EMERGENCY RESPONSE DATA**

Fire	Fire Extinguishing Media	In case of fire, use foam, dry chemical powder or carbon dioxide extinguisher or spray.
	Special Procedures	Remove all the personnel from the vicinity.
	Unusual Hazards	In a fire or if heated, a pressure increase will occur and container may burst.
Exposure	First Aid Measures	<b>Eye Contact:</b> In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Eyelids should be held away from the eyeball to ensure thorough rinsing. Check for and remove any contact lenses. Get medical attention. <b>Skin Contact:</b> Wash skin

		<p>thoroughly with soap and water or use recognized skin cleanser. Remove contaminated clothing and shoes. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention if irritation develops.</p> <p><b>Inhalation:</b> If inhaled, remove to fresh air. Get medical attention if symptoms appear.</p> <p><b>Ingestion:</b> Do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Get medical attention if symptoms occur.</p> <p><b>Advice to doctor:</b> Treatment should in general be symptomatic and directed to relieving any effects.</p>
Spills	Steps to be taken	Stop leak if without risk. Move containers from spill area.
	Waste Disposal Method	Prevent entry into sewers or confined areas.

## 10. OXYGEN

### (i). CHEMICAL IDENTITY:

Product Name	<b>Oxygen, Medical</b>
Chemical classification	Oxygen
Synonyms	Molecular oxygen; Oxygen molecule; Pure oxygen; O <sub>2</sub> ; UN 1072; Dioxygen; Oxygen USP, Aviator's Breathing Oxygen (ABO)
Trade Name	-
Formula	-
C.A.S. Number	7782-44-7
U.N. Number	-
Regulated Identification	-
Shipping name Codes / Label	-
HAZCHEM Code	2S
Hazardous waste Identification Number	-
Hazardous Ingredients	-

**(ii) PHYSICAL AND CHEMICAL PROPERTIES:**

Physical State	Gas
Appearance	Colourless
Odour	Odourless
Boiling Point ( °C)	-183 °C
Melting / Freezing Point ( °C)	-219 °C
Vapour pressure @ 35°C (mm-Hg)	NA
Vapour Density(air =1)	1.11
Evaporation rate @ 30 °C	NA
Solubility in water @ 30°C	0.039 g/l
Specific Gravity (Water =1)	NA
pH	NA

**(iii) FIRE AND EXPLOSIVE HAZARDS DATA :**

Explosion /Flammability	Non-flammable
LEL (%)	-
UEL (%)	-
Flash Point (°C)	-
Auto ignition Temperature (°C)	-
TDC Flammability (Classification)	-
Combustible Liquids	-
Flammable Material	-
Pyrophoric Material	NA
Explosive Material	NA
Unstable Material	NA
Corrosive Material	NA
Oxidiser	Yes
Organic Peroxide	NA

**(iv) REACTIVE HAZARDS:**

Impact(Hazardous Combustion Products)	NA
Static Discharge(Hazardous Decomposition Product)	NA
Reactivity ( Conditions to avoid)	NA
Hazardous Polymerization	NA
Incompatibility	NA

**(v) HEALTH HAZARD DATA:**

Routes of Entry	Ingestion, Inhalation, Skin contact, Eye contact.
Effects of Exposure / Symptoms	Ingestion: Ingestion is not considered a potential route of exposure. Inhalation: No adverse effect. Eyes contact: Breathing 75% or more oxygen at atmospheric pressure for more than a few hours may cause nasal stuffiness, cough, sore throat, chest pain and breathing difficulty. Breathing pure oxygen under pressure may cause lung damage and also central nervous system effects.. Skin contact: No adverse effect.
LD 50(rat) (mg / kg of body wt.)	NA
LC 50 (rat) Mg / ¼ hours.	NA
Permissible Exposure Limit ( PEL)	NA
Short Term Exposure Limit(STEL)	NA
Threshold Limit Value (TLV) of ACIGH	NA
Odour Threshold	NA
NFPA Hazard Signal	Health 0      Flammability 0      Stability 0      Special OX

**(vi) SAFE USAGE DATA**

Ventilation	General / Mechanical	-
Protective Equipment	Eyes (Specify) Respiratory (Specify)	Safety goggles, Face Shield. Avoid breathing of vapors, mist or spray. Use respirator with organic vapor filters or dust/mist filters.
Required	Gloves (Specify)	Insulated gloves suitable for low temperatures.
	Clothing (Specify)	-
	Others (Specify)	-
Precautions	Handling & Storage	High pressure gas. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Store in tightly-closed container. Avoid contact with combustible materials. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable

		hand truck for cylinder movement. Keep container tightly closed. Keep container in a cool, well-ventilated area. Separate from acids, alkalies, reducing agents and combustibles. Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F).
	Others (Specify)	-

**(vii) EMERGENCY RESPONSE DATA**

Fire	Fire Extinguishing Media	Use an extinguishing agent suitable for the surrounding fire.
	Special Procedures	Remove all the personnel from the vicinity.
	Unusual Hazards	Upon exposure to intense heat or flame, cylinder will vent rapidly and or rupture violently. Oxidant. Strongly supports combustion. May react violently with combustible materials. Some materials which are noncombustible in air may burn in the presence of an oxidizer. Move away from container and cool with water from a protected position. Keep adjacent cylinders cool by spraying with large amounts of water until the fire burns itself out. If possible, stop flow of product.
Exposure	First Aid Measures	<p><b>Eye Contact:</b> Check for and remove any contact lenses. Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical attention immediately.</p> <p><b>Skin Contact:</b> In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention immediately.</p> <p><b>Frostbite:</b> Try to warm up the frozen tissues and seek medical attention.</p> <p><b>Inhalation:</b> If inhaled, remove to fresh</p>

		air. If not breathing, give artificial respiration. Get medical attention. Immediately. Get medical attention if symptoms occur. <b>Advice to doctor:</b> Treatment should in general be symptomatic and directed to relieving any effects.
Spills	Steps to be taken	Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment.

#### 4.(b) POSSIBLE TRANSFORMATION OF CHEMICALS ON RELEASE

Any release of liquid ammonia under pressure (from discharge of ammonia transfer pumps, from pipelines during unloading from ship tankers, etc), would result in the form of a spray of droplets and gas, besides it would mix violently with air. There could be extensive flashing and liquid temperatures would start falling to its boiling point (- 33°C). The mixing of gas with air would cause air to cool, as it would lose heat to evaporated liquid. The resulting cold mixture of gas, mist and air will be heavier than the surrounding air and may disperse in the form of a dense cloud or puff. However, release of liquid ammonia from refrigerated ammonia storage tanks; etc would be like any other volatile liquid. The evaporated gas from such liquefied ammonia spillage would disperse like a neutral gas plume, as it is likely to be lighter than air. On account of possible transformation of chlorine on release from tonner will spread heavily on lower level as it is heavier than air. However, the use of water at the release point could react violently forming hypo chloric acid which in term more corrosive and may lead release more chlorine on the source.

HSD and Furnace Oil are not likely to transform into vapour phase unless exposed to abnormally high temperature due to fire.

## SAFETY REPORT

### 4. (c) DEGREE OF PURITY

The specifications (including purity) of various products and chemicals handled at IFFCO complex are indicated below:

S.No.	Product / Chemical	Purity	Other Specifications
1.	Ammonia	99.9 %	Specific Gravity = 0.6814 Temperature = - 33°C
2.	Chlorine	99.9 %	Specific Gravity = 1.47 Temperature = 35°C
3.	High Speed Diesel		Specific Gravity = 0.85 Flash Point = >32°C Pour Point = 60°C Viscosity = 2 to 7.5 cst Sulphur Content = 1%
4.	Furnace Oil		Specific Gravities = 0.92 – 0.96 Flash Point = 66°C Pour Point = 18°C Viscosity = 180 cst Sulphur Content = 4 %
5.	Sulphuric Acid	98.6 %	Specific Gravity = 1.846 Temperature = 40°C
6.	Phosphoric Acid	26%	Specific Gravity = 1.32 Temperature = 30°C
		58%	Specific Gravity = 1.7 Temperature = 30°C
7.	Sulphur	99%	Specific Gravity = 1.84 Temperature = 35°C
8.	Transformer oil	99.9 %	Specific Gravity = 0.88 Temperature = 35°C
9.	Caustic soda	48.9 %	Specific Gravity = 1.53 Temperature = 35°C
10.	Oxygen	99.99 %	Specific Gravity = NA Boiling Point ( °C) = -183°C Melting / Freezing Point ( °C) = - 219°C Vapour Density(air =1) = 1.11 Solubility in water @ 300C= 0.039 g/l

## **SAFETY REPORT**

### **Chapter – 5**

#### **5.0 INFORMATION ON THE PRELIMINARY HAZARD ANALYSIS**

##### **5.(a) TYPE OF ACCIDENTS**

The possible types of accidents that could occur in the plant are following:

- (i) Release of toxic gases (Ammonia / Chlorine) from storage tank /pipeline
- (ii) Pool Fires involving Fuels (HSD & Furnace Oil)
- (iii) Fire / Explosion involving Sulphur Dust.
- (iv) Fires involving combustibles in offices, stores, yards etc.
- (v) Work injuries to employees during various operations
- (vi) Use or generate oxygen is elevated risk of fire & explosion

##### **5.(b) SYSTEM ELEMENT OR FORESEEN EVENTS THAT CAN LEAD TO A MAJOR ACCIDENTS:**

Basic events that could result into major accidents are listed below:

###### **1. Ammonia Unloading at the Jetty**

- (i) Release of Liquid ammonia from the Unloading Arm.
- (ii) Safety Relief Valve (on pipeline) Pop-off.
- (iii) Safety Relief Valve (on vent drum) Pop-off.
- (iv) Ammonia Release due to Flange Leak on the Cross-country pipeline during unloading
- (v) Guillotine Rupture of the Cross-country pipeline.

###### **2. Ammonia Storage Tanks**

- (i) Full Failure of Liquid Ammonia Outlet Line (after first flange)
- (ii) Partial Failure of Liquid Ammonia Outlet Line (after first flange)
- (iii) Ammonia Pumps' Seal failure
- (iv) Partial Failure of Discharge Line of Ammonia Pumps.
- (v) Catastrophic Failure of one of the Ammonia Storage Tanks

## SAFETY REPORT

### 3. Furnace Oil Storage Tank

- (i) Furnace Oil Storage Tank Top Fire
- 3.2 Full Failure of the Bottom Nozzle
- (ii) Partial Failure of the Bottom Nozzle
- (iii) Furnace Oil Transfer Pump Seal failure

### 4. HSD Storage Tank

- (i) HSD Storage Tank Top Fire
- (ii) Full Failure of the Bottom Nozzle of HSD Storage Tank
- (iii) Partial Failure of the Bottom Nozzle of HSD Tank
- (iv) HSD Transfer Pump Seal failure

### 5. Chlorine Tonners

- (i) Catastrophic Failure of a Tonner
- (ii) Failure of 1" Line on the Manifold

### 6. Oxygen Plant

- (i) Fire and explosion where pure oxygen is in contact with different types of equipment. Mechanism such as friction, mechanical impact and contact with organic materials not compatible with oxygen can quickly spark a fire inside valves for instance followed by explosion.

### 5.(c) HAZARDS

The possible hazards associated with the hazardous chemicals stored, processed and handled at the complex of IFFCO are described below :

#### 5.(c).1 Ammonia

##### Health Hazards

Ammonia is a severe toxic hazard because it is handled on a large scale, it is a liquefied gas and is therefore readily dispersed, and it is highly toxic.

## SAFETY REPORT

Physiologically ammonia is an irritant gas. The effects of a single exposure include irritation of mucous membranes, attack of the respiratory tract and pulmonary edema.

Ammonia is very much soluble in water and therefore tends to attack particularly the upper respiratory tract, stripping the lining and including laryngeal edema. Splashes of liquid ammonia can result in damage of the cornea in eyes besides frostbites.

Concentration (ppm)	Effect on Humans
25	Threshold Limit Value(TLV for 8 hours TWA)
35	STEL (Short term exposure limit ) for 15 minutes
300	IDLH, strong to intolerable irritation, with some risk to highly susceptible individuals.
400	Severe irritation of throat, nasal passages and upper nasal tract.
700	Severe eye irritation.
1700	Coughing, bronchial spasms, possibly fatal for exposure of less than ½ hour.
5000	Oedema, strangulation, asphyxia, fatal almost immediately.

### Fire & Explosion Hazards

Ammonia is combustible in air within its explosive limits (16 % - 25 %) and a major leak may lead to an explosion. Fire hazard is enhanced in the presence of oil or other combustible materials.

### 5.(c).2 Chlorine

Chlorine gas is a respiratory irritant. Its characteristic penetrating odour gives ample warning of its presence and its greenish-yellow colour makes it visible when high concentrations are present. It irritates the mucous membranes of the respiratory system. In extreme cases, breathing difficulty may reach the point where death can occur by suffocation. It reacts with body moisture to form acids, and at high concentrations, it acts as an asphyxiant.

Liquid Chlorine can cause serious skin burns. Exposure to Chlorine gas can cause burning eyes and nose.

## SAFETY REPORT

### EFFECTS OF CHLORINE AT VARIOUS CONCENTRATIONS

Concentration (in ppm)	Effects
0.2 – 0.5	No noxious long term effect
0.5	Slight Odour
1 – 3	Definite odour, irritation to eyes and nose
6	Irritation to throat
10	IDLH (Immediate Danger to Life & Health ) if exposed for 30 minutes
30	Intense cough fits
40 – 60	Exposure without effective respirator for 30 to 60 minutes or more may cause serious damage.
100	May cause lethal damage
1,000	Danger to life even after few inhalations

#### 5.(c).3 Liquid Fuels (HSD & Furnace Oil)

##### Fire & Explosion Hazards

Storage tanks containing liquid fuels like High Speed Diesel (HSD) and Furnace Oil have been involved in many fires of serious nature. The contents of a large tank can cause extensive damage if released during a fire. Study shows that lightning was the ignition source in 43% of fires whereas internal explosions of unknown origin and static electricity generated, during splash filling, each caused 11% of the incidents. Other causes included spontaneous ignition (8%), cutting & welding (7%), exposure fires (6%), overfilling (6%) and tank collapse (4%). There were individual cases reported, failure of an internal heating system and ignition of vapours within a dyke area, which flashed back to the tank. Thus, the major hazard associated with the liquid fuel storage tanks is ignition of fuel release resulting in a pool fire with possible impact on the surrounding facilities.

#### 5.(c).4 Sulphur

##### Health Hazards

Sulphur dust irritates the eyes and mucous membrane of the respiratory tract. It also has an irritant action on the skin, which may be aggravated by perspiration or moisture. When inhaled, there may not be much effect due to pure molten

## SAFETY REPORT

sulphur. However, impurities like Sulphur Dioxide may cause severe respiratory irritation and hydrogen sulphide may cause headache and dizziness.

### Fire & Explosion Hazards

Sulphur ignites by frictional heat or instinctive sparks, particularly when suspended as dust in air. It also ignites when reacted with halogen oxides like Chlorine Dioxide gas or Iodine Oxide, and such reactions may lead to explosions. When mixed with metals like powdered zinc or calcium and ignited, Sulphur will explode violently. Even when mixed and ignited with non-metals like yellow phosphorus, lamp black or freshly calcined charcoal, potassium or other alkali metal nitrites, it forms a highly flammable mixture that may explode.

#### 5.(c).5 Oxygen Plant

Any industrial process that generates or uses oxygen is exposed to an elevated risk of fire. This applies in particular to air separation plants, where pure oxygen is in contact with different types of equipment. Mechanisms such as friction, mechanical impact and contact with organic materials not compatible with oxygen can quickly spark a fire inside valves, for instance. The resulting explosion-like reaction is a substantial risk to people working nearby. In the presence of oxygen, any flammable material – once ignited – will readily burn. Depending on operational conditions, even metals may become ignited.

#### 5.(d) SAFETY- RELEVANT COMPONENTS

The safety relevant components identified in the plant for Consequence Analysis calculations are as follows:

- (i) Refrigerated Ammonia Storage Tanks, Transfer Pumps and Pipelines.
- (ii) Chlorine Tonners
- (iii) HSD Storage Tanks
- (iv) Furnace Oil Storage Tanks

The above components have been identified on the basis of dangerous properties, inventories and storage / handling parameters of the hazardous materials.

## SAFETY REPORT

### Chapter – 6

## 6.DESCRPTION OF SAFETY RELEVANT UNITS, AMONG OTHERS

### 6.(a) SPECIAL DESIGN CRITERIA

Ammonia Storage Tanks ( 20,000 MT capacity ) are designed to store liquid ammonia at atmospheric pressure under refrigerated conditions (Storage Temperature = -33°C). These double – walled tanks (double integrity) are cold insulated with PUF (Poly Urethane Foam) to restrict the heat inflow from the ambient atmosphere through pipelines and tank surfaces. However, some heat inflow exits and evaporate some part of the liquid ammonia thereby the pressure in the storage tanks increases. Vapours from the tanks are drawn, compressed, cooled and condensed. The condensed liquid ammonia flash cooled and taken back into the storage tanks and thus the pressure and temperature of the tanks are maintained. In case of emergency, to safe guard the tanks against possible excess pressure, five numbers of Safety Relief Valves (SRVs) are provided to release the pressure when it reaches the maximum set value. A flare is also provided to vent out and burn the excess ammonia vapours. Ammonia storage tanks are also safeguarded against high level, low level and low pressure. Eight fixed detectors (sensors) have been installed at selected locations in ammonia storage area. These would facilitate quick detection of any release of ammonia from the storage facilities by raising an alarm inside the ammonia storage control room.

Chlorine is stored under pressure inside tonners, which are designed to withstand maximum vapour pressure of chlorine under ambient conditions.

Furnace Oil and HSD are stored in vertical aboveground storage tanks under atmospheric conditions. These tanks are designed in accordance with relevant standards (IS-803, etc.) and are provided with vents of adequate size to protect the tanks against possible pressurization and vacuum conditions.

### 6.(b) CONTROLS AND ALARMS

#### i) Pressure / Temperature Control:

Normally the pressure / temperature in storage tanks is maintained between 350 mmWC and 450mmWC and -33°C. However, the tanks are designed for a pressure range of -50 mm WC to 1050mmWC. The tanks are provided with pressure transmitters, which are used for recording the pressure & controlling of the discharge pressure of Blower. In addition to these, there is a pressure Switches on common header for interlocks. Interlock is provided to close liquid inlet control valves when tank pressure is high. At very high tank pressure, interlock is

## SAFETY REPORT

provided to open the vent valve to flare ammonia. The tanks are also provided with pressure gauges on top. One pressure indicating recorder gauge and one pressure indicating controller is provided in control panel. One number multi-point temperature recorder is provided to record liquid ammonia temperature in storage tanks. The tank pressures are also controlled by manual venting. When the tank pressures rise, the operator will manually vent vapour ammonia to flare stack.

### ii) **Level Control:**

The inner tank is provided with one servo type float operated level gage (LG) with remote indication and an electrical transmitter with indicator in central panel is also provided.

### **6.(c) PRESSURE RELIEF SYSTEMS**

Each of the three Liquid Ammonia storage tanks is provided with five pressure relief valves and two vacuum relief valves (breathers) of 100% capacity. The pressure relief valves are designed for external fire condition. These safety valves discharge directly to atmosphere and protect the tank from over pressure and vacuum in the event of failure of safety interlocks or re-liquefaction system. The safety relief valves and vacuum relief valves are mounted on three way valves in such a way that even if one pressure and vacuum relief valve is isolated for maintenance the other valve remains lined up with tank.

### **6.(d) QUICK ACTING VALVES**

Since the liquid ammonia storage tanks operate at a low pressure and no fire and explosion hazards exist, quick-acting valves are not provided.

### **6.(e) COLLECTING TANKS / DUMP TANK**

There is an ammonia receiver to collect condensed ammonia from condenser and a vent drum has been provided to contain liquid drained from any such point to flare.

### **6.(f) SPRINKLER SYSTEM**

Automatic/Manual Sprinkler System arrangement is provided in the sulphur storage yard and all along the sulphur conveyor belt. Sprinkler system has been provided through the entire cross country conveyor belt area (Port to plant). The Ammonia storage is also provided with Automatic Water Curtain System in Transfer Pump area and Control room.

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### 6.(g) FIRE PROTECTION

A well-designed fire hydrant system is provided in the plant premises to control major fire emergency scenarios. The plant is provided with adequate water supply for process as well as hydrant system with exclusive static firewater storage of 6600 m<sup>3</sup>.

The hydrant system, comprising of 310 equivalent hydrant outlets is fed with water by means of six main pumps with a capacity of 273 m<sup>3</sup>/hr at a discharge pressure of 8.0 kg/cm<sup>2</sup>.

Four of these pumps are electrically driven while the remaining two are driven by diesel engines. Two jockey pumps are provided to keep the system pressurized, taking care of minor leakages / losses.

The hydrant mains are laid in loop form to ensure water supply to hydrants even during the maintenance operation involving a part of the hydrant main.

A number of automatic fixed fire protection arrangements are provided in the plant with a view to ensure rapid control and extinguishment of fires besides minimization of damage.

The plant is itself equipped with three fire tenders (two water cum foam and one water tender) and a trained fire fighting squad led by qualified fire engineers for controlling major fire emergencies inside the plant premises.

Moreover, when required IFFCO may seek assistance from the Mutual Aid Industries namely Paradeep Phosphate Limited, IOCL Paradeep Refinery, IOCL Pipeline Division and Paradeep Port Trust in the event of major fire emergencies.

Fire extinguishers of suitable type are provided at selected locations for extinguishing fires in their incipient stages.

However, the employees are to be trained in fire fighting with the aid of extinguishers as well as the hydrant system.

Employees selected from various departments given extensive training to form a core group under the leadership of the incident controller.

After these employees are trained, it may be ensured that these employees are uniformly distributed in all shifts.

# SAFETY REPORT

## Chapter - 7

### 5. INFORMATION ON THE HAZARD ASSESSMENT

#### 7.(a) IDENTIFICATION OF HAZARDS

NFPA classification for all the chemicals handled at the plant, their quantities & hazardous properties have been used for identifying the possible hazards associated with the plant.

Based on further study following cases has been identify as the most credible hazard

1. Leakage of ammonia from ammonia storage tank /pipeline
2. Leakage of chlorine gas from Chlorine tonner
3. Fire in HSD storage tank
4. Fire in F.O. storage tank

#### 7.(b) THE CAUSE OF MAJOR ACCIDENTS

Basic events that could result into major accidents are listed below:

##### A. Ammonia Unloading at the Jetty

- a. Release of Liquid ammonia from the Unloading Arm.
- b. Safety Relief Valve (on pipeline) Pop-off.
- c. Safety Relief Valve (on vent drum) Pop-off.
- d. Ammonia Release due to Flange Leak on the Cross-country pipeline during unloading
- e. Guillotine Rupture of the Cross-country pipeline.

##### B. Ammonia Storage Tanks

- f. Full Failure of Liquid Ammonia Outlet Line (after first flange)
- g. Partial Failure of Liquid Ammonia Outlet Line (after first flange)
- h. Ammonia Pumps' Seal failure
- i. Partial Failure of Discharge Line of Ammonia Pumps.
- j. Catastrophic Failure of one of the Ammonia Storage Tanks

##### C. Furnace Oil Storage Tank

## SAFETY REPORT

- (i) Furnace Oil Storage Tank Top Fire
- (ii) Full Failure of the Bottom Nozzle.
- (iii) Partial Failure of the Bottom Nozzle.
- (iv) Furnace Oil Transfer Pump Seal failure

### D. HSD Storage Tank

- (i) HSD Storage Tank Top Fire
- (ii) Full Failure of the Bottom Nozzle of HSD Storage Tank.
- (iii) Partial Failure of the Bottom Nozzle of HSD Tank.
- (iv) HSD Transfer Pump Seal failure

### E. Chlorine Tonners

- (i) Catastrophic Failure of a Tonner.
- (ii) Failure of 1" Line on the Manifold

### F. Oxygen Plant

- (i) Fire & Explosion

## 7.(c) ASSESSMENT OF HAZARDS ACCORDING TO THEIR OCCURRENCE, FREQUENCY

The frequencies of occurrence the earlier identified failure scenarios have been calculated with reasonable approximation and are tabulated below.

These calculations are based on the international data on basic events / top incidents of specific equipment.

SI.No.	Failure Scenario	Probable Failure Frequency (per year) (Approximately)
<b>1.0</b>	<b>During Ammonia Unloading from Ship Tankers</b>	
1.1	Release of Ammonia from Unloading Arm	$10^{-6} - 10^{-7}$
1.2	Safety Relief Valve (on line) Pop-off	$10^{-4}$
1.3	Safety Relief Valve (on Vent Drum) pop off	$10^{-4}$
1.4	Flange Leak on Cross-Country Pipeline	$10^{-5}$

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1.5	Guillotine Rupture of the Cross-country Pipeline	$10^{-6}$
<b>2.0</b>	<b>Ammonia Storage Tanks</b>	
2.1	Full (100%) Failure of Bottom Outlet Nozzle	$9.29 \times 10^{-5}$
2.2	Partial (20%) Failure of Bottom Outlet Nozzle	$3.41 \times 10^{-3}$
2.3	Ammonia Transfer Pump Seal Failure	$3.10 \times 10^{-3}$
2.4	Partial (20%) Failure of Ammonia Transfer Pump Discharge Line	$2.19 \times 10^{-4}$
2.5	Catastrophic Failure of one of the Storage Tanks	$10^{-12}$
<b>3.0</b>	<b>Chlorine Tonners</b>	
3.1	Catastrophic Failure of a Chlorine Tonner	$10^{-6}$
3.2	Failure of 1" Diameter Line on the Manifold	$8.8 \times 10^{-6}$
<b>4.0</b>	<b>HSD Storage Tank</b>	
4.1	Storage Tank Top Fire	$10^{-4}$
4.2	Full (100%) Failure of Bottom Outlet Nozzle	$8.76 \times 10^{-6}$
4.3	Partial (20%) Failure of Bottom Outlet Nozzle	$2.54 \times 10^{-5}$
4.4	Transfer Pump Seal Failure	$7.11 \times 10^{-3}$
<b>5.0</b>	<b>Furnace Oil Storage Tank</b>	
5.1	Storage Tank Top Fire	$10^{-4}$
5.2	Full (100%) Failure of Bottom Outlet Nozzle	$8.76 \times 10^{-6}$
5.3	Partial (20%) Failure of Bottom Outlet Nozzle	$2.54 \times 10^{-5}$
5.4	Transfer Pump Seal Failure	$7.11 \times 10^{-3}$
<b>6.0</b>	<b>Oxygen Plant</b>	
6.1	Fire & explosion in oxygen plant	$10^{-4} - 10^{-5}$

### 7.(d) ASSESSMENT OF ACCIDENT CONSEQUENCES

The assessment of hazards identified as above and its consequences have been calculated and its dispersion impact has been given in **chapter 9**.

### 7. (e) SAFETY SYSTEMS

In accordance with the mandatory requirement under the factories act, IFFCO complex has a full-fledged safety organization led by General Manager

## SAFETY REPORT

(Production, E&S), Jt. G.M. (Production, Fire & Safety and Environment), who is qualified and is well experienced in the field. He is presently supported by a Deputy manager (F&S), Assistant Manager (F&S), Two Senior Fire & Safety Engineer, Four Safety Officers, and one Officer (F&S), Fire Safety Inspectors and firemen cum drivers for carrying out fire & safety related activities on day to date basis.

A Safety policy has been formulated and made known to all concerned. A Central safety & plant level safety committee have been set up in accordance with the requirements of the factories act. This committee is headed by the Unit Head, as chairman, who would be supported by the Jt. G.M. (Production, Fire & Safety and Environment), who works as the secretary of the committee. Representatives of management as well as workers are included in equal numbers as committee members. The committee meetings is held monthly to discuss matters related to safety at the plant.

Besides distribution of material safety datasheets among employees, hazardous properties of various chemicals would be displayed at several locations within the plant (Bilingual display). There is a well-structured system by which all accidents / incidents, whether lost time or minor injuries, fires, release of products or any other dangerous occurrence is reported on a prescribe format. Accidents are investigated by the safety officers, who later refer their findings to the Central Safety Committee for further discussions on the solutions for preventing their recurrence.

The work permit system is diligently practiced in the plant for all maintenance jobs including both hot and cold work with a view to ensure a personal and collective discipline and to provide checks for minimization of problems and errors. This work permit system ensures that proper consideration is given to the risks and that they are dealt with prior to commencement of the work. A locking and tagging system is practiced for carrying out inspection and maintenance of moving parts of equipment and electrical installations.

Contractor workers, hired for various jobs in the plant, are given adequate training and proper instructions to ensure that necessary safety precautions are observed by them. In order to motivate workers to improve safety performance, various competitions would be organized on different occasions. Training programs would be held periodically for training field operators in the field of safety and fire prevention / protection.

### **7.(f) KNOWN ACCIDENT HISTORY**

The records related to the accident are available with Fire & Safety department. However, the history of known accident, published in various general is available in technical library as well as in Management information system

## **SAFETY REPORT**

### **Chapter - 8**

## **8 DESCRIPTION OF INFORMATION ON ORGANISATIONAL SYSTEMS USED TO CARRY ON INDUSTRIAL ACTIVITY SAFELY**

### **8.(a) MAINTENANCE AND INSPECTION SCHEDULES**

Each plant in the complex is subject to continuous monitoring in the form of surveillance and checks in the control rooms and locally in the form of periodic inspection tours through the plant to check for normal operating conditions. Safety related systems are checked regularly according to the maintenance and inspection plan. Equipment, machines, pipe work and valves are serviced and repaired, as necessary. The pressure vessels are inspected regularly in compliance with the Factories Act. In view of recent commissioning of the plants, the experienced managers and engineers of maintenance departments are presently in the process of formulating preventive maintenance schedules for different equipment and facilities. These preventive maintenance schedules, based on national as well as international standards, shall be diligently implemented after formulation.

#### **8.(a) 1. Inspection of Ammonia Storage Tanks**

IFFCO Paradeep unit have Four nos. of ammonia tank viz. FA 101-A, B ,C & D having capacity 20000, 20000 , 10000 & 20000 MT respectively.

The Ammonia Storage Tanks inspection is done once in 10 years and its Safety Valves also inspected and tested once in four years.

To meet the statutory requirement of the complex, it is proposed to check the health of 20000MT Ammonia Storage tank-A.

Inspection of Ammonia tank could only be done by de-commissioning, inspection, repair & re-commissioning of the tank.

It was decided that decommissioning, inspection, repair & re-commissioning will be carried out in four phases.

Phase-1: Empty out the Ammonia Tank by dry process to avoid ammonia waste.

Phase-2: Cutting of manhole, blind insertion in all connecting line to tank, scaffolding work, insulation removal & air blowing.

## **SAFETY REPORT**

Phase-3: Detail inspection, repair & re-insulation of tank.

Phase-4: Re-commissioning of tank.

### **01. INSPECTION OF CUP SHELLS**

#### **a) CUP SHELL: -**

- i) Visual inspection of complete shell wall using magnifying glass to find out any abnormality / defects.
- ii) 100% MPT of all circumferential & vertical welding joints to detect surface & subsurface discontinuities / cracks.
- iii) 100% DPT of corner joint.
- iv) 100% UFD of all T joints (approx-267 nos)
- v) Thickness test of complete shell wall at 30/35 nos selected points on each plate.
- vi) Hardness test at selected points.
- vii) Microstructure test at 18 locations in selected points.
- viii) Radiography test up to 4th course of about 180 nos T joints.
- ix) DP test of all attachment weld on shell plate.
- x) 100% MPT up to 2nd course from outside / annular space & all T joints from 3rd course.
- xi) 100% DP test of all 32nos of anchors from annular space (c-clamps & stopper plate)

#### **b) CUP BOTTOM:-**

- i) Visual inspection of bottom plate for any abnormality.
- ii) Thickness measurement of bottom plates at selected points.
- iii) 100% MPT of all weld joints (all vertical & horizontal)
- iv) 100% vacuum box test off all vertical & horizontal weld joints including annular ring joints.
- v) 100% Vacuum Box tests of corner joint.
- vi) DP test of corner joint.
- vii) Microstructure examination at 9 selected points & 9nos of minor bulging areas of annular plate.
- viii) Hardness test of bottom plate at selected points.
- ix) Magnetic Particle Test for bottom of ammonia tank.

### **2) INSPECTION OF OUTER TANK**

#### **a) OUTER TANK BOTTOM**

## SAFETY REPORT

- i) Visual inspects of annular ring from annular space.
- ii) Thickness of annular bottom plate at selected points.
- iii) Hardness test of annular bottom plate at selected points.
- iv) 100% DP test of corner joint from annular space.
- v) 100% vacuum box test of both corner joint from annular space including lap joints.
- vi) Microstructure examination at 9 locations as selected areas.

### b) OUTER TANK SHELL WALL

- i) Visual inspection up to 4th coarse / 12 mtr height.
- ii) 100% surface crack detection by MPT up to 4th co arse from annular space.
- iii) UFD of all T joints from annular space.
- iv) Thickness test at selected points.
- v) Hardness test at selected points.
- vi) 100% DP test of all 96 nos of anchors including manhole joints, pad plate joint from outside.
- vii) 100% radiograph test of 02 nos. cutting manholes.
- viii) DP test of all attachments like tank roof nozzles, cleats & supports.
- ix) Microstructure examination at 6 locations as selected areas.

### 3) TANK ROOF INSPECTION

- i) Visual inspection including nozzles.
- ii) 100% DP of all 72 segments of welding joints (after sand blasting)
- iii) 100% surface crack detection of all roof welding joints.
- iv) Thickness test of roof plate including nozzle necks (pipes)

### 4) OTHER TESTS

- I) Hydro test (water in cup tank up to 13.5 mtr)
- II) Pneumatic test of outer tank.
- III) Partial Vacuum test.

## CONCLUSION:

From over all considerations of various NDT technique (DP, MPT, UT Thickness measurement, Ultrasonic Flaw Detection, Hardness measurement results, it can be construed that the Atmospheric Ammonia Storage Tank No. FA-101A, capacity 20000 MT is free from any significant internal as well as external defects except by visual observation.

## SAFETY REPORT

### Hydro- Pneumatic Test Report of Ammonia Tank-A:

Hydro- Pneumatic test of Ammonia Tank-A was done. The Tank pressure was increased from zero to 1250 mmwc by instrument air through 1" line at bottom of the tank (4" nozzle, outer tank drain) and at top of the tank through safety valve air header. The pressure of the tank was hold for 30 minutes, during this period leakage from valves, flanges and weld joints of roof were checked by soap solution. No leakage found from any points. During this period pressure was steady up to 30 minutes.

### Testing of safety valves mounted on its Roof:

The pop-up and reset pressure of the safety valves is as follows:

Valve Sr No. From flare stack side	SRV Sr. No.	Pop up pressure in mm of WC	Reset Pressure in MM of WC
1	98/13876	1032	865
2	98/13873	1112	780
3	98/13875	930	620
4	98/13877	860	690
5	98/13874	1060	930

### Testing of the vacuum breather valve:

The test report of the vacuum breather valves are as follows:

Valve Sr. No. from Flare Stack side MmWC	VRV Sr. No.	Breathing pressure	Reset pressure mmWC
1	98/13882	-50	-43
2	98/13885	-50	-37

### 8.(b) GUIDELINES FOR THE TRAINING OF PERSONNEL

Training and briefing based on the operating and safety instructions are arranged for the plant engineers / employees by their superiors at the time of joining and on day-to-day basis to ensure safe operation of the plant. On-the-job training on the use of firewater and safety appliances to mitigate emergency

## **SAFETY REPORT**

arising out from ammonia leakage is also conducted periodically. IFFCO envisages designing comprehensive training modules for employees at different levels and departments. Besides, a rehearsal on On-Site Emergency Plan has been planned to conduct once in six months in which all personnel shall participate directly or indirectly.

### **8.(c) ALLOCATION AND DELEGATION OF RESPONSIBILITY FOR PLANT SAFETY**

In accordance with the Safety Policy of IFFCO, all the employees are responsible for maintaining safe working conditions at the plant premises. Managers of each of the units are responsible for maintaining safe working conditions and ensuring adherence to safe work practices by their subordinates. The fire & safety department has been entrusted with the responsibility of ensuring safe working conditions within the plant premises by carrying out inspections on day-to-day basis. The department is also responsible for controlling emergencies like fires etc. inside the plant premises with the assistance of firemen and the employees who are trained in carrying out fire fighting operations. The Fire Engineers hold degree from the National Fire Service College, Nagpur and IES IPS Academy, Indore besides the Safety Officers hold Diploma in Industrial Safety from recognized institution, and hence the department is capable of shouldering the responsibility. Most of the security guards are well trained in fire fighting. These guards are responsible for security of the plant for 24 hours.

### **8.(d) IMPLEMENTATION OF SAFETY PROCEDURES**

Safety procedures have been implemented and are closely monitored by the safety organization of the company. IFFCO plant has a well-defined safety policy, which has been implemented by the management to ensure safe and healthy working conditions, equipments and systems of work for all employees. It has been the endeavor of IFFCO management to ensure that the surrounding area is not adversely affected by the manufacturing activities. Every employee has to abide by the safety rules / regulations, operating procedures, work permit systems etc. in the plant premises. Each employee has been assigned with personal responsibility for maintaining and improving safety standards at the plant. Safety during maintenance jobs is ensured with the help of a work permit system. Work permit system is practiced in the plant for all maintenance jobs including both hot and cold work with a view to ensure a personal and collective discipline and to provide checks for minimization of problems and errors. This work permit system ensures that proper consideration is given to the risks and that they are dealt with prior to commencement of the work. A locking and tagging system is practiced for carrying out inspection and maintenance of moving part of equipment and electrical installations.

## Chapter – 9

### 9 INFORMATION ON ASSESSMENT OF THE CONSEQUENCES OF MAJOR ACCIDENTS

#### 9. (a) ASSESSMENT OF POSSIBLE RELEASE OF HAZARDOUS CHEMICALS

This is the methodology used to determine the potential for damage or injury from specific incidents. A single incident (e.g., rupture of Ammonia pipeline, etc.) can have many distinct incident outcomes (e.g, jet fire, Unconfined Vapour Cloud Explosion, Toxic Affect). These outcomes are analysed using source and dispersion models and explosion and fire models. Mathematical models are then used to determine the consequences to people or structures. Source and dispersion models provide quantitative information on source rates and dispersion of vapour clouds to some concentration levels. Fire and explosion models convert the information on the cloud for flammable releases into hazard potentials such as thermal radiation and explosion overpressures. Models convert these incident-specific results into effects on people (injury or death) and structures. The models used for evaluating affected distances consequent to the failure scenarios identified have been carried out with internationally recognized modern software. The various models used are described below.

#### 9. (a)1 VARIOUS MODELS ON RELEASE OF CHEMICALS OR ENERGY:

##### Gas Outflow Model

Bernoulli's equation has been used for evaluating gas outflow rates following failure of pipe joints, valves, pipeline, etc. The driving force for the gas outflow would be the pressure difference. A general value of 0.62 has been assumed for the discharge coefficient for gas release under pressure.

##### Liquid Outflow Model

Bernoulli's equation has been used for evaluating liquid outflow rates following failure of joints on the piping and nozzles of storage tanks as well as process vessels. The driving force for the outflow may be the liquid head or the pressure difference. It may also be a combination of the two. The model assumes incompressible flow.

## SAFETY REPORT

### Pool Fire Model

These generally tend to be localized in effect and are of concern mainly in establishing the potential for domino effects and employee safety zones. Issues relating to spacing of critical equipment, etc. can be addressed based on specific consequence analysis for a range of possible pool fires. The effects of a pool fire depend upon factors such as flammability, combustibility, the amount of material released, temperature, humidity, the pool size, flame height and tilt of the flame.

### Dispersion Models

Dispersion modeling aims at estimating the distances likely to be affected due to release of certain quantity of flammable vapours within an acceptable concentration limit. Depending upon the properties of the material released and the release conditions, dense gas dispersion or a buoyant gas release model is used for estimating the affected areas. Both the models describe the behavior of material after its release in the predominant downwind direction, at a particular wind speed and at the existing meteorological conditions such as humidity, temperature, etc. It may be noted that the release rate would depend on storage conditions (temperature and pressure), the release / failure point, intervention time, the release area and other factors. Since Chlorine is heavier than air, dense gas dispersion models have been applied for its dispersion calculations. Whereas, neutrally buoyant dispersion distances for hydrogen release scenarios. Wind speed and turbulence are significant factors, as the amount of air entrainment into the released gas would depend on the velocity at which the cloud is traveling and turbulence in the surroundings. Varying terrain contours in the area would affect the dispersion. The atmospheric stability class takes into account atmospheric turbulence and is another important consideration in modeling. This in turn depends on several factors such as wind speed, isolation, cloud cover and the time i.e., day or night. Stable atmospheric conditions lead to the least amount of mixing thus resulting in larger areas for gas dispersion and unstable condition results in maximum mixing of gas with air leading to the dilution of vapours.

In case the boiling point of the liquid under storage condition is higher than the ambient temperature, a release would generally form a pool, which may result in a pool fire, if it encounters an ignition source. In case the pool does not find ignition source, heat transfer from the atmosphere may result in evaporation of the pool, which would subsequently lead to either a dense gas or buoyant gas dispersion. Moreover, in case the flammable materials in the cloud is within the

## SAFETY REPORT

upper and lower flammability limits, and encounters an ignition source it could result in an unconfined vapour cloud explosion (UVCE).

Surroundings of the area including building and other structures also have a marked effect on the dispersion of released gas. The dispersion would vary with the size and position of the building relative to the source of release along with the other factors already discussed above.

### Vapour Cloud Explosion (VCE)

When a large amount of flammable gas / vapour is released to the atmosphere, it rapidly disperses resulting in formation of a vapour cloud. If the cloud encounters an ignition source, an unconfined vapour cloud explosion or flash fire may occur depending on the flammable mass. However, a vapour cloud explosion is not generally expected if the explosive mass is below 5 Te. If the mass is below 5 Te,

A flash fire is more likely. If the ignition source is reached when concentrations are between LFL and UFL, damage due to both fire and blast effects may take place. Flammable vapour clouds may be ignited from a number of sources, which may be continuous (e.g., pilot flames / flares etc.) or intermittent (e.g., from smoking, vehicles, etc.).

The blast effects produced by confined vapour cloud explosion have been proved to have a potential for higher damage as compared to an unconfined vapour cloud explosion.

## 9. (a)2 DAMAGE CRITERIA

### Damage Caused at Different Incident Levels of Thermal Radiation

Damage to people and property because of BLEVE, jet fire involving gas / vapour release and pool fire involving flammable liquids release is generally expressed in terms of thermal radiation intensity. The effect on people is expressed in terms of the probability of fatalities and different degrees of injury for different levels of radiation. The effect on installations, equipment and natural surroundings is measured in terms of the probability of ignition. In the **Table-9(A)** below, the radiation or incident flux is related to the levels of damage. This table is based on observation of large fires. Eisenberg's probit model has been used to estimate injury levels for a given thermal dose from pool fires. The Eisenberg's probit equation is as follows:

## SAFETY REPORT

### Explosion Overpressure Damage Estimates

Distances are estimated for vapour cloud explosion for overpressures of 0.30, 0.10, 0.03 and 0.01 bars. These overpressures are the peak pressures formed in excess of normal atmospheric pressure by blast and shock waves.

The severity of explosion of 0.30 bar blast overpressure could cause collapse of conventional buildings and rupture of pipeline connections. Such damage is considered to produce 50% mortality in humans.

Over pressure affects of 0.10 bar could cause damage to storage tanks at ambient pressure, booster pumps, pipelines & roads and can cause repairable damage to both domestic and office buildings. About 10% fatality could occur.

The severity of explosion of 0.03 bar could cause damage to windows with the likelihood of injury due to flying glass.

The concept that flames in unconfined vapour clouds have to accelerate before achieving speeds sufficient to cause blast effects implies that only low over pressures can be attained in small clouds. Acceleration affects have been observed experimentally, and the fall of in over pressure with reducing flammable mass has been reported for small clouds.

It is also claimed some times that there may be an upper limit to the amount of material that can actively contribute to an unconfined vapour cloud explosion. This is based on the notion that a massive release of gas would find an ignition source within the installation long before the whole mass is released and diluted to flammable concentrations. The affect of various overpressures of process equipment is shown in **Table- 9(B)**.

**TABLE – 9 (A)**

### **DAMAGE DUE TO INCIDENT RADIATION INTENSITY**

<b>INCIDENT RADIATION INTENSITY (kW / m<sup>2</sup>)</b>	<b>EXTENT OF DAMAGE</b>
117.0	50% lethally after 4 secs. exposure
66.0	1% lethally after 4 secs. exposure
37.5	Sufficient to cause damage to process

## SAFETY REPORT

	equipments unless the equipment is fully thermally fire protected (insulation, fire proofing, sprinkler protection etc.).
25.0	Minimum energy required to ignite wood at infinitely long exposure (non-piloted) and would damage thermally unprotected tanks, equipment, etc.
12.5	Minimum energy required for piloted ignition of wood, melting plastic tubing, etc.
4.5	Sufficient to cause pain to personnel if unable to reach cover within 20 seconds, blistering of skin (1 <sup>st</sup> degree of burns) is likely.
1.0	Equivalent to solar radiation on a warm day during summer.

**TABLE – 9 (B)**

Overpressure (in psi)	Likely Effects
– 0.5	Window breakage
0.5	Minor structural damage to buildings
1.0	Major damage to houses
1.0	Cone roof collapse
1.16	Industrial buildings partially demolished
1.74	Wired glass breakage
3.0	Some broken piping, deluge / sprinkler piping broken
3.0	Steel frame buildings distorted, walls damaged
3.0	Vessels overturned

## SAFETY REPORT

3.0	Empty part of oil tank collapses
4.5	Much broken piping
6.0	Building steel cladding ruptured
6.0	Damage to distillation columns
7.0	Loaded wagons and trucks overturned
7.0	Brick panels in steel or concrete frame ruptured
10.0	Total destruction of buildings
14.0	Large filled vessels overturned
1.5	Damage to human organs
0.5	Damage to hearing

### 9.(a)3 INPUTS

At various stages of calculations, some assumptions have been made with professional engineering approach.

#### Inputs on Meteorological Data

The affected distances consequent to a release and dispersion depend on the wind speed, wind direction, atmospheric stability category and weather conditions which may fluctuate considerably. The meteorological data for Paradeep (provided by IFFCO) has been used for consequence evaluation.

The data is as follows:

Ambient Temperature = 32°C (305°K)

## **SAFETY REPORT**

Average wind speed = 3.0 m/s  
Relative Humidity = 80%  
Pasqual Stability Category = 'D'

### **9.(a)4 OTHER ASSUMPTIONS**

#### **Pool Fires**

The following assumptions have been considered:

- 1) Steady state burning is assumed and the burning rate is independent of pool diameter.
- 2) The flame is cylindrical in shape.
- 3) A constant and uniform surface heat flux is maintained by the flames.
- 4) No account is made for the pulsation effects known to occur within large fires.

#### **Cloud Dispersion**

The following assumptions have been considered:

- 1) The cloud is pancake shaped for dense cloud dispersion.
- 2) Ground surface is level and the ground roughness for a given surface is uniform.
- 3) It is assumed that the atmospheric conditions are constant for at least the time taken for the cloud to develop as a plume to the lowest concentration of interest.
- 4) Concentration fluctuations within the cloud are ignored.

#### **General Assumptions**

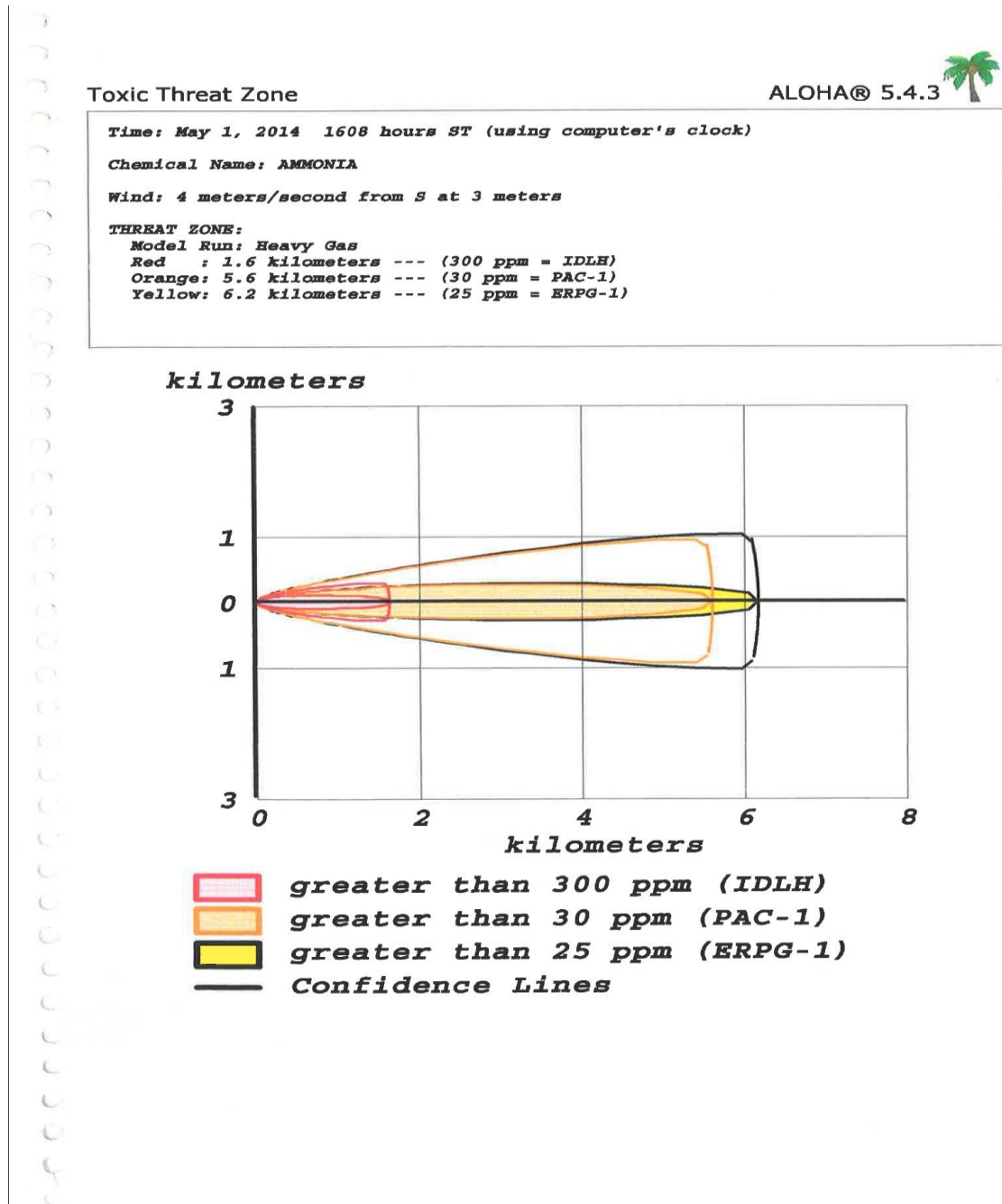
- 1) Simultaneous failure leading to more than one scenario is not considered. However, this is not ruled out completely as a major fire / explosion is likely to cause domino effects.
- 2) The horizontal wind vector is assumed to be independent of the altitude.

## SAFETY REPORT

### 9.(b) POSSIBLE DISPERSION OF RELEASED CHEMICALS:

#### 9.(b).1 Case-1

#### Leakage of Ammonia from Ammonia Storage Tank



# SAFETY REPORT

## Toxic Threat Zone

ALOHA® 5.4.3



**Time:** May 1, 2014 1610 hours ST (using computer's clock)

**Chemical Name:** AMMONIA

**Wind:** 1 meters/second from NE at 3 meters

### THREAT ZONE:

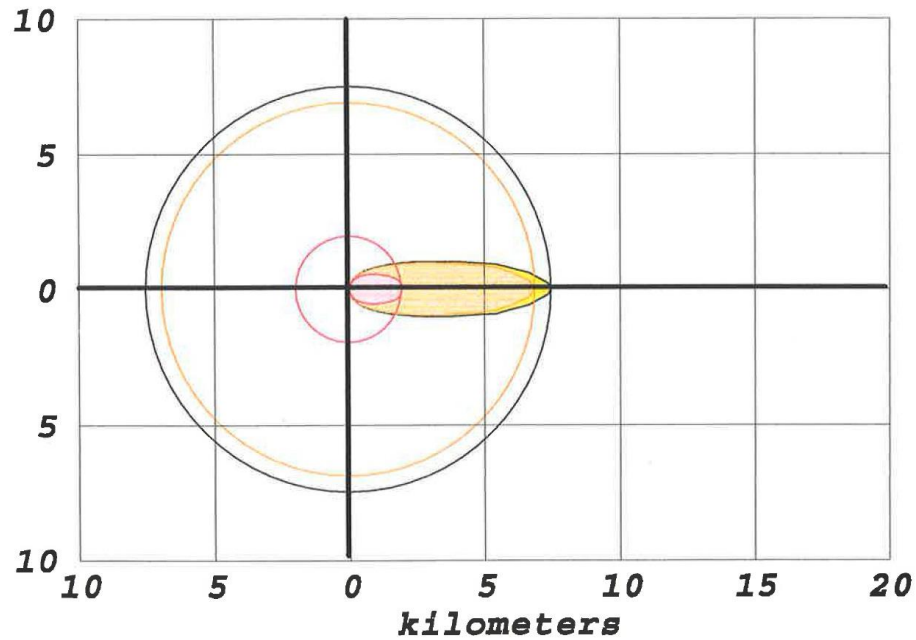
**Model Run:** Heavy Gas





**Red :** 2.0 kilometers --- (300 ppm = IDLH)

**Orange:** 6.9 kilometers --- (30 ppm = PAC-1)

**Yellow:** 7.5 kilometers --- (25 ppm = ERPG-1)

**kilometers**



-  **greater than 300 ppm (IDLH)**
-  **greater than 30 ppm (PAC-1)**
-  **greater than 25 ppm (ERPG-1)**
-  **Confidence Lines**



# SAFETY REPORT

## Toxic Threat Zone

ALOHA® 5.4.3 

**Time:** May 1, 2014 1602 hours ST (using computer's clock)

**Chemical Name:** AMMONIA

**Wind:** 6 meters/second from SW at 3 meters

### THREAT ZONE:

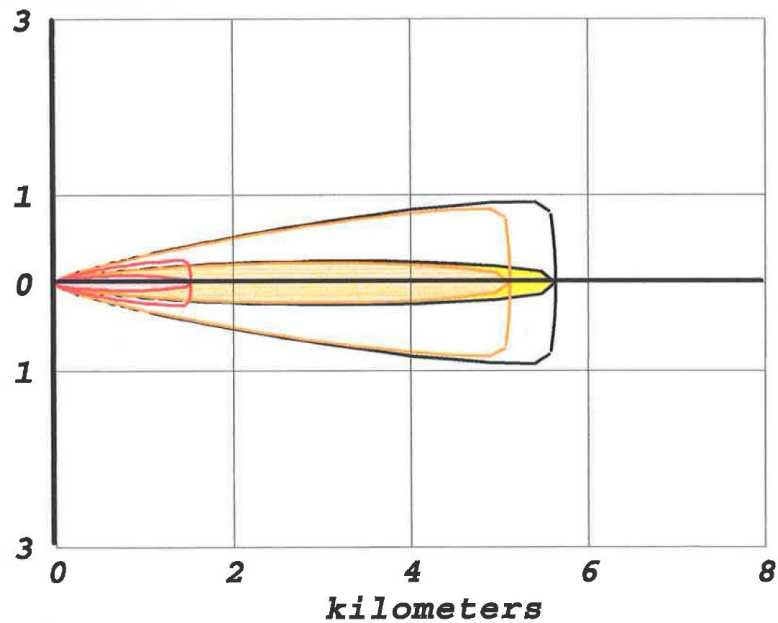
**Model Run:** Heavy Gas





**Red :** 1.5 kilometers --- (300 ppm = IDLH)

**Orange:** 5.1 kilometers --- (30 ppm = PAC-1)

**Yellow:** 5.6 kilometers --- (25 ppm = ERPG-1)

kilometers



-  greater than 300 ppm (IDLH)
-  greater than 30 ppm (PAC-1)
-  greater than 25 ppm (ERPG-1)
-  Confidence Lines





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PARADEEP UNIT

## SAFETY REPORT

AMMONIA 20000 MT RAINY
<b>SOURCE STRENGTH:</b>
Leak from hole in horizontal cylindrical tank Flammable chemical escaping from tank (not burning) Tank Diameter: 45 meters Tank Length: 20.5 meters Tank Volume: 32,603,841 liters Tank contains liquid Internal Temperature: 24.6° C Chemical Mass in Tank: 18000 tons Tank is 83% full Circular Opening Diameter: 1 inches Opening is 2.70 meters from tank bottom Release Duration: ALOHA limited the duration to 1 hour Max Average Sustained Release Rate: 668 kilograms/min (averaged over a minute or more) Total Amount Released: 40,066 kilograms
AMMONIA 20000 MT SUMMER
<b>SOURCE STRENGTH:</b>
Leak from hole in horizontal cylindrical tank Flammable chemical escaping from tank (not burning) Tank Diameter: 45 meters Tank Length: 20.5 meters Tank Volume: 32,603,841 liters Tank contains liquid Internal Temperature: 39° C Chemical Mass in Tank: 18000 tons Tank is 86% full Circular Opening Diameter: 1 inches Opening is 2.70 meters from tank bottom Release Duration: ALOHA limited the duration to 1 hour Max Average Sustained Release Rate: 798 kilograms/min (averaged over a minute or more) Total Amount Released: 47,891 kilograms
AMMONIA 20000 MT WINTER
<b>SOURCE STRENGTH:</b>
Leak from hole in horizontal cylindrical tank Flammable chemical escaping from tank (not burning) Tank Diameter: 45 meters Tank Length: 20.5 meters Tank Volume: 32,603,841 liters Tank contains liquid Internal Temperature: 13.4° C Chemical Mass in Tank: 18000 tons Tank is 81% full Circular Opening Diameter: 1 inches Opening is 2.70 meters from tank bottom Release Duration: ALOHA limited the duration to 1 hour Max Average Sustained Release Rate: 575 kilograms/min (averaged over a minute or more) Total Amount Released: 34,504 kilograms



# SAFETY REPORT

9.(b)2

## Case-2

### Leakage of Chlorine gas from Chlorine Tonner:

Toxic Threat Zone

ALOHA® 5.4.3 

Time: May 1, 2014 1924 hours ST (using computer's clock)

Chemical Name: CHLORINE

Wind: 6 meters/second from SW at 3 meters

THREAT ZONE:

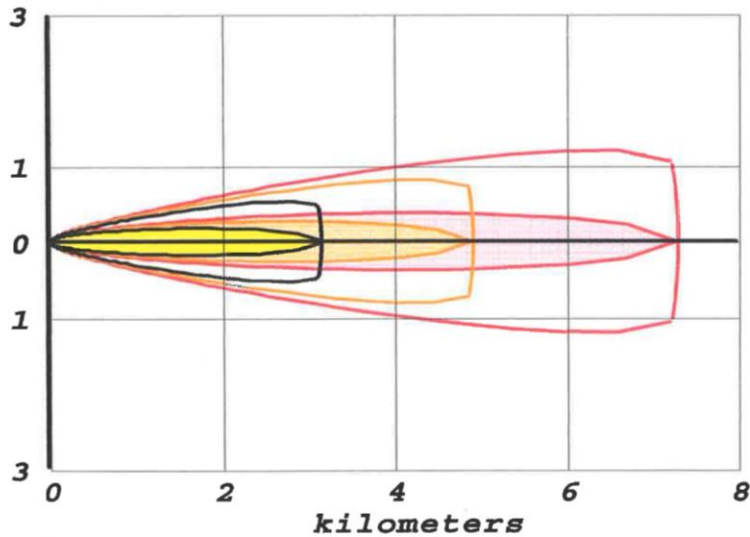
Model Run: Heavy Gas

Red : 7.3 kilometers --- (1 ppm = ERPG-1)

Orange: 4.9 kilometers --- (3 ppm = ERPG-2)

Yellow: 3.2 kilometers --- (10 ppm = IDLH)

kilometers



- greater than 1 ppm (ERPG-1)
- greater than 3 ppm (ERPG-2)
- greater than 10 ppm (IDLH)
- Confidence Lines



# SAFETY REPORT

## Toxic Threat Zone

ALOHA® 5.4.3 

**Time:** May 1, 2014 1854 hours ST (using computer's clock)

**Chemical Name:** CHLORINE

**Wind:** 1 meters/second from NE at 3 meters

### THREAT ZONE:

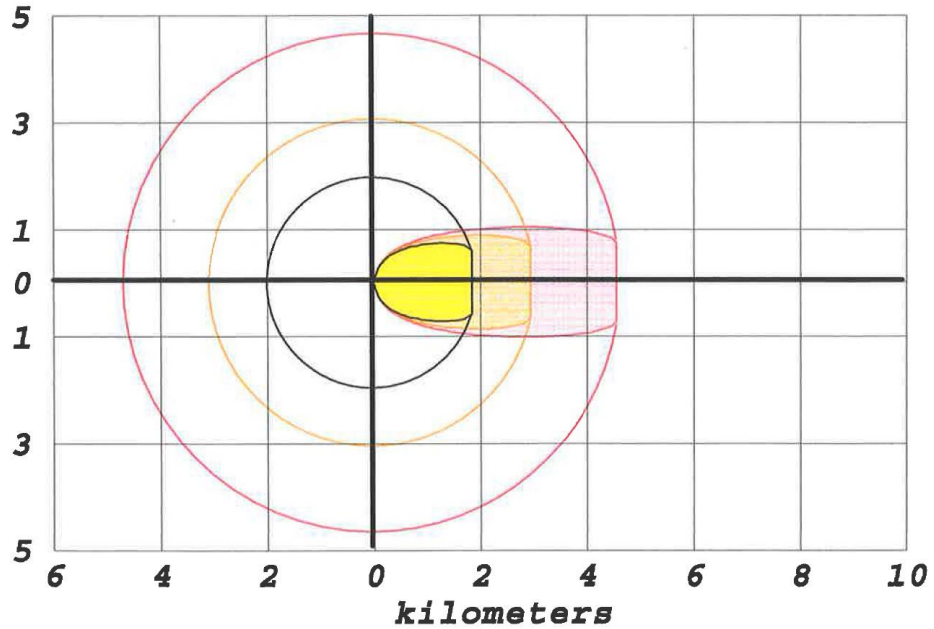
**Model Run:** Heavy Gas





**Red :** 4.6 kilometers --- (1 ppm = ERPG-1)

**Orange:** 3.0 kilometers --- (3 ppm = ERPG-2)

**Yellow:** 1.9 kilometers --- (10 ppm = IDLH)

**kilometers**



-  **greater than 1 ppm (ERPG-1)**
-  **greater than 3 ppm (ERPG-2)**
-  **greater than 10 ppm (IDLH)**
-  **Confidence Lines**



# SAFETY REPORT

## Toxic Threat Zone

ALOHA® 5.4.3



**Time:** May 1, 2014 1922 hours ST (using computer's clock)

**Chemical Name:** CHLORINE

**Wind:** 1 meters/second from S at 3 meters

### THREAT ZONE:

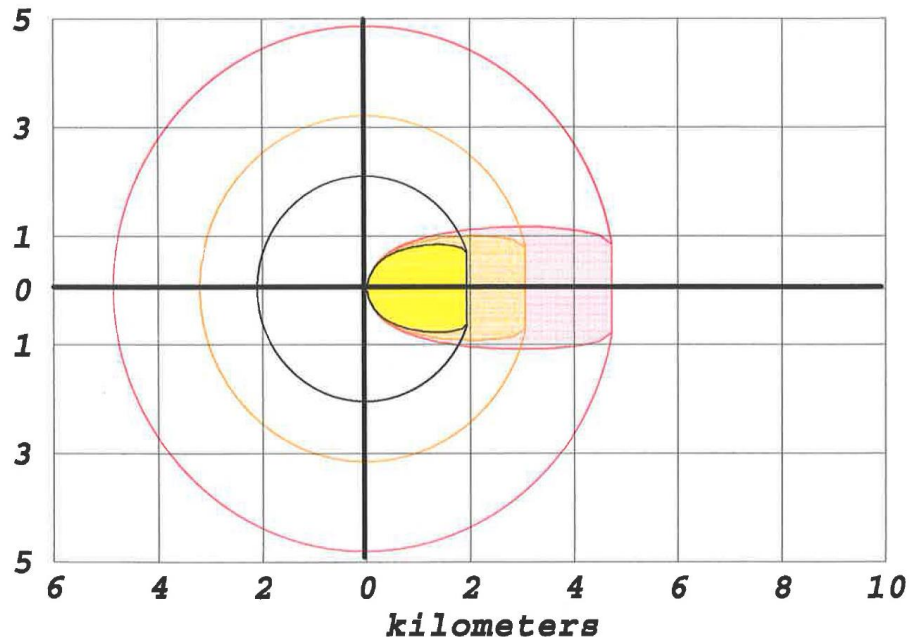
**Model Run:** Heavy Gas





**Red :** 4.8 kilometers --- (1 ppm = ERPG-1)

**Orange:** 3.1 kilometers --- (3 ppm = ERPG-2)

**Yellow:** 2.0 kilometers --- (10 ppm = IDLH)

**kilometers**



-  greater than 1 ppm (ERPG-1)
-  greater than 3 ppm (ERPG-2)
-  greater than 10 ppm (IDLH)
-  Confidence Lines



# SAFETY REPORT

CHLORINE 900 KG MT RAINY
<b>SOURCE STRENGTH:</b>
Leak from hole in horizontal cylindrical tank Non-flammable chemical is escaping from tank
Tank Diameter: 0.75 meters Tank Length: 7 meters
Tank Volume: 3,093 liters
Tank contains liquid Internal Temperature: 24.6° C
Chemical Mass in Tank: 900 kilograms
Tank is 19% full
Circular Opening Diameter: 1 inches
Opening is 0.038 meters from tank bottom
Release Duration: 2 minutes
Max Average Sustained Release Rate: 767 kilograms/min
(averaged over a minute or more)
Total Amount Released: 834 kilograms
CHLORINE 900 KG MT SUMMER
<b>SOURCE STRENGTH:</b>
Leak from hole in horizontal cylindrical tank Non-flammable chemical is escaping from tank
Tank Diameter: 0.75 meters Tank Length: 7 meters
Tank Volume: 3,093 liters
Tank contains liquid Internal Temperature: 39° C
Chemical Mass in Tank: 900 kilograms
Tank is 19% full
Circular Opening Diameter: 1 inches
Opening is 0.038 meters from tank bottom
Release Duration: 3 minutes
Max Average Sustained Release Rate: 832 kilograms/min
(averaged over a minute or more)
Total Amount Released: 846 kilograms
CHLORINE 900 KG MT WINTER
<b>SOURCE STRENGTH:</b>
Leak from hole in horizontal cylindrical tank Non-flammable chemical is escaping from tank
Tank Diameter: 0.75 meters Tank Length: 7 meters
Tank Volume: 3,093 liters
Tank contains liquid Internal Temperature: 13.4° C
Chemical Mass in Tank: 900 kilograms
Tank is 19% full
Circular Opening Diameter: 1 inches
Opening is 0.038 meters from tank bottom
Release Duration: 2 minutes
Max Average Sustained Release Rate: 653 kilograms/min
(averaged over a minute or more)
Total Amount Released: 834 kilograms

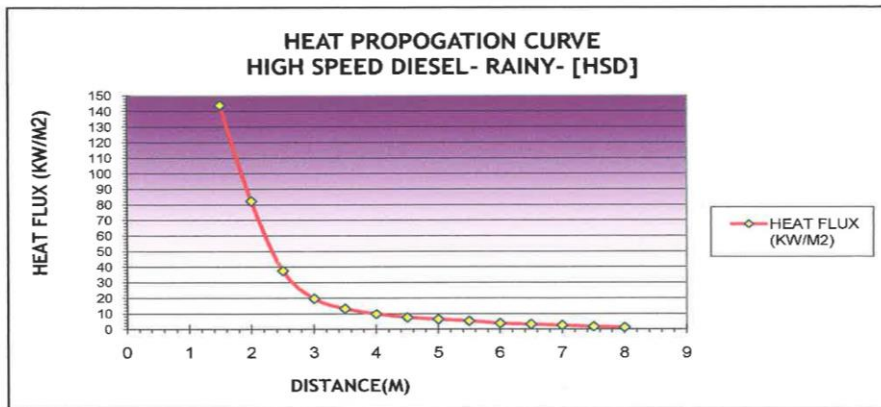


## SAFETY REPORT

### 9.(b).3 Case-3

#### Fire on HSD Storage Tank

##### MODELING OF HIGH SPEED DIESEL (HSD) IN RAINY SEASON



##### POOLFIRE MODEL - HIGH SPEED DIESEL- RAINY- [HSD]

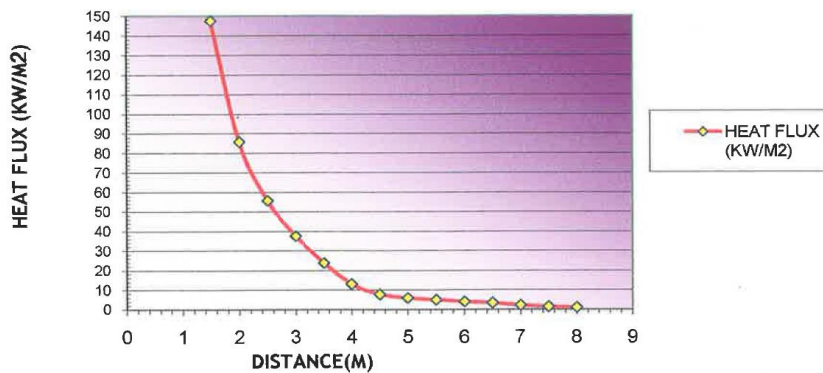
DISTANCE(M)	HEAT FLUX (KW/M2)
1.5	143.8
2	82.3
2.5	37.5
3	19.7
3.5	13.2
4	9.8
4.5	7.6
5	6.4
5.5	5.3
6	3.8
6.5	3.1
7	2.6
7.5	1.7
8	1.2



# SAFETY REPORT

## MODELING OF HIGH SPEED DIESEL (HSD) IN SUMMER SEASON

### HEAT PROPOGATION CURVE HIGH SPEED DIESEL- SUMMER [HSD]



### POOLFIRE MODEL - HIGH SPEED DIESEL -SUMMER [HSD]

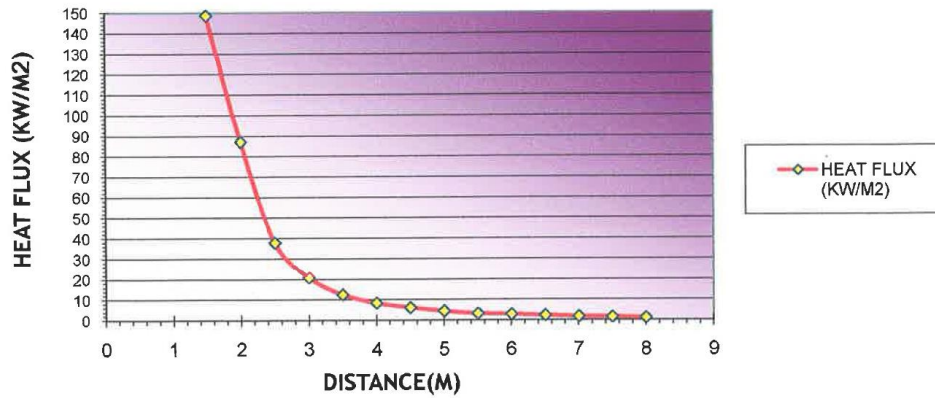
DISTANCE(M)	HEAT FLUX (KW/M2)
1.5	147.6
2	85.7
2.5	55.6
3	37.5
3.5	23.7
4	12.9
4.5	7.6
5	5.8
5.5	4.9
6	4.0
6.5	3.3
7	2.0
7.5	1.3
8	1.0



# SAFETY REPORT

## MODELING OF HIGH SPEED DIESEL (HSD) IN WINTER SEASON

### HEAT PROPOGATION CURVE HIGH SPEED DIESEL- WINTER- [HSD]



### POOLFIRE MODEL - HIGH SPEED DIESEL- WINTER- [HSD]

DISTANCE(M)	HEAT FLUX (KW/M2)
1.5	148.6
2	87.2
2.5	37.9
3	20.8
3.5	12.5
4	8.4
4.5	6.2
5	4.5
5.5	3.3
6	2.9
6.5	2.4
7	1.8
7.5	1.6
8	1.1

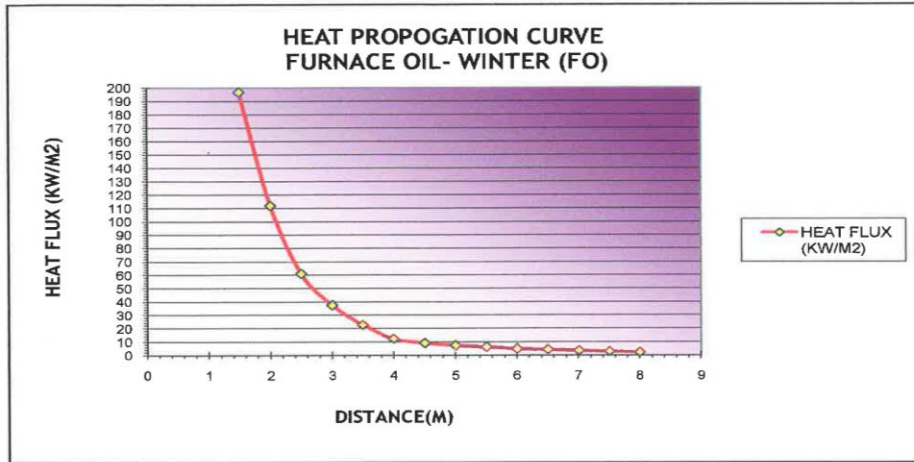


# SAFETY REPORT

## 9.(b)4 Case-4

### Fire on FO Storage Tank

#### MODELING OF FURNACE OIL (FO) WINTER SEASON



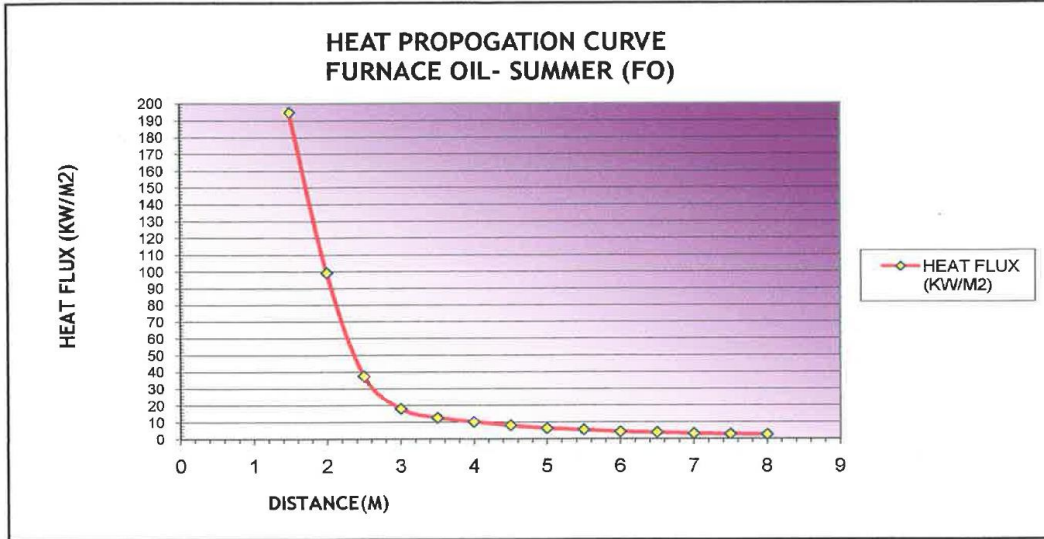
#### POOLFIRE MODEL - FURNACE OIL- WINTER (FO)

DISTANCE(M)	HEAT FLUX (KW/M2)
1.5	196.8
2	112.0
2.5	61.0
3	37.5
3.5	22.8
4	12.5
4.5	9.1
5	7.5
5.5	6.6
6	5.1
6.5	4.5
7	3.7
7.5	3.2
8	2.4



# SAFETY REPORT

## MODELING OF FURNACE OIL (FO) SUMMER SEASON



### POOLFIRE MODEL - FURNACE OIL -SUMMER (FO)

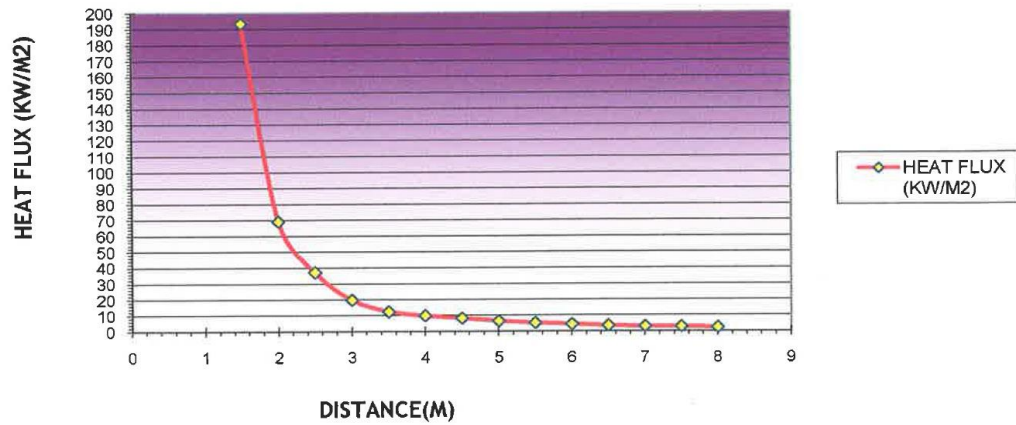
DISTANCE(M)	HEAT FLUX (KW/M2)
1.5	194.8
2	99.2
2.5	37.5
3	18.0
3.5	12.5
4	10.3
4.5	8.0
5	6.3
5.5	5.4
6	4.1
6.5	3.8
7	3.2
7.5	2.7
8	2.5



# SAFETY REPORT

## MODELING OF FURNACE OIL (FO) RAINY SEASON

### HEAT PROPOGATION CURVE FURNACE OIL- RAINY (FO)



### POOLFIRE MODEL - FURNACE OIL- RAINY (FO)

DISTANCE(M)	HEAT FLUX (KW/M2)
1.5	193.5
2	69.3
2.5	37.2
3	19.8
3.5	12.5
4	9.9
4.5	8.3
5	6.6
5.5	5.4
6	4.5
6.5	3.6
7	3.2
7.5	2.9
8	2.4



# SAFETY REPORT

STATION: PARADEEP								
Year	Month	Highest Max (Date)	Lowest Min (Date)	24hrs Highest Rainfall(mm)	Total Monthly Rainfall(mm)	Humidity	Wind direction	Average Wind Spd at 17.30
2009	JAN	30.2(20)	16.2(15)	0	0	74	C	4
	FEB	35(22)	19.8(17)	0	0	75	SSE	5
	MAR	33.6(6)	20.9(14)	0.1(22)	0.1	78	SW	6
	APR	34.5(9)	23.9(10)	35.1(17)	35.5	84	SW	8
	MAY	33.9(23)	21.6(15)	263.8(25)	342.4	83	SW	9
	JUN	39(03)	25(05)	12.4(30)	43.1	82	SW	6
	JUL	35.9(24)	24.1(3)	109.1(20)	727.7	87	W	5
	AUG	34.7(3)	34.6(25)	90.4(4)	380.4	83	C	3
	SEP	34(13)	24.6(9)	59(28)	266.9	83	C	4
	OCT	35.2(11)	20(27)	27.7(1)	82.1	71	C	1
	NOV	32.5(15)	14.6(30)	37.2(20)	37.2	71	C	2
	DEC	30(17)	13.4(25)	0	0	69	C	1



## SAFETY REPORT

### 9.(c) ASSESSMENT OF EFFECTS OF THE RELEASES (SIZE OF THE AFFECTED AREA, HEALTH EFFECTS, PROPERTY DAMAGE):

#### 9.(c)1 Leakage of Ammonia from Ammonia Storage Tank

**Health Hazard from Ammonia Storage Tank is considered as most Credible Scenario because of the following reasons;**

Ammonia is a toxic gas as per schedule-1, Part-II (b) (v). Fire & Health classification as per NFPA, it comes under category Flammability-1\* & Health Hazard-3\*\*. The Threshold Limit Value (TLV) is 25 PPM, Short Time Exposure Limit (STEL) is 30 PPM & Immediate Danger to Life and Health (IDLH) is 300 PPM. The hazard assessment is done through modeling in different seasons as mentioned below.

Toxic Gas	Health Hazard Classification	Experience at distance in Kms			Indication
		Summer	Rainy	Winter	
Ammonia 20,000 MT	TLV (TWA) (8 Hrs Exposure) 25 PPM	5.6	6.2	7.5	No adverse effect
	STEL (15 Min Exposure) 30 PPM	5.1	5.6	6.9	No adverse effect
	IDLH (30 min Exposure) 300 PPM	1.5	1.6	2	Immediate nose and throat irritation

\*Materials that must be preheated before ignition can occur. Materials in this degree require considerable preheating, under all ambient temperature condition, before ignition and combustion can occur. This degree should include:

- Materials which will burn in air when exposed to a temperature of 1500°F (815.5°C) for a period of 5 minutes or less;
- Liquids, solids, and semisolids having a flash point above 200°F (93.4°C);
- This degree includes most ordinary combustible materials.

\*\*Materials which upon short-term exposure could cause serious temporary or residual injury even though prompt medical treatment is given, including those requiring protection from all bodily contact. This degree should include:

- Materials giving off highly toxic combustion products;

## SAFETY REPORT

Materials corrosive to living tissue or toxic by skin absorption.

### 9.(c)2 Leakage of Chlorine gas from Chlorine Tonner:

Leakage of Chlorine from Chlorine tonner is considered as most Credible Scenario because of the following reasons;

Chlorine is a toxic gas as per schedule-1, Part-II (b) (v) non-flammable gas. Health classification as per NFPA, it comes under hazard Category-4\*. The Threshold Limit Value (**TLV**) is 1 PPM, Short Time Exposure Limit (**STEL**) is 3 PPM & Immediate Danger to Life and Health (**IDLH**) is 10 PPM. The hazard assessment is done through modeling in different seasons as mentioned below.

Storage details	Significant heat level Kw/m <sup>2</sup>	Experience at distance in Kms			Indication
		Summer	Rainy	Winter	
CHLORINE 900 KG	TLV (TWA) (8 Hrs Exposure) 1 PPM	7.3	4.8	4.6	No adverse effect
	STEL (15 Min Exposure) 3 PPM	4.9	3.1	3.0	Pungent, Choking, irritating Odor
	IDLH (30 min Exposure) 10 PPM	3.2	2.0	1.9	Irritation of eyes, mucous membranes, respiratory tract

\*Materials which upon very limited exposure could cause death or major residual injury even though prompt medical treatment is given, including those which are too dangerous to be approached without specialized protective equipment. This degree should include:

- Materials which can penetrate ordinary rubber protective clothing;
- Materials which under normal conditions or under fire conditions give off gases which are extremely hazardous (i.e., toxic or corrosive) through inhalation or through contact with or absorption through the skin.

### 9.(c)3 Fire on HSD Storage Tank:

## SAFETY REPORT

**Fire Hazard in HSD Storage Tank is considered as most Credible Scenario because of the following reasons;**

HSD is a flammable liquid as per schedule-1, Part-II (b) (v) having flash point of  $> 66^{\circ}\text{C}$  and auto ignition temperature of  $225^{\circ}\text{C}$  and explosive limit of 1.0% volume in air. Fire classification as per NFPA, it comes under category Flammability-2 (Moderate)\*. So, it is susceptible to fire hazard. Whenever HSD catches fire it shall manifest in the form of pool fire. The Hazard assessment is done through modeling in different seasons as mentioned below.

Storage details	Significant heat level $\text{Kw/m}^2$	Experience at distance in Mtrs.			Indication
		Summer	Rainy	Winter	
HSD 502 KL	4.5	5.5	5.5	5	Causes pain if unable cover the body within 20 seconds. However blistering of the skin (2nd degree burn) is likely caused with no lethality
	12.5	4	3.5	3.5	Minimum energy required for melting of plastic
	37.5	3	2.5	2.5	Sufficient to cause damage to the equipment

\* Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur. Materials in this degree would not under normal conditions form hazardous atmospheres with air, but under high ambient temperatures or under moderate heating may release vapor in sufficient quantities to produce hazardous atmospheres with air. This degree should include:

- Liquids having a flash point above  $100^{\circ}\text{F}$  ( $37.8^{\circ}\text{C}$ ), but not exceeding  $200^{\circ}\text{F}$  ( $93.4^{\circ}\text{F}$ );
- Solids and semisolids which readily give off flammable vapors.

## SAFETY REPORT

### 9.(c)4 Fire on FO Storage Tank:

Fire Hazard in FO Storage Tank is considered as Credible Scenario because of the following reasons;

FO is flammable liquid as per schedule 1, Part - II (b) (v) having flash point of  $>43^{\circ}\text{C}$  and auto ignition temperature of  $220-300^{\circ}\text{C}$  and explosive limit of 1.0% volume in air. Fire classification as per NFPA, it comes under category Flammability-2 (Moderate)\*. So, it is susceptible to fire hazard. Whenever FO catches fire it shall manifest in the form of pool fire. The Hazard assessment is done through modeling in different seasons as mentioned below.

Storage details	Significant heat level $\text{Kw/m}^2$	Experience at distance in Mtrs.			Indication
		Summer	Rainy	Winter	
FO 902 KL	4.5	6	6	6.5	Causes pain if unable cover the body within 20 seconds. However blistering of the skin (2nd degree burn) is likely caused with no lethality.
	12.5	3.5	3.5	4	Minimum energy required for melting of plastic
	37.5	2.5	2.5	3	Sufficient to cause damage to the equipment.

\* Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur. Materials in this degree would not under normal conditions form hazardous atmospheres with air, but under high ambient temperatures or under moderate heating may release vapor in sufficient quantities to produce hazardous atmospheres with air. This degree should include:

- Liquids having a flash point above  $100^{\circ}\text{F}$  ( $37.8^{\circ}\text{C}$ ), but not exceeding  $200^{\circ}\text{F}$  ( $93.4^{\circ}\text{F}$ );
- Solids and semisolids which readily give off flammable vapors.

Note: PAC: Protective Action Criteria  
ERPG: Emergency Response Planning Guidelines

## **SAFETY REPORT**

### **Chapter – 10**

## **10 INFORMATION ON THE MITIGATION OF MAJOR ACCIDENTS**

### **10. (a) Fire Brigade**

Presently, the Fire & Safety Department of IFFCO is led by General Manager (Production, E&S), Jt. G.M. (Production, Fire & Safety and Environment), who is qualified and is well experienced in the field. He is presently supported by a Deputy manager (F&S), Assistant Manager (F&S), Two Senior Fire & Safety Engineer, Four Safety Officers, and one Officer (F&S), Fire Safety Inspectors and firemen cum drivers.

The plant itself equipped with Four fire tenders and a trained fire fighting squad led by three qualified fire Engineers for controlling major fire emergencies inside the plant premises. About eight firefighting personnel (including Sr, Firemen, driver, and firemen) are available in each shift. Moreover, when required IFFCO may seek assistance from the Mutual Aid Industries namely Paradeep Phosphate Limited, IOCL Paradeep Refinery, IOCL Pipeline Division and Paradeep Port Trust in the event of major fire emergencies.

#### **Fire Station**

A Fire Station, manned by qualified and experienced persons, is established to control & mitigate any kind of fire and release of toxic gas. The following appliances are available at the fire station.

#### **Water-Cum Foam Tender- Registration Number: OD-21 F-8440**

Chassis (Make)	: Tata AL 1920/47
Water Tank Capacity	: 4000 Lts
Foam Tank Capacity	: 1000 Lts
Monitor Discharge @ 7 Kg/cm <sup>2</sup>	: 2850 LPM
High Pressure Hose Reel @ 7 Kg/cm <sup>2</sup>	: 250 LPM
Diesel tank capacity	: 360 Lts



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## SAFETY REPORT

### **Water-Cum Foam Tender- Registration Number: OD-21 F-4845**

Chassis (Make)	: Tata LPT 1613/42
Water Tank Capacity	: 3000 Lts
Foam Tank Capacity	: 500 Lts
Monitor Discharge @ 7 Kg/cm <sup>2</sup>	: 1400 LPM
High Pressure Hose Reel @ 7 Kg/cm <sup>2</sup>	: 15 LPM
Diesel tank capacity	: 260 Lts

### **Water Tender- Registration Number: OD-21-4723**

Chassis (Make)	: Tata LPT 1616/48
Water Tank Capacity	: 6500 Lts
Monitor Discharge @ 7 Kg/cm <sup>2</sup>	: 1800 LPM
High Pressure Hose Reel @ 7 Kg/cm <sup>2</sup>	: 30 LPM
Diesel tank capacity	: 350 Lts

### **Water Tender- Registration Number: OD-21P-6842**

Chassis (Make)	: Ashok Leyland 1920/47 HH
Water Tank Capacity	: 6500 Lts
Monitor Discharge @ 7 Kg/cm <sup>2</sup>	: 2850 LPM
High Pressure Hose Reel @ 40 Kg/cm <sup>2</sup>	: 125 LPM
Diesel tank capacity	: 350 Lts

### **Fire Hydrant System:**

#### **General**

The Facility is provided with a fire water system consisting of fire water storage tanks, fire water pumps and a fire main network that will support the necessary hydrants, monitors, and fixed systems required throughout the facility.

The fire hydrant system is laid out in a ring network of pipelines with isolation valves at Section branching. Ring ensures the supply of water from both sides of the network.

## SAFETY REPORT

### Water Supplies

For the purpose of quantifying the firewater requirements, two major concurrent incidents in different locations shall be considered. The fire water demand for these two incidents is calculated to be 1160 m<sup>3</sup>/hr.

### Storage Tank Capacity

There is one fire water storage tank of 6600 M<sup>3</sup> capacity. During emergency water available in the above tank shall be utilized for fire water service. The source of water for the plant is from the Taladanda Canal, which originates from Mahanadi Barrage.

Firewater Pumps

### Fire Water Pump Data

4 Nos of Electrical driven Main Pumps with a capacity of 273 M<sup>3</sup>/hr at a head of 88 mts

2 Nos of Diesel driven Main Pumps with a capacity of 273 M<sup>3</sup>/hr at a head of 88 mts

Jockey Pumps

2 Nos of Electrical driven Jockey Pumps with a capacity of 35 M<sup>3</sup>/hr at a head of 88 mts

### Details of Fire Fighting Systems Plant Wise

S. No.	Plant	Hydrant		Monitor	No. of Risers	Manual Water Spray System
		1 way	2 way			
1.	Sulphuric Acid	45	04	12	02	02

## SAFETY REPORT

	Plant					
2.	Phosphoric Acid Plant	26	03	04	02	-
3.	Di-ammonium Phosphate Plant	47	-	02	03	-
4.	Offsite & Utility					
5.	Ammonia Storage Area & Export Tank Area	33	02	13	-	-
6.	Energy Centre/ Boiler	35	01	02	02	-
7.	Coal Handling Plant					
8.	Bagging Plant	20	-	02	-	-
9.	Non Plant Area	12	-	-	-	-
10.	Port Jetty & Cross Country	114	-	-	-	-

## SAFETY REPORT

	Conveyor					
	Total	332	10	35	09	02

Fire Hydrant:-

- ✓ No. of fire Hydrant Hose: 100 no's
- ✓ Size of the fire hydrant hose: dia-63 mm (15 Mtr length)
- ✓ Fire hydrant line pressure: 7 kg/cm<sup>2</sup>

### ❖ Other Fire Protection Systems :

A number of automatic fixed fire protection arrangements are provided in the plant with a view to ensure rapid control and extinguishment of fires besides minimization of damage.

- Automatic sprinkler system for Sulphur conveyor belts and sulphur silos.
- Automatic water curtain system in ammonia storage pump and control room area.
- CO<sub>2</sub> flooding system for Turbine generator I & II.
- Smoke detection system in Plant buildings and offices.
- Automatic modular type fire extinguisher in UPS battery rooms.
- Nitrogen injection system for transformers.
- Automatic Medium Velocity water spray system for HSD (High Speed Diesel) storage tank.
- Automatic Foam Pourer system for HSD (High Speed Diesel) storage tank.

### ❖ Personal Protective Equipment's (PPE) & Fire Fighting Equipment's:

Sl. No.	Equipment	Qty.
1.	Fire Tender : Water Cum Foam Tender Water Tender	02 Nos. 02 Nos.
2	Fire Jeep	02 Nos.
3.	Fire Extinguisher	1000 Nos.

## SAFETY REPORT

Sl. No.	Equipment	Qty.
4.	AFFF Foam (3%)	4500 Lts.
5.	Portable Water Monitor	05 Nos.
6.	B.A. Set	25 Nos.
7.	Spare Cylinder of B.A. Set	10 Nos.
8.	ELBA Set	15 Nos.
9.	Airline with Mask	15 Nos.
10.	B.A. Set Filling Compressor	01 Nos.
11.	Half Face Mask Ammonia/Chlorine Canister	50 Nos.
12.	Chlorine Kit	02 Nos.
13.	Fire Proximity suit (Aluminized)	03 Nos.
14.	Gas Tight Suit	03 Nos.
15.	PVC Chemical suit (Disposable)	100 Nos.
16.	Hot Liquid Resistance Suit	50 Nos.
17.	Arch Flash Suit	03 Nos.
18.	Refractive Jacket	25 Nos.
19.	Multi Gas Detector/Explosimeter (LEL/O2)	09 Nos.
20.	Heat Resistant Blanket	10 Nos.
21.	Ear Plug	400 Nos.
22.	Ear Muff	25 Nos.
23.	Dust Respirator	2000 Nos.
24.	Full Body Harness	100 Nos.
25.	Safety Goggles	150 Nos.
26.	Chemical Splash Goggles	100 Nos.
27.	Wind Socks (with stand)	25 Nos.
28.	Safety Shower	60 Nos.
29.	Safety Net	20 Nos.
30.	Barricading Tape	100 rolls
31.	Gum Boot	6 pairs
32.	Leather /chrome Hand Gloves	50 Nos.
33.	Kevlar hand gloves	10 Nos.
34.	Cotton Hand Gloves	50 pairs
35.	Life Buoy Ring	10 Nos.
36.	Safety Helmet	200 Nos.
37.	Face Shield	25 Nos.

## SAFETY REPORT

### ❖ SIREN:

Main emergency siren is installed above the security building in the factory; its audible range is 5 KM. Looking to the vast area, additional four sirens are also installed locally as below.

- In Ammonia Storage Area
- In Sulphuric Acid Plant
- Phosphoric Acid Plant
- AFBC Boiler

Actuation of the entire siren can be done from the security office.

### ❖ EMERGENCY SIREN CODE:

In case of emergency the siren will be blown as below:

- *Toxic Release/ Major Fire -(On-site Emergency Plan)- High /Low*

----- OFF-----OFF-----OFF----- OFF-----OFF (Five Times)  
(15/05 Sec) (15/05 Sec) (15/05 Sec) (15/05 Sec) (15/05 Sec)

- *Toxic Release- (Off-site Emergency Plan)-High / Low*

----- OFF-----OFF-----OFF----- OFF-----OFF----- OFF-----OFF-----OFF----- (10 times)  
(15/05 Sec) (15/05 Sec) (15/05 Sec) (15/05 Sec) (15/05 Sec) (15/05 Sec) (15/05 Sec)

- ALL CLEAR: Continuous sound for two Minutes.

- TESTING: 1st day of every month at 11.00 Hrs.

### ❖ PUBLIC ADDRESS SYSTEM (PAS) :

- Public Address System (PAS) is provided in the control rooms of all the plants.

### ❖ COMMUNICATION FACILITIES :

- Satellite phone & Mobile Phones
- P&T Telephone
- Intercom
- Walkie- Talkie
- E-mail

## SAFETY REPORT

- Messengers
- Vehicles

### ❖ TRANSPORTATION:

- Fire Jeep - 02
- Bus - 03
- Ambulance - 03
- Company's Car - 10
- Hired Car - 10
- Truck / Jeep - 03
- Truck - 70
- Crane - 08
- Hydra - 10
- Personal & Official vehicles of Employees.

### ❖ MEDICAL FACILITIES

- First Aid Centre
- 20 bed Dispensary at IFFCO Township
- Three numbers of ambulances

### ❖ FIRE FIGHTING ARRANGEMENT

Fire prevention and fighting have been given much importance in the factory. The salient features of the systems are:-

- Fire station manned by qualified, experienced and trained personnel round the clock.
- Mobile Fire Tenders
- Fire water storage
- Fire hydrant network of 16.5 km with monitors and hydrant points

## SAFETY REPORT

- Portable Fire extinguishers of different types including DCP, CO<sub>2</sub>, Fire ball, Clean Agent modular type fire extinguisher and mobile trolley monitors.

### ❖ LIST AND TYPE OF FIRE EXTINGUISHER:

Sl. NO	Plant / Location	DCP Extinguisher	CO <sub>2</sub> Extinguisher	Fixed Modular Type	Clean agent	Fire Ball	Total
		6 Kg	2 Kg/4.5 Kg	5 kg	2 kg	1.3 kg	
1.	DAP	30	13	02	06	-	51
2.	PAP	15	24	06	08	-	53
3.	SAP	16	19	04	02	-	41
4.	Off Sit & Utility	22	28	07	03	-	60
5.	NON PLANT	26	62	04	13	30	135
6	BOILER & CHP	07	13	03	-	-	23
7	POWER PLANT	21	14	04	04	-	43
8	BAGGING PLANT	18	20	01	-	-	39
9	PORT JETTY	15	24	03	-	-	42
10	Township Area	07	90	06	21	-	124
11	Fire store	114	192	16	73	120	515
	<b>TOTAL</b>	<b>291</b>	<b>499</b>	<b>56</b>	<b>130</b>	<b>150</b>	<b>1126</b>

### ❖ FIRE BUCKETS:

SL NO	NAME OF AREA	NUMBER OF FIRE BUCKETS
1.	Di-Ammonium Phosphate Plant	04 No's
2.	Phosphoric Acid Plant	04 No's
3.	Sulphuric Acid Plant	04 No's
4.	Off-Sites & Utilities	12 No's
5.	Non Plant	04 No's

## SAFETY REPORT

6.	Boiler	04 No's
7.	Energy Center	12 No's
8.	Oxygen Plant	4 No's
Total		48 No's

### 10.(b) ALARM SYSTEM (Emergency Communication)

Both internal as well as external telephone facilities are provided at selected locations in each plant of the complex for quick communication during an emergency. Contract vehicles (cars) are available for communicating emergencies and rushing casualties to hospitals. Telephone numbers of external agencies like police, fire brigade, hospitals, etc are available in emergency plans as well as at selected locations in the plant.

Manual fire alarms (break glass type) are being provided at various locations, which are connected to a main fire annunciator panel located at the Fire & Safety department. In the event of a fire, the person noticing it can break the glass for actuation of the alarm, which would alert all the employees and enable them in initiating the necessary action.

We also have a hotline system with IOCL Paradip Refinery for immediate communication in case of emergency.

### 10.(c) EMERGENCY PLAN CONTAINING SYSTEM OF ORGANIZATION USED TO FIGHT THE EMERGENCY, THE ALARM AND THE COMMUNICATION ROUTES, GUIDE LINES FOR FIGHTING THE EMERGENCY, EXAMPLES OF POSSIBLE ACCIDENT SEQUENCES

A comprehensive On-site Emergency Plan has been formulated and adopted for a well – managed mitigation action in the event of an emergency. The On-site Emergency Plan was approved and accepted by Director of Factories & Boilers on dt. 13.04.2021

## SAFETY REPORT

### **10.(d) COORDINATION WITH THE DISTRICT COLLECTOR OR DISTRICT EMERGENCY /AUTHORITY AND ITS OFF-SITE EMERGENCY PLAN:**

The On-site Emergency Plan contains instructions for the plant employees to contact the District Collector, Local police station, Govt. Medical Hospital, Local Meteorological office and Neighboring industries in case of an emergency with possible off-site implications. IFFCO maintains close liaison with the aforementioned local authorities and installations. IFFCO also signed mutual-aid agreement with the neighboring industries namely Paradeep Phosphate Limited, IOCL Paradeep Refinery, IOCL Pipeline Division and Paradeep Port Trust.

Off-Site Emergency Plan has been prepared by Disaster Management Institute, Bhopal. They have prepared and submitted the updated Off-Site Emergency Plan to the District Administration for review and approval. In September 2019 it was reviewed and approved by Collector & District Magistrate cum-Chairperson DCG, Jagatsinghpur District.

### **10.(e) NOTIFICATION OF THE NATURE AND SCOPE OF THE HAZARD IN THE EVENT OF AN ACCIDENT**

In the event of any major release of ammonia from any part of the storage and distribution system, creating major accident hazard situation, necessary notification will be given to the concerned authorities as per schedule-5 in the prescribed form as given in Schedule-6 of the Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989.

### **10.(f) ANTIDOTES / MEDICAL FACILITIES IN THE EVENT OF RELEASE OF HAZARDOUS CHEMICALS:**

Unit has 20 bed well equipped hospital with five permanent doctors, 18 paramedical staffs and three ambulances with drivers are available round the clock in our hospital. The hospital has adequate no's of stretchers, suction apparatus and oxygen administration facility with oxygen cylinders. The medical staff is led by a Chief Medical Officer, who is supported by four other doctors. Besides, there are total 4 male Compounders and two female nurses. These all are distributed in shifts to ensure round the clock manning of the medical center.



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## SAFETY REPORT

A well-equipped First-Aid Centre is available inside the plant premises. This first-aid center is operational round the clock with one doctor, two supporting paramedical staff and one ambulance with driver.

In case of emergency, the victim may be shifted to higher medical center at Cuttack/Bhubaneswar. We may also take help of Port/IOCL/PPL Hospital depend on the need.

Necessary antidotes for treating exposure to toxic gases, etc. are also available in the medical center.

\*\*\*\*\*