SAFETY REPORT

पूर्णतः सहकारी स्वामित्व
Wholly owned by Cooperatives

INDIAN FARMERS FERTILISER CO-OPERATIVE LIMITED
PARADEEP UNIT

Village: Musadia, PO: Paradeep,Dist.: Jagatsinghpur, Pin-754142, Odisha, India

CONTENTS

Chapter- 1

1.0 THE NAME AND ADDRESS OF THE PERSON FURNISHING THE INFORMATION

In compliance with Rule 9 (1) of the Odisha Factories (Control of Major Accident Hazard) Rules, 2001, this Safety Report has been prepared in the format specified under Schedule-VIII of the said Rules. The initial version of the report was submitted to the Directorate of Factories & Boilers, Odisha, in December 2011.

As per the provisions of Rule 10, the Safety Report was subsequently updated and re-submitted in July 2015, November 2020, and October 2023.

This current version has been further revised and is now being submitted in August 2025, on behalf of the Phosphatic Fertilizer Manufacturing Complex of Indian Farmers Fertiliser Co-operative Limited (IFFCO), located at Village- Musadia, Post-Paradeep, District - Jagatsinghpur, Odisha.

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

Name:
Shri A. K. Sharma
Director (Technical) & Occupier

Shri P. K. Mahapatra
Sr. General Manager & Factory Manager

Address:
Indian Farmers Fertiliser Co-operative Limited (IFFCO)
Paradeep Unit
Village – Musadia
Post – Paradeep,
District – 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 36,000 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 53 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	86^0 40' 0" E
Latitude	20^0 18' 30" N
Village, Tehsil, District, State	Village: Musadia, PO: Paradeep, Tehesil: Kujang, Jagatsinghpur, Odisha
Max. Temp.	40.7^0C.
Min. Temp.	16^0C.
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 53
Nearest Railway Station	Paradeep
Nearest Railway Junction	Cuttack – 85 Km.
Nearest Village	Musadia – 1 Km
Nearest Industries	Arcelor Mittal Nippon Steel India Limited - 1 Km, Paradeep Phosphates Ltd. – 7 Km
Nearest Airport	Bhubaneswar-120 Km

Nearest Forest	Hatmundia – 5 Km
Name & Address of The Factory	IFFCO, Paradeep Unit Village: Musadia, PO: Paradeep, Tahesil: Kujang Dist- Jagatsinghpur, Odisha Tele fax No.- 06722-224112 License No. JS-54
Name & Designation of Occupier	Name: Shri A.K.Sharma, Director (Technical) Cell : 9099982004 Telephone No. +91-11-42592607 E-mail: aksharma@iffco.in
Name & Designation of Factory Manager	Name : Shri P.K. Mahapatra, Sr. General Manager (Unit Head) Cell : 9937238313 Telephone No. 06722-224001 E-mail : pkmahapatra@iffco.in

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-53 in Odisha. Besides, Paradeep is also accessible by rail transport. The complex presently has only one gate, which opens to a 28 m 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 4956 including 1138 employees and 3810 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 labours.

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 + 1x 2000 MTPD)
- Phosphoric Acid (One-unit of 2650 MTPD)
- DAP / NP / NPK Fertiliser (3 x 2090 MTPD)

The Sulphuric Acid plant-I & II is based on the technology supplied by LURGI Gmbh, Germany, Sulphuric Acid Plant-III is based on the technology supplied by Shiv Sulphuric Solutions (OPC) Pvt. Ltd. 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 at IFFCO Jetty	68,000 MT	75,000 MT	Above Ground Silo	L- 204 Mtrs W- 37 Mtrs H- 16 Mtrs
			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
			90,000 MT	1,00,000 MT	Above Ground Silo	L- 228 Mtrs W- 40.4 Mtrs H- 16 Mtrs
4	Molten Sulphur	Through Tankers	233 MT	259 MT	Underground pit	L- 18 Mtrs W- 4Mtrs DP- 2Mtrs
5	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 southernmost 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

Sulphuric Acid Plant (SAP I & II)

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 145^0C. 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 1120^0C. The resulting SO_2 of combustion gas is cooled down to 420^0C in a water tube boiler and saturated steam at 61.2 kg/cm2g is generated. These gases pass through the Converters I & II, which contain V_2O_5. The part of the SO_3 generated in the converter layers 1 to 3 is absorbed in intermediate absorption tower to firm 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_3 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_3 per NM^3 gas and SO_2 concentration of < 0.035% is routed through the tail gas stack to the atmosphere.

$$SO_3 + H_2O = H_2SO_4$$

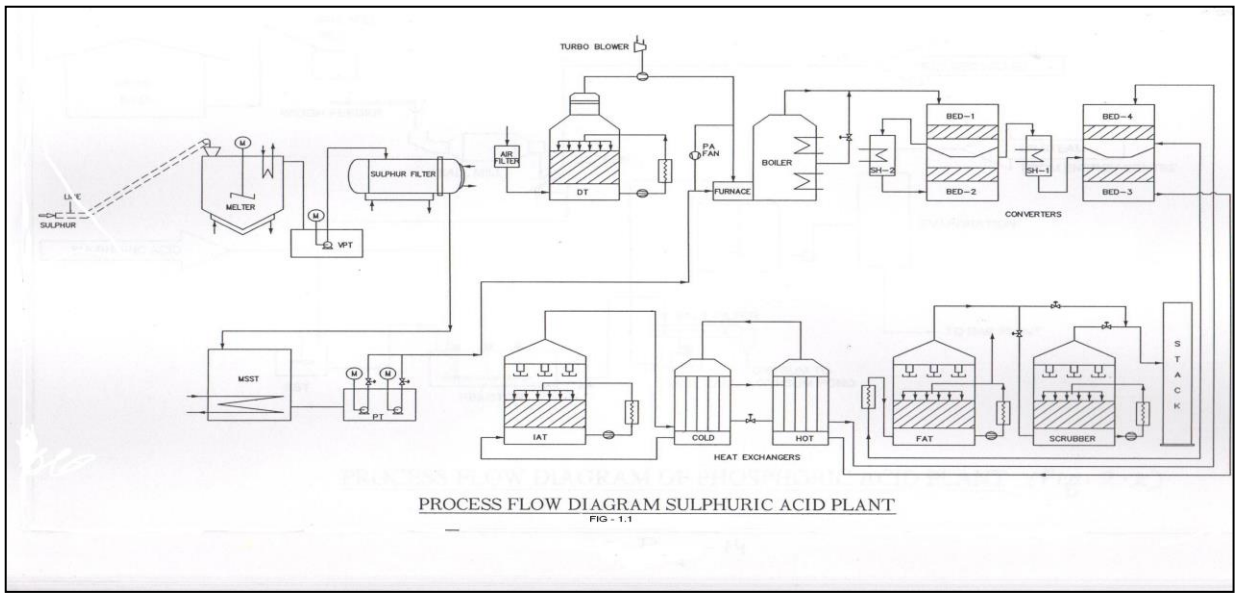
$$SO_3 + H_2SO_4 = H_2S_2O_7$$

$$H_2S_2O_7 + H_2O = 2H_2SO_4$$

In each stream generates 185.3 MTPH of superheated steam at 61.2kg/cm^2 and 480^{0}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_2 concentration in outlet gas during plant start up to maximum of 200 mg / NM^3

PROCESS FLOW DIAGRAM OF SULPHURIC ACID PLANT - I & II



PROCESS FLOW DIAGRAM SULPHURIC ACID PLANT
FIG - 1.1

Sulphuric Acid Plant (SAP III)

The Sulphuric acid plant is based on the DCDA (Double Contact and Double Absorption) technology and incorporates a 5-bed converter with intermediate absorption after the 3rd bed and final absorption after 5th bed. (3 + 2 configuration).

The process may be divided into the following three (3) steps:

1) Formation of Sulphur dioxide by burning molten Sulphur.

2) Conversion of Sulphur dioxide to Sulphur trioxide.

3) Absorption of Sulphur trioxide in Sulphuric acid.

Atmospheric air is drawn through an inlet air filter and then passes through packed drying tower counter-current to a flow of 98.5 % H2SO4. The main compressor compresses and the forces the clean, dry air from the drying tower through remainder of the plant.

The dry, warm air enters the Sulphur burner where the Sulphur combusts with oxygen in the air to form Sulphur di oxide. The temperature of the resulting Sulphur dioxide gas from the Sulphur Burner is higher than required for inlet to the conversion system. Waste Heat Boiler cools this process gas to the required temperature for conversion by recovering surplus heat as high-pressure saturated steam.

Conversion of SO_2 to SO_3 takes place in a five-pass Converter in the presence of oxygen and catalyst. The available oxygen and temperature increase limit the extent of the reaction in each stage. To increase the efficiency of conversion, the reaction is carried out in successive catalyst passes. Partial cooling between the passes (with the help of superheaters, economizers, and interpass exchangers) re- establishes the conversion capability for the catalyst of the subsequent passes. HP Superheater cools the partially converted gas leaving the 1st Converter pass by recovering the reaction heat as superheated high-pressure steam. The cool process gas flows from HP Superheater to the 2nd Converter pass where further conversion of Sulphur dioxide to Sulphur trioxide takes place, generating additional heat.

The Hot Interpass Heat Exchanger cools the hot gas leaving the 2nd Converter pass. Cooled process gas leaving the Hot Interpass Heat Exchanger flows to the 3rd Converter pass where additional conversion takes place. The Cold Interpass Heat Exchanger cools the hot gases leaving the 3rd Converter pass. Economizers provides additional cooling by heating deaerated boiler feedwater. The process gas from Economizer then flows to the Interpass Tower where SO3 is absorbed into a stream of 98.5% H2SO4. The removal of SO3 from the process gas by interpass tower shifts the equilibrium conditions for SO2 oxidation.

The Cold Interpass and Hot Interpass Heat Exchangers reheat the cool gas leaving the Interpass Tower, containing unreacted SO_2, before flowing to the 4th Converter pass. Further heat recovery from converter outlet gases of 4th and 5th pass are carried out by HP superheaters and Economizers. From the economizers, the process gas flows to the Final Tower, where a stream of 98.5% H_2SO_4 absorbs the remaining SO_3 in the gas.

The SO3 gas produced in the converter, even though adequaetly cooled,will not combine with water , but must be combined indirectly by absorbing it in 98.5% Sulphuric acid in the Interpass and Final towers.

The concentration and temperature of the circulating acid in Acid Towers must be maintained within certain limits to obtain the most efficient absorption of SO_3 and water vapor. Acid from the bottom of the Acid Towers drains to a combination pump tank. Dilution water is added to the acid for concentration control. To maintain optimum acid temperatures, the acid stream is pumped through the coolers and is circulated back to the top of the Towers.

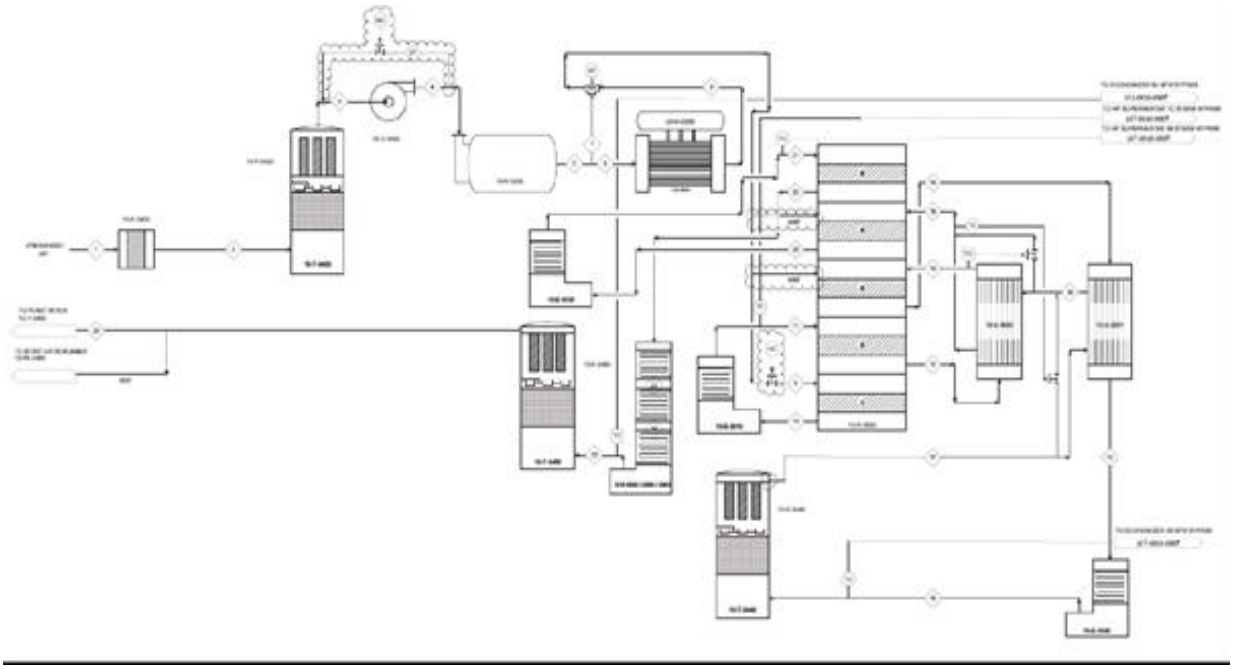
$SO_3 + H_2O = H_2SO_4$

$SO_3 + H_2SO_4 = H_2S_2O_7$

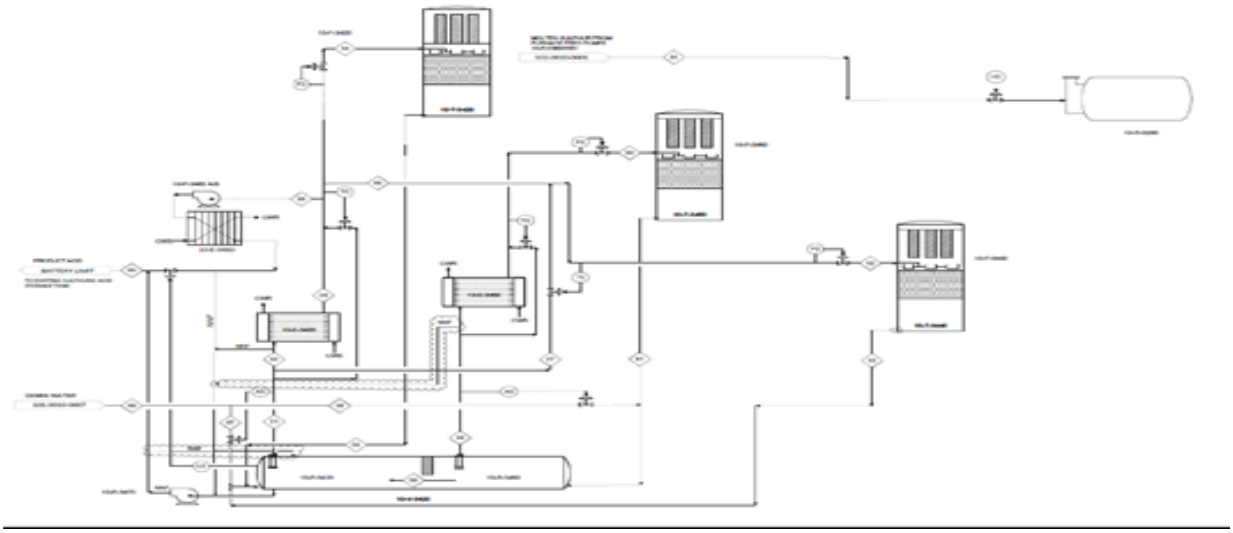
$H_2S_2O_7 + H_2O = 2H_2SO_4$

The plant generates 105 MTPH of superheated steam at 61.2kg/cm^2 and 4800C, which is used to generate 55 MW power each and some part of steam used to run Air Blower. Product acid is continuously taken off downstream of the Coolers, cooled and pumped to storage. Process gas leaving the Final Tower is discharged to the atmosphere through Plant Stack. Start-up scrubber is used to limit the amount of SO_2 discharged from the plant stack during start-up and emergency conditions. The gas is adiabatically saturated with water and any unreacted SO_2 is scrubbed using a counter-current flow of caustic circulating solution. This system guaranties SO_2 concentration in outlet gas during plant start up to maximum of 0.5 Kg/MT of Sulphuric Acid (as 100%).

PROCESS FLOW DIAGRAM OF SULPHURIC ACID PLANT (III)



Simplified Block Gas Flow diagram of SA plant III



Simplified Block Strong Acid Flow diagram of SA plant III

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.

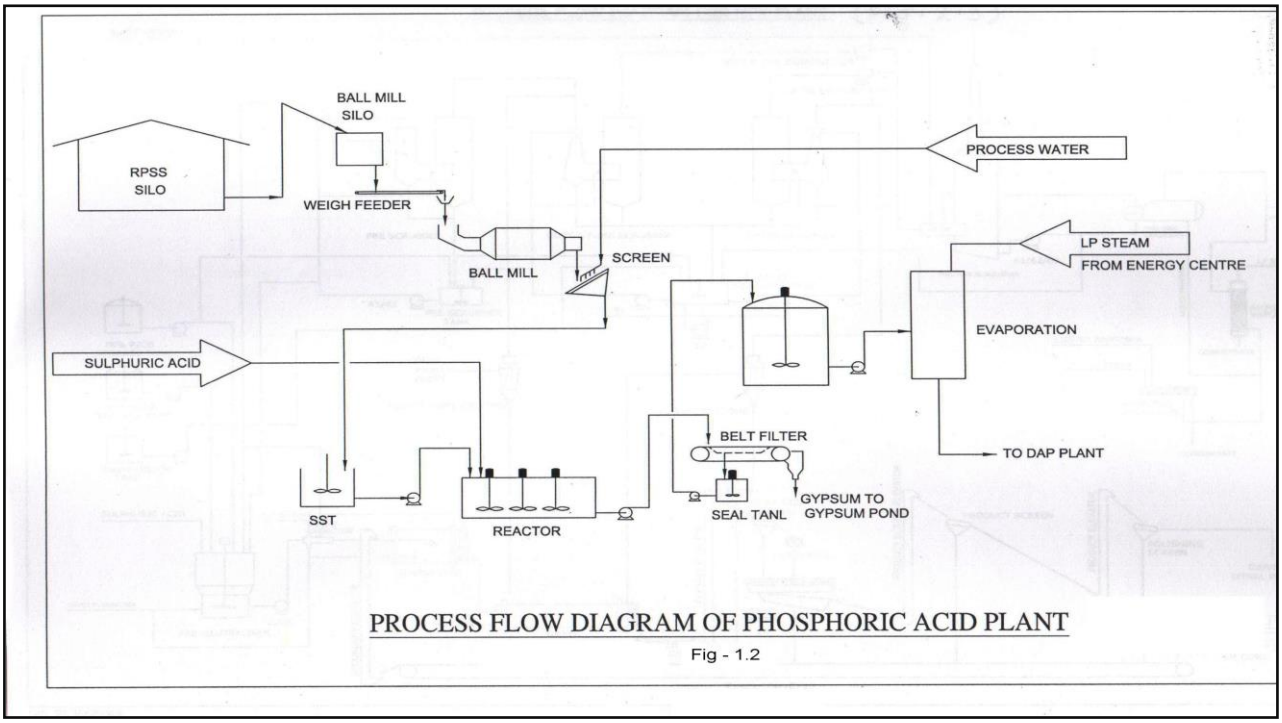
Concentration Section:

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 85^0 C overflows from the Flash Chamber to a concentrated Acid pump, which delivers acid to strong acid Clarifier Tank. Vapors leaving the flash chamber flow under vacuum to Fluorine Scrubber via Entrainment Separator. The separated acid from Entrainment separator returns to the flash chamber and the vapor flows to Fluorine Scrubber. Vapors leaving the Fluorine scrubber enter to a direct contact Barometric Condenser where a large flow of cooling tower water condenses all but a small amount of water vapor. This water vapor and any non-condensable gases are extracted by a two-stage vacuum jet system consisting of two medium pressure steam ejectors and a water-cooled inter condenser. Pressure in the evaporator flash chamber is controlled by bleeding atmospheric air into the vacuum jet system through a pressure control valve. Water and steam from the Barometric Condenser and vacuum jet system pass through seal legs to Condenser seal tank, which overflows by gravity to cooling water return system.

Fume Scrubber:

Gas streams from various plant sections flow through three packing stages where they are brought into contact with cooling tower water. The demister stage eliminates droplet entrainment. The scrubber operates at a slight vacuum by Scrubber exhaust fan. Spray water drains to the scrubber sump, which seal the scrubber against vacuum. The 50% to 54% concentrated acid is clarified in the strong acid clarifier and is transferred to DAP / NPK plants.

PROCESS FLOW DIAGRAM OF PHOSPHORIC ACID PLANT



3. (c).3 DAP / NP / NPK Fertilizer Manufacturing Process

PROCESS DESCRIPTION OF DI-AMMONIUM PHOSPHATE PLANT (DAP)

The process utilizes and updated version of the standard Jacobs' Slurry process with Pre-Neutralizer and Pipe Reactor combination and dual mole scrubbing system. Normal capacity of each train is 95 MTPH for DAP (18:46:00).

The raw materials required are Phosphoric Acid, Ammonia, and Sulphuric Acid.

Process:

Phosphoric Acid and Ammonia react in the Pre-Neutraliser (PN) along with scrubber liquor from the scrubbing system. The feed rates of the acid, 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 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 90^0C 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 50^0C in a Fluid Bed Cooler (FBC). FBC is supplied by cold air from Air Chiller, which uses liquid 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. –2 mm) 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

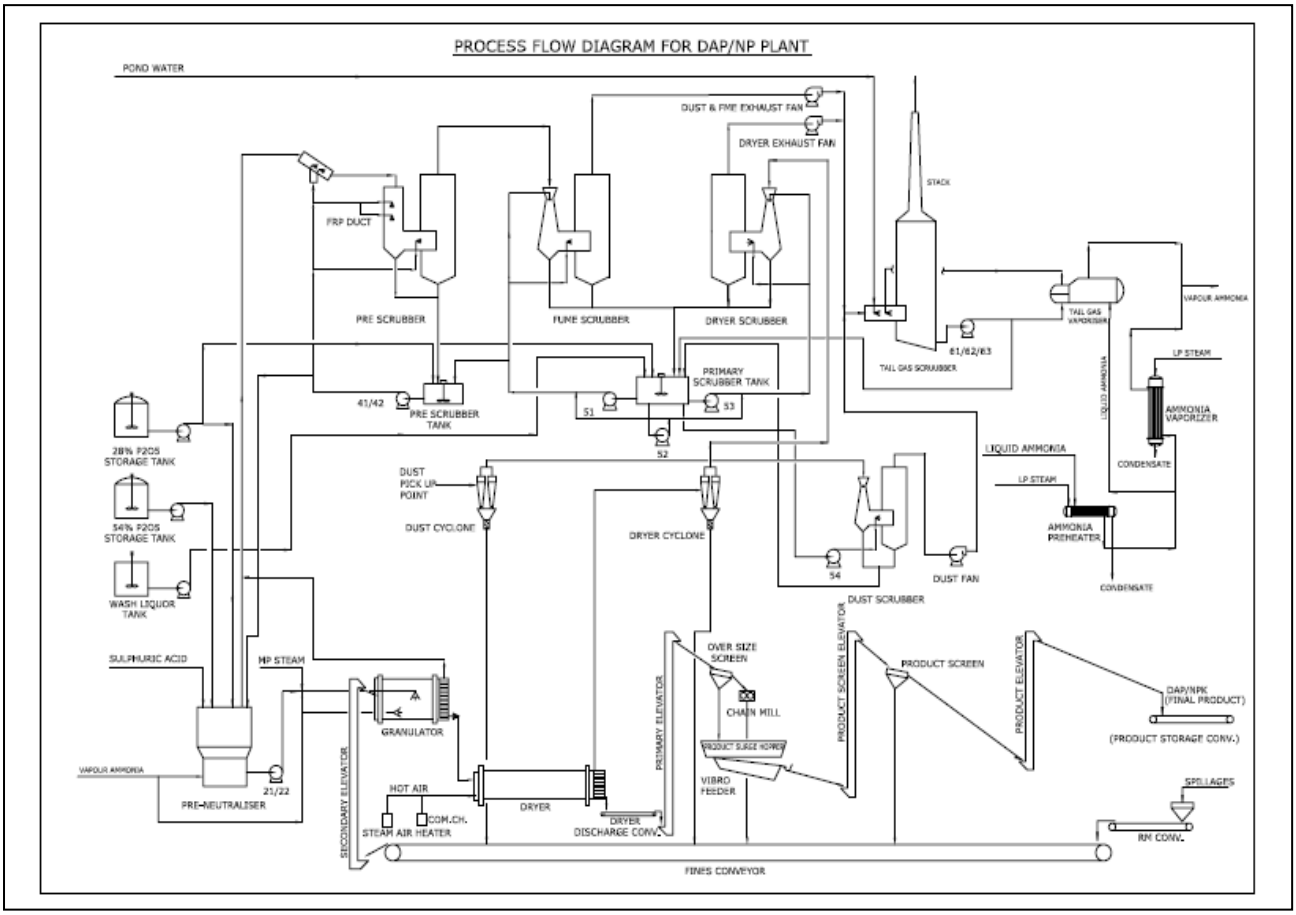
De-dusting air

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 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^2 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 ^{0}C by bubbling dry Nitrogen (from Molecular Sieve dryer/distillation column) in the pool of water. Air at 20 ^{0}C exiting from evaporation coil passes into the Chilling coil tank which is having chilled water at 6-10 ^{0}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_2 and left-over moisture, oil free air after Oil adsorber is passed to the Molecular sieve drier vessels. (There are 0_2 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 ^{0}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 ^{0}C. Outlet Air from Heat exchanger-1 is bifurcated into 0_2 streams. The main air streams enter Expansion engine at 40Kg/cm^2 and will be expanded to 5Kg/cm^2 and -150 ^{0}C. the rest of the air is passed

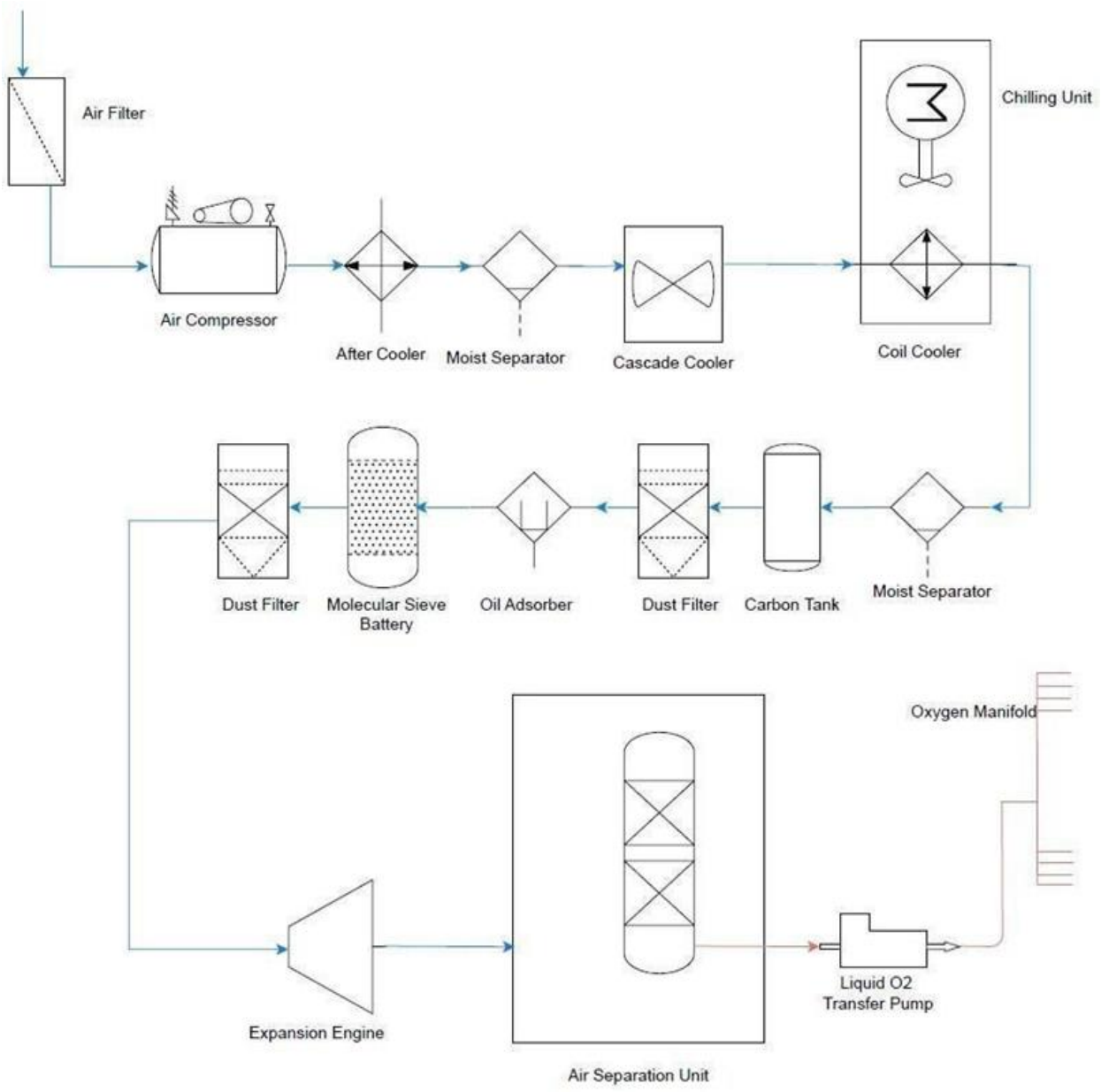
through heat exchanger No.2 and here it is cooled to about -155 ^{0}C by outgoing Oxygen(from Liq. Oxygen Pump) and Nitrogen (from distillation column). This air is then expanded by an expansion valve to form liquid air.

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 0_2 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^2 in the lower Column to 0.5 Kg/cm^2 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.

PROCESS FLOW DIAGRAM OF OXYGEN PLANT



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 & M/s-Siemens. 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)

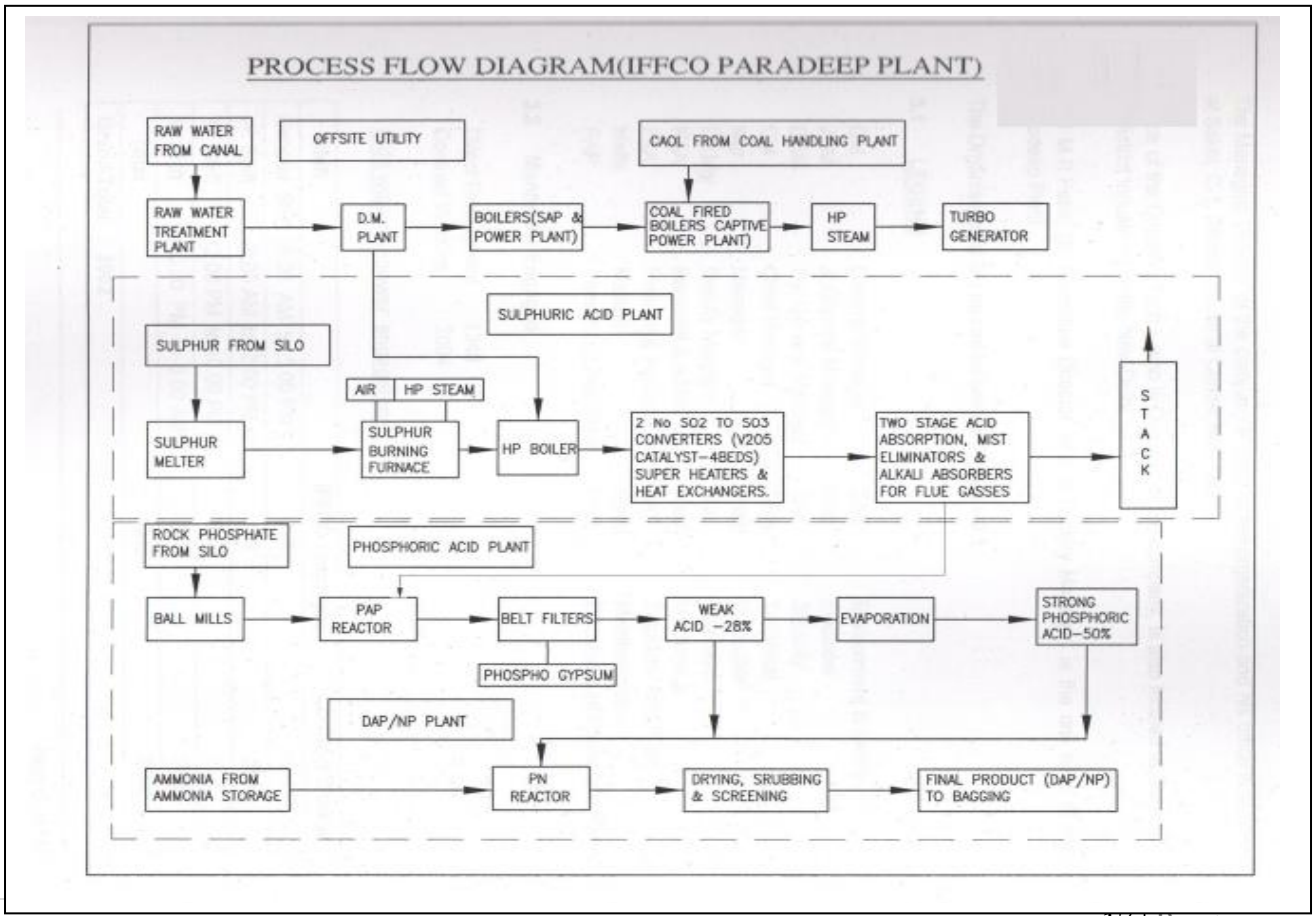
The steam generator is a Bi-drum, natural circulation, water tube balance draft, top supported construction, equipped with Atmospheric Fluidized Bed Combustion system having in-bed evaporator & in-bed super heater coils with under bed fuel feeding system supplied by M/s-Thermax (India) Ltd. having an 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.

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 hoppers 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 trained & qualified 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^3. 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	04 nos. above ground tanks	OD- 45 M, H- 20.5 M	Qty. is stored at ATM pressure & -33^{0}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	Sulphuric Acid	12,000 MT	20,000 MT	06 nos. above ground tanks.	D- 40 Mtrs H-10 Mtrs	Qty. is stored in above ground tanks of (2x20,000 MT + 4 x 25,000 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	
3	Phosphoric Acid	2,600 MT	2,600 MT	01 no of above ground Tank	D- 20 Mtrs H- 7.5 Mtrs	Tank is located at Phosphoric acid plant
		12,300 MT	12,300 MT	02 no's of above ground Tanks	D- 20 Mtrs H- 13.5 Mtrs	Tank is located at Phosphoric acid plant
		7000 MT	7000 MT	01 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	01 no of above	D- 40 Mtrs H- 12 Mtrs	Tank is located at Export tank area

SL. NO.	NAME	QUANTITY OF ONE TIME STORAGE	STORAGE CAPACITY	TYPE OF STORAGE	SIZE OF THE STORAGE AREA	REMARKS
				ground Tank		
		16,600 MT	16,600 MT	01 no of above ground Tank	D- 36 Mtrs H- 11 Mtrs	Tank is located at Export tank area
		1400 MT	1400 MT	01 No of above ground Tank	D- 12 Mtrs H- 11 Mtrs	Tank is located at Phosphoric acid plant
		22,700 MT	22,700 MT	10 nos of above ground Tanks	D- 14 Mtrs H- 11.2 Mtrs	Tank is located at Di-Ammonium Phosphate plant
		12700 MT	12700 MT	01 no. above ground Tank	D- 36 Mtrs H- 10 Mtrs	Tank is located at Phosphoric acid plant
4	Sodium Hydroxide	15 M^3	15 M^3	01 No above ground Tank	D- 2.5 Mtrs H- 3 Mtrs	Vertical storage tanks located in Utility & off site
		13 M^3	13 M^3	01 No Above Ground Tank	D- 2.3 Mtrs H- 3.2 Mtrs	Vertical storage tanks located in Utility & off site
		50 M^3	50 M^3	01 No Above Ground Tank	D- 4 Mtrs H- 4 Mtrs	Vertical storage tanks located in Sulphuric acid plant
5	High Speed Diesel	450 KL	502 KL	01 no of above ground Tank	D- 8 Mtrs H- 10 Mtrs	Vertical storage tanks located in Utility & Off site
6	Furnace oil	810 KL	902 KL	01 no of above ground Tank	D- 10 Mtrs H- 11.5 Mtrs	Vertical storage tanks located in Utility & off site
7	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

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- 4.1 (a) & 4.1(b), given below:**

TABLE – 4.1 (a)

CHEMICAL PROPERTIES

Name of Chemical	Ignition temp (^{0}c)	Explosive limits (%)		Flash point (^{0}c)	Boiling point (^{0}c)	IDLH values (ppm)	Chemical Property
		LEL	UEL				
Ammonia	651	16	25	Gas	- 33	300	Soluble in water
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
H_2SO_4	3	0	2
Caustic soda	3	0	1
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) 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 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. Possible failures involving release of both the gases have been simulated using software 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_2) 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

Health

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

PRODUCT NAME : AMMONIA

1. IDENTIFICATION OF THE SUBSTANCE / PREPARATION AND THE COMPANY

Product Name: Ammonia (User: CDU, VBU, Laboratory)		Chemical Designation: Anhydrous Ammonia	
Trade Name: Ammonia		Synonyms: Ammonia, Anhydrous Ammonia, Spirit of Hart Shron	
Formula: NH_3	Label: Category Class : 2.2 / 2.3	CAS Number: 7664-41-7	UN Number: 1005
Regulated Identification: UN Number 1005	Shipping Name Codes / Label: Poisonous gas		Hazchem Code: 2 PE

2. HAZARDS IDENTIFICATION

OSHA/HCS status: This material is considered hazardous by the OSHA Hazard Communication Standard

Classification of the substance or mixture: FLAMMABLE GASES – Category 2
GASES UNDER PRESSURE - Liquefied gas

ACUTE TOXICITY (inhalation) - Category 4
SKIN CORROSION/IRRITATION -Category 1

SERIOUS EYE DAMAGE/ EYE IRRITATION - Category 1

AQUATIC HAZARD (ACUTE) - Category 1

Signal word: Danger

Hazard statements **:** Flammable gas.

Contains gas under pressure; may explode if heated. May cause frostbite. May form explosive mixtures in Air. Harmful if inhaled. Causes severe skin burns and eye damage. Very toxic to aquatic life.

Precautionary statements Prevention:

Wear protective gloves. Wear eye or face protection. Wear protective clothing. Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. Non-smoking. Use

only outdoors or in a well- ventilated area. Avoid release to the environment. Avoid breathing gas. Wash hands thoroughly after handling.

GHS label elements

General: Read and follow all Safety Data Sheets (SDS'S) before use. Close valve after each use and when empty. Use equipment rated for cylinder pressure. Do not open valve until connected to equipment preparedfor use. Use a back flow preventative device in the piping. Use only equipment of compatible materials of construction. Always keep container in upright position. Approach suspected leak area with caution

Response:

IF INHALED: Remove person to fresh air and keep comfortable for breathing. Immediately call a POISONCENTER or physician.

IF SWALLOWED: Immediately call a POISON CENTER or physician. Rinse mouth. Do NOT induceVomiting

IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water or shower. Wash contaminated clothing before reuse. Immediately calla POISON CENTER or physician.

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy todo. Continue rinsing. Immediately call a physician.

Leaking gas fire: Do not extinguish, unless leak can be stopped safely. Eliminate all ignition sources if safe to do so.

Storage: Store locked up. Protect from sunlight when ambient temperature exceeds 52°C/125°F.Store in awell-ventilated place.

Disposal: Dispose of contents and container in accordance with all local, regional, national and internationalregulations.

Hazards not otherwise classified: Liquid can cause burns similar to frostbite.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Composition:

Name	CAS #	% By Weight
ammonia, anhydrous	7664-41-7	100

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

4. FIRST AID MEASURES

Description of necessary first aid measures

Eye contact: Get medical attention immediately. Call a physician. Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Chemical burns must be treated promptly by a physician.

Skin contact: Get medical attention immediately. Call a physician. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. If unconscious, place in recovery position and get medical attention immediately. Maintaining open airway. Loosen tight clothing such as a collar, tie, belt or waistband. In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.

Inhalation: Get medical attention immediately. Call a physician. Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. To avoid the risk of static discharges and gas ignition, soak contaminated clothing thoroughly with water before removing it. Continue to rinse for at least 10 minutes. In case of contact with liquid, warm frozen tissues slowly with lukewarm water and get medical attention. Do not rub affected area. Chemical burns must be treated promptly by a physician. Wash clothing before reuse. Clean shoes thoroughly before reuse.

I**ngestion:** Get medical attention immediately. Call a poison centre or physician. Remove victim to fresh air and keep at rest in a position comfortable for breathing. Chemical burns must be treated promptly by a physician. Ingestion of liquid can cause burns similar to frostbite. If frostbite occurs, get medical attention. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband. As this product rapidly becomes a gas when released, refer tithe inhalation section.

Most important symptoms/effects, acute and delayed

Eye contact: Causes serious eye damage. Liquid can cause burns similar to frostbite

Inhalation: Harmful if inhaled.

Ingestion: Ingestion of liquid can cause burns similar to frostbite.

Frostbite: Try to warm up the frozen tissues and seek medical attention.

Skin contact: Causes severe burns. Dermal contact with rapidly evaporating liquid could result in freezingof the tissues or frostbite

Over-exposure signs/symptoms

Eye contact: Adverse symptoms may include the following: pain, watering, redness, frostbite

Skin contact: Adverse symptoms may include the following: pain or irritation, redness, blistering mayoccur, frostbite

Ingestion: Adverse symptoms may include the following: frostbite, stomach pains

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician: In case of inhalation of decomposition products in a fire, symptoms may be delayed.The exposed person may need to be kept under medical surveillance for 48 hours.

Specific treatments: No specific treatment.

Protection of first-aiders: No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water before removing it, or wear gloves.

5. FIRE FIGHTING MEASURES

Extinguishing media

Suitable extinguishing media: Use an extinguishing agent suitable for the surrounding fire.
Specific hazards arising from the chemical: Contains gas under pressure. Flammable gas. In a fire or if heated, a pressure increase will occur and the container may burst, with the risk of a subsequent explosion. This material is very toxic to aquatic life. Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain.

Hazardous thermal decomposition products

Decomposition products may include the followingmaterials: nitrogen oxides

Special protective actions for fire-fighters: Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Contact supplier immediately for specialist advice. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool. If involved in fire, shut off flow immediately if it can be done without risk. If this is impossible, withdraw from area and allow fire to burn. Fight fire from protected location or maximum possible distance. Eliminate all ignition sources if safe to do so.

Special protective equipment for fire-fighters: Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode. For incidents involving large quantities, thermally insulated undergarments and thick textile or leather gloves should be worn.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures For non-emergency personnel:

Accidental releases pose a serious fire or explosion hazard. No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Shut off all ignition sources. No flares, smoking or flames in hazard area. Do not breathe gas. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders:

If specialized clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For nonemergency personnel".

Environmental precautions: Ensure emergency procedures to deal with accidental gas releases are in place to avoid contamination of the environment. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Water polluting material. May be harmful to the environment if released in large quantities. Collect spillage.

Methods and materials for containment and cleaning up

Small spill:

Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Large spill:

Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment.

7. HANDLING AND STORAGE

Precautions for safe handling

Advice on general occupational hygiene

Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Protective measures:

Put on appropriate personal protective equipment (see Section 8). Contains gas under pressure. Do not get ineyes or on skin or clothing. Do not breathe gas. Avoid release to the environment. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not enter storage areas and confined spaces unless adequately ventilated. Store and use away from heat, sparks, open flame or any other ignition source. Empty containers retain product residue and can be hazardous. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement.

Conditions for safe storage, including any incompatibilities

Store in accordance with local regulations. Store in a segregated and approved area. Store away from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10). Store locked up. Eliminate all ignition sources. Keep container tightly closed and sealed until ready for use. 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).Refer to ANSI/CGA G-2.1, Section 5.13 for electrical classification of anhydrous ammonia storage and handling areas. Where anhydrous ammonia is stored indoors, use electrical (ventilating, lighting and material handling) equipment with the appropriate electrical classification rating and use only non-sparking tools.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
ammonia, anhydrous	**ACGIH TLV (United States, 3/2015).** STEL: 24 mg/m³ 15 minutes. STEL: 35 ppm 15 minutes. TWA: 17 mg/m³ 8 hours. TWA: 25 ppm 8 hours. **NIOSH REL (United States, 10/2013).**
	STEL: 27 mg/m³ 15 minutes. STEL: 35 ppm 15 minutes. TWA: 18 mg/m³ 10 hours. TWA: 25 ppm 10 hours. **OSHA PEL (United States, 2/2013).** TWA: 35 mg/m³ 8 hours. TWA: 50 ppm 8 hours. **OSHA PEL 1989 (United States, 3/1989).** STEL: 27 mg/m³ 15 minutes. STEL: 35 ppm 15 minutes.

Environmental exposure controls

Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Appropriate engineering controls

Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapour or dust concentrations below any lower explosive limits. Use ventilation equipment with the appropriate electrical classification rating.

Individual protection measures

Hygiene measures Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: chemical splash goggles and/or face shield. If inhalation hazards exist, a full-face respirator may be required instead.

Skin protection

Hand protection

Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator. Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. If contact with the liquid is possible, insulated gloves suitable for low temperatures should be worn. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective

properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Respiratory protection

Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Body protection

Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product. When there is a risk of ignition from static electricity, wear antistatic protective clothing. For the greatest protection from static discharges, clothing should include anti-static overalls, boots and gloves.

Other skin protection: Appropriate footwear and any additional skin protection measures

9. PHYSICAL & CHEMICAL PROPERTIES

should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Appearance

Physical state	**:** Gas. [Liquefied gas]
Colour	**:** Colorless.
Molecular weight	**:** 17.03 g/mole
Molecular formula	**:** H3-N
Boiling/condensation point	**:** -33°C (-27.4°F)
Melting/freezing point	**:** -77.7°C (-107.9°F)
Critical temperature	132.85°C (271.1°F)
Odour	**:** Pungent.
Flammability (solid, gas)	**:** Extremely flammable in the presence of the following materials or conditions: oxidizing materials.
LEL	: 16 %
UEL	**:** 25%
Vapour pressure	**:** 114.1 (psig)
Vapour density	**:** 0.59 (Air = 1)
Specific Volume (ft 3/lb)	**:** 22.7273
Gas Density (lb/ft 3)	**:**0.044
Solubility in water	**:** 540 g/l
Auto-ignition temperature	**:** 651°C (1203.8°F)
Specific Gravity	: 0.59
PH	: Approx.

10. STABILITY & REACTIVITY

Reactivity: No specific test data related to reactivity available for this product or its ingredients.

Chemical stability: The product is stable

Possibility of hazardous reactions: Under normal conditions of storage and use, hazardous reactions willnot occur.

Conditions to avoid: Avoid all possible sources of ignition (spark or flame). Do not pressurize, cut, weld, braze, solder, drill, grind or expose containers to heat or sources of ignition.

Incompatible materials: Oxidizers

Hazardous decomposition products: Under normal conditions of storage and use, hazardousdecomposition products should not be produced.

Hazardous polymerization: Under normal conditions of storage and use, hazardous polymerization willnot occur.

11. TOXICOLOGICAL INFORMATION

Information on toxicological effects

Product/ingredient name	Result	Species	Dose	Exposure

Ammonia, anhydrous.	LC 50 Inhalation Gas	Rat	7338 ppm	1 hours

Potential acute health effects

Eye contact: Causes serious eye damage. Liquid can cause burns similar to frostbite.

Skin contact: Causes severe burns. Dermal contact with rapidly evaporating liquid could result in freezingof the tissues or frostbite

Ingestion: Ingestion of liquid can cause burns similar to frostbite.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact: Adverse symptoms may include the following: pain, watering, redness, frostbite

Skin contact: Causes severe burns. Dermal contact with rapidly evaporating liquid could result in freezingof the tissues or frostbite.

Ingestion: Adverse symptoms may include the following: frostbite, stomach pains Harmful if inhaled.

Other information: IDLH: 300 ppm

12. ECOLOGICAL INFORMATION

Product/ingredient name	Result	Species	Exposure
ammonia, anhydrous	Acute EC50 29.2 mg/l Marine water	Algae - Ulva fasciata – Zoea	96 hours
	Acute LC50 2080 µg/l Fresh water	Crustaceans - Gammarus pulex	48 hours
	Acute LC50 0.53 ppm Fresh water	Daphnia - Daphnia magna	48 hours
	Acute LC50 300 µg/l Fresh water	Fish- Hypophthalmichthys nobilis	96 hours
	Chronic NOEC 0.204 mg/l Marine water	Fish - Dicentrarchus labrax	62 days

13. DISPOSAL CONSIDERATION

Disposal methods

The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional

local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Empty Airgas-owned pressure vessels should be returned to Airgas. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Do not puncture or incinerate container.

14. TRANSPORT INFORMATION

	DOT	TDG	Mexico	IMDG	IATA
UN number	UN1005	UN1005	UN1005	UN1005	UN1005
UN proper shipping name	AMMONIA, ANHYDROUS	AMMONIA, ANHYDROUS; OR ANHYDROUS AMMONIA	AMMONIA, ANHYDROUS	AMMONIA, ANHYDROUS	AMMONIA, ANHYDROUS

Environment	No.	No.	No.	Yes.	No.
Additional information	Inhalation hazard This product is not regulated as a marine pollutant when Transported on inland waterways in sizes of≤5 L or ≤5 kg or by road,rail, or inland airing non-bulk sizes, provided the packaging meet the general provisions of§§ 173.24 and 173.24a. **Reportable quantity** 100 lbs / 45.4 kg packagesizes shipped in quantities less than the product reportable quantity are not subject to the RQ (reportable quantity) transportation requirements. **Limited quantity** Yes. **Packaging instruction** **Passenger aircraft** Quantity limitation: Forbidden. **Cargo aircraft** Quantity limitation: Forbidden. **Special provisions** 13,T50	Product classified as per the following sections of the Transportation of Dangerous Goods Regulations: 2.17(Class 2), 2.40-2.42 (Class 8), 2.7 (Marine pollutant mark). The marine pollutant mark is not required when transported by road or rail. **Explosive Limit and Limited Quantity Index** 0 **ERAP Index** 3000 **Passenger Carrying Ship Index** Forbidden **Passenger Carrying Road or Rail Index** Forbidden **Special provisions**	Toxic Inhalation Hazard dZone D	The marine pollutant mark is not required when transported in sizes of ≤5 L or ≤5 kg.	The environmentally hazardous substance mark may appear if required by other transportation regulations. **Passenger Aircraft** Quantity limitation: Forbidden **Cargo Aircraft Only** Quantity limitation: Forbidden

15. REGULATORY INFORMATIONS

Clean Air Act (CAA) 112 regulated toxic substances: ammonia, anhydrous

16. OTHER INFORMATION

PRODUCT NAME : SULPHURIC ACID

1. IDENTIFICATION OF THE SUBSTANCE / PREPARATION AND THE COMPANY

Product Name: Sulphuric Acid (User / Handling: OM&S/ ETP, Laboratory)		Chemical Designation: Sulphuric Acid	
Trade Name: Sulphuric Acid		Synonyms: Dipping oil, oil of Victor	
Formula H_2 SO_4	Label: Category Class 8	CAS Number 7664-93-9	UN Number 1830/1832
Regulated Identification: UN Number 1830/1832	Shipping Name Codes / Label: Corrosive		Hazchem Code: 2P

2. HAZARDS IDENTIFICATION

Potential Acute Health Effects:

Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (irritant, corrosive), of ingestion, of inhalation. Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth, and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Severe over-exposure can result in death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:

CARCINOGENIC EFFECTS: Classified 1 (Proven for human.) by IARC, + (Proven.) by OSHA. Classified A2 (Suspected for human.) by ACGIH.

MUTAGENIC EFFECTS: Not available.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTALTOXICITY: Not available.

The substance may be toxic to kidneys, lungs, heart, cardiovascular system, upper respiratory tract, eyes, teeth. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

Composition:

3. COMPOSITION / INFORMATION ON INGREDIENTS

Name	CAS #	% by Weight
Sulfuric acid	7664-93-9	100

4. FIRST AID MEASURES

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

Skin Contact:

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:

Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:

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

Serious Inhalation:

Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to- mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:

Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

5. FIRE FIGHTING MEASURES

Flammability of the Product : Non-flammable.
Auto-Ignition Temperature : Not applicable.
Flash Points : Not applicable.
Flammable Limits : Not applicable.

Products of Combustion:
Products of combustion are not available since material is non-flammable. However, products of decomposition include fumes of oxides of sulfur. Will react with water or steam to produce toxic and corrosive fumes. Reacts with carbonates to generate carbon dioxide gas. Reacts with cyanides and sulfides to form poisonous hydrogen cyanide and hydrogen sulfide respectively.

Fire Hazards in Presence of Various Substances: Combustible materials
Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available. Slightly explosive in presence of oxidizing materials.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards:
Metal acetylides (Monocesium and Monorubidium), and carbides ignite with concentrated sulfuric acid. White Phosphorous +boiling Sulfuric acid or its vapor ignites on contact. May ignite other combustible materials. May cause fire when sulfuric acid is mixed with Cyclopentadiene, cyclopentanone oxime, nitroaryl amines, hexalithium silicide, phosphorous (III) oxide, and oxidizing agents such as chlorates, halogens, permanganates.

Special Remarks on Explosion Hazards:
Mixtures of sulfuric acid and any of the following can explode: p-nitro toluene, pentasIlver trihydroxydiaminophosphate, perchlorates, alcohols with strong hydrogen peroxide, ammonium tetraperoxychromate, mercuric nitrite, potassium chlorate, potassium permanganate with potassium chloride, carbides, nitro compounds, nitrates,carbides, phosphorous, iodides, picratres, fulminats, dienes, alcohols (when heated) Nitramide decomposes explosivelyon contact with concentrated sulfuric acid. 1,3,5- Trinitrosohexahydro-1,3,5-triazine + sulfuric acid causes explosive.

6. ACCIDENTAL RELEASE MEASURES

Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. Ifnecessary: Neutralize the residue with a dilute solution of sodium carbonate.

Large Spill:
Corrosive liquid. Poisonous liquid. Stop leak if without risk. Absorb with DRY earth, sand or other non- combustible material. Do not get water inside container. Do not touch spilled material. Use water spray curtain to divert vapor drift. Use water sprayto reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal.Neutralize the residue with a dilute solution of sodium carbonate. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

7. HANDLING AND STORAGE

Precautions:
Keep locked up.. Keep container dry. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Never add water to this product.In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and showthe container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, reducingagents, combustible materials, organic materials, metals, acids, alkalis, moisture. May

corrode metallic surfaces. Store in ametallic or coated fiberboard drum using a strong polyethylene inner package.

Storage:

Hygroscopic. Reacts. violently with water. Keep container tightly closed. Keep container in a cool, well- ventilated area. Do notstore above 23°C (73.4°F).

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Controls:

Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respectivethreshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:

Face shield. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Boots.

Personal Protection in Case of a Large Spill:

Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self-contained breathing apparatus should be used to avoidinhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling thisproduct.

Exposure Limits:

TWA: 1 STEL: 3 (mg/m3) [Australia] Inhalation TWA: 1 (mg/m3) from OSHA (PEL) [United States] Inhalation TWA: 1 STEL: 3(mg/m3) from ACGIH (TLV) [United States] [1999] Inhalation TWA: 1 (mg/m3) from NIOSH [United States] Inhalation TWA: 1(mg/m3) [United Kingdom (UK)]Consult local authorities for acceptable exposure limits.

9. PHYSICAL & CHEMICAL PROPERTIES

Physical state and appearance: Liquid. (Thick oily liquid.)
Odor: Odorless, but has a choking odor when hot.

Taste: Marked acid taste. (Strong.)
Molecular Weight: 98.08 g/mole
Color: Colorless.
pH (1% soln/water): Acidic.
Boiling Point:270°C (518°F) - 340 deg. C Decomposes at 340 deg.C
Melting Point: -35°C (-31°F) to 10.36 deg. C (93% to 100% purity)
Critical Temperature: Not available.
Specific Gravity: 1.84 (Water = 1)
Vapor Pressure: Not available.
Vapor Density:3.4 (Air =1)
Volatility: Not available.
Odor Threshold: Not available.
Water/Oil Dist. Coeff.: Not available.
Ionicity (in Water): Not available.
Dispersion Properties: See solubility in water.
Solubility: Easily soluble in cold water. Sulfuric is soluble in water with liberation of much heat. Soluble in ethyl alcohol.

10. STABILITY & REACTIVITY

Stability: The product is stable.
Instability Temperature: Not available.

Conditions of Instability:
Conditions to Avoid: Incompatible materials, excess heat, combustible material materials, organic materials, exposure to moistair or water, oxidizers, amines, bases. Always add the acid to water, never the reverse.

Incompatibility with various substances:

Reactive with oxidizing agents, reducing agents, combustible materials, organic materials, metals, acids, alkalis, moisture.

Corrosivity:

Extremely corrosive in presence of aluminum, of copper, of stainless steel(316). Highly corrosive in presence of stainlesssteel(304). Non-corrosive in presence of glass.

Special Remarks on Reactivity:

Hygroscopic. Strong oxidizer. Reacts violently with water and alcohol especially when water is added to the product Incompatible (can react explosively or dangerously) with the following: ACETIC ACID, ACRYLIC ACID, AMMONIUMHYDROXIDE, CRESOL, CUMENE, DICHLOROETHYL ETHER, ETHYLENE CYANOHYDRIN, ETHYLENEIMINE, NITRICACID, 2-NITROPROPANE, PROPYLENE OXIDE, SULFOLANE, VINYLIDENE CHLORIDE, DIETHYLENE GLYCOLMONOMETHYL ETHER, ETHYL ACETATE, ETHYLENE CYANOHYDRIN, ETHYLENE GLYCOL MONOETHYL

ETHERACETATE, GLYOXAL, METHYL ETHYL KETONE, dehydrating agents, organic materials, moisture (water), Acetic anhydride, Acetone, cyanohydrin, Acetone+nitric acid, Acetone + potassium dichromate, Acetonitrile, Acrolein, Acrylonitrile, Acrylonitrile+water, Alcohols + hydrogen peroxide, ally compounds such as Allyl alcohol, and Allyl Chloride, 2-Aminoethanol, Ammonium hydroxide, Ammonium triperchromate, Aniline, Bromate + metals, Bromine pentafluoride, n- Butyraldehyde, Carbides, Cesiumacetylene carbide, Chlorates, Cyclopentanone oxime, chlorinates, Chlorates + metals, Chlorosulfonicacid, 2-cyano-4-nitrobenzenediazonium hydrogen sulfate, Cuprous nitride, p-chloronitrobenzene, 1,5-Dinitronaphthlene + sulfur, Di isobutylene, p- dimethylaminobenzaldehyde, 1,3-Diazidobenzene, Dimethylbenzylcarbinol + hydrogen peroxide, Epichlorohydrin, Ethyl alcohol + hydrogen peroxide, Ethylene diamine, Ethylene glycol and other glycols, , Ethylenimine,Fulminates, hydrogen peroxide, Hydrochloric acid, Hydrofluoric acid, Iodine heptafluoride, Indane + nitric acid, Iron, Isoprene,Lithium silicide, Mercuric nitride, Mesityl oxide, Mercury nitride, Metals (powdered), Nitromethane, Nitric acid + glycerides,p-Nitrotoluene, Pentasilver trihydroxydiaminophosphate, Perchlorates, Perchloric acid, Permanganates + benzene, 1-Phenyl-2- methylpropyl alcohol + hydrogen peroxide, Phosphorus, Phosphorus isocyanate, Picrates, Potassium tert- butoxide,Potassium chlorate, Potassium Permanganate and other permanganates, halogens, amines, Potassium Permanganate +Potassium chloride, Potassium Permanganate + water, Propiolactone (beta)-, Pyridine, Rubidium aceteylene carbide, Silverpermanganate, Sodium, Sodium carbonate, sodium hydroxide, Steel, styrene monomer, toluene + nitric acid, Vinyl acetate,Thalium (I) azidodithiocarbonate, Zinc chlorate, Zinc Iodide, azides, carbonates, cyanides, sulfides, sulfites, alkali hydrides,carboxylic acid anhydrides, nitriles, olefinic organics, aqueous acids, cyclopentadiene, cyano-alcohols, metal acetylides, Hydrogen gas is generated by the action of the acid on most metals (i.e. lead, copper, tin, zinc,

aluminum, etc.). Concentrated sulfuric acid oxidizes, dehydrates, or sulfonates most organic compounds.

Special Remarks on Corrosivity:

Non-corrosive to lead and mild steel, but dilute acid attacks most metals. Attacks many metals releasing hydrogen. Minor corrosive effect on bronze. No corrosion data on brass or zinc.

Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation. Ingestion.

Toxicity to Animals:

WARNING: THE LC50 VALUES HEREUNDER ARE ESTIMATED ON THE BASIS OF A 4-HOUR

EXPOSURE. Acute oral toxicity (LD50): 2140 mg/kg [Rat.]. Acute toxicity of the vapor (LC50): 320 mg/m3 2 hours [Mouse].

Chronic Effects on Humans:

CARCINOGENIC EFFECTS: Classified 1 (Proven for human.) by IARC, + (Proven.) by OSHA. Classified A2 (Suspected for human.) by ACGIH. May cause damage to the following organs: kidneys, lungs, heart, cardiovascular system, upper respiratory tract, eyes, teeth.

Other Toxic Effects on Humans:

Extremely hazardous in case of inhalation (lung corrosive). Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (corrosive), of ingestion, .

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans:

Mutagenicity: Cytogenetic Analysis: Hamster, ovary = 4mmol/L Reproductive effects: May cause adverse reproductive effects based on animal data. Developmental abnormalities (musculoskeletal) in rabbits at a dose of 20 mg/m3 for 7 hrs.(RTECS)Teratogenicity: neither embryotoxic, fetoxic, nor teratogenetic in mice or rabbits at inhaled doses producing some maternal Toxicity.

Special Remarks on other Toxic Effects on Humans:

Acute Potential Health Effects: Skin: Causes severe skin irritation and burns. Continued contact can cause tissue necrosis. Eye: Causes severe eye irritation and burns. May cause irreversible eye injury. Ingestion: Harmful if swallowed. May cause permanent damage to the digestive tract. Causes gastrointestinal tract burns. May cause perforation of the stomach, GI bleeding, edema of the glottis, necrosis and scarring, and sudden circulatory collapse (similar to acute inhalation). It may also cause systemic toxicity with acidosis. Inhalation: May cause severe irritation of the respiratory tract and mucous membranes with sore throat, coughing, shortness of breath, and delayed lung edema. Causes chemical burns to the respiratory tract. Inhalation may be fatal as a result of spasm, inflammation, edema of the larynx and bronchi, chemical pneumonitis, and pulmonary edema. Cause corrosive action on mucous membranes. May affect cardiovascular system (hypotension, depressed cardiac output, bradycardia). Circulatory collapse with clammy skin, weak and rapid pulse, shallow respiration, and scanty urine may follow. Circulatory shock is often the immediate cause of death. May also affect teeth (changes in teeth and supporting structures - erosion, discoloration). Chronic Potential Health Effects: Inhalation: Prolonged or repeated inhalation

may affect behavior (muscle contraction or spasticity), urinary system (kidney damage), and cardiovascular system, heart (ischemic heart leisons), and respiratory system/lungs (pulmonary edema, lung damage), teeth (dental discoloration, erosion). Skin: Prolonged or repeated skin contact may cause dermatitis, an allergic skin reaction.

12. ECOLOGICAL INFORMATION

Ecotoxicity: Ecotoxicity in water (LC50): 49 mg/l 48 hours [bluegill/sunfish].

BOD5 and COD: Not available.

Products of Biodegradation:

Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

13. DISPOSAL CONSIDERATION

Special Remarks on the Products of Biodegradation: Not available.

Waste Disposal:

Sulfuric acid may be placed in sealed container or absorbed in vermiculite, dry sand, earth, or a similar material. It may also be diluted and neutralized. Be sure to consult with local or regional authorities (waste regulators) prior to any disposal. Waste must be disposed of in accordance with federal, state and local environmental control regulations.

14. TRANSPORT INFORMATION

DOT Classification: Class 8: Corrosive material
Identification: Sulfuric acid UNNA: 1830 PG: II
Special Provisions for Transport: Not available.

15. REGULATORY INFORMATIONS

Other Regulations:

OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). EINECS: This product is on theEuropean Inventory of Existing Commercial Chemical Substances.

16. OTHER INFORMATION

PRODUCT NAME : PHOSPHORIC ACID

SECTION 1: Identification of the substance/mixture and of the supplier

Product name: Phosphoric Acid, ACS

Manufacturer/Supplier Trade name:

Manufacturer/Supplier Article number: S25470B

Recommended uses of the product and uses restrictions on use:

Manufacturer Details:

Manufacturer's Name - Indian Farmers Fertiliser Cooperative Limited

Address - IFFCO, Musadia Paradeep Jagatsinghpur Odisha

Telephone Number - 06722224021

SECTION 2: Hazards identification

Classification of the substance or mixture:

Corrosive
Skin corrosion, category 1B
Corrosive to metals, category 1

Corrosive to Metals 1
Skin Corrosion 1B
Signal word: Danger.
Hazard statements:
May be corrosive to metals.
Causes severe skin burns and eye damage.

Precautionary statements:
If medical advice is needed, have product container or label at hand Keep out of reach of children.Read label before use. Do not breathe dust/fume/gas/mist/ vapors /spray Wash thoroughly after handling.Wear protective gloves/protective clothing/eye protection/face protection Keep only in original container.Do not eat, drink or smoke when using this product Immediately call a doctor/physician Specific treatment (see … on this label).Wash contaminated clothing before reuse

IF SWALLOWED: Rinse mouth. Do NOT induce vomiting

IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/showerIF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do.Continue rinsing.

Store locked up :Store in a corrosive resistant/… container with a resistant inner linerDispose of contents/container to …

Conc 10% to <25%:

Eye Irritation 2, Skin Irritation 2

Conc <10%:

Not classified for physical or health hazards under GHS.

SECTION 3 : Composition/information on ingredients

Ingredients:		
CAS 7664-38-2	Phosphoric Acid	>85 %
CAS 7732-18-5	Deionized Water	<15 %
		Percentages are by weight

SECTION 4 : First aid measures

Description of first aid measures

After inhalation: Seek medical attention immediately. Move exposed individual to fresh air. Loosen clothingas necessary and position individual in a comfortable position.

After skin contact: Remove contaminated clothing and wash before reuse or discard. Rinse skin with for 30 minutes with deluge of water or under a shower. Seek immediate medical attention. Wash affected area with soap and water.

After eye contact: Rinse immediately with plenty of water, also under the eyelids, for at least 30 minutes. Remove contact lens(es) if able to do so during rinsing. Seek medical attention immediately. Protect unexposed eye.

After swallowing: Seek medical attention immediately. Rinse mouth thoroughly. Do not induce vomiting.Have exposed individual drink sips of water.

Most important symptoms and effects, both acute and delayed:

Irritation, Nausea, Headache, Shortness of breath. May cause severe burns and ulcerations. May cause severe burn and irreversible eye injury. May cause gastrointestinal tract burns, corrosion and permanent tissue damage of the digestive tract and esophagus.

Indication of any immediate medical attention and special treatment needed:

If seeking medical attention, provide SDS document to physician. Wipe off contact areas with a dry cloth if possible, before flushing with water. Dispose of cloth by soaking in water.

SECTION 5 : Firefighting measures

Neutralize the soaking solution withsodium hydroxide solution.

Extinguishing media :

Suitable extinguishing agents: If in laboratory setting, follow laboratory fire suppression procedures. Use appropriate fire suppression agents for adjacent combustible materials or sources of ignition

For safety reasons unsuitable extinguishing agents:

Special hazards arising from the substance or mixture:

Hydrogen gas is released in contact with most metals. Combustion products may include carbon oxides or othertoxic vapors. Combustion products may include phosphine, oxides of phosphorus, and hydrogen gas.

Advice for firefighters:

Protective equipment: Wear protective equipment Use respiratory protective device against the effects of fumes/dust/aerosol/vapor . Use NIOSH-approved respiratory protection/breathing apparatus.

Additional information (precautions): Move product containers away from fire or keep cool with water spray as a protective measure, where feasible.

SECTION 6 : Accidental release measures

Personal precautions, protective equipment and emergency procedures:

Wear protective equipment. Avoid contact with eyes, skin, and clothing. Use respiratory protective device against the effects of fumes/dust/aerosol. Keep unprotected persons away. Ensure adequate ventilation. Keep away from ignition sources. Protect from heat. Stop the spill, if possible. Contain spilled material by diking or using inert absorbent. Transfer to a disposal or recovery container.

Environmental precautions:

Prevent from reaching drains, sewer or waterway. Collect contaminated soil for characterization per Section 13

Methods and material for containment and cleaning up:

Absorb spillage to prevent material damage due to corrosiveness to metal. If in a laboratory setting, follow Chemical Hygiene Plan procedures. Place into properly labeled containers for recovery or disposal. If necessary, use trained response staff/contractor. Collect liquids using inert absorbent material.

Reference to other sections:

SECTION 7 : Handling and storage

Precautions for safe handling:

Wash hands after handling. Do not mix with bases. Use in a chemical fume hood. Follow good hygiene procedures when handling chemical materials. Do not eat, drink, smoke, or use personal products when handling chemical substances. If in a laboratory setting, follow Chemical Hygiene Plan.Use only in well ventilated areas.Prevent contact with eyes, skin, and clothing

Conditions for safe storage, including any incompatibilities:

Store away from oxidizing agents.Store in cool, dry conditions in well sealed containers. Keep container tightly sealed.Do not store under direct sun light. Do not pile up the containers. Do not store at temperatures close to freezing point.Container materials should be made of stainless steel 316-L, high-density polyethylene, or glass. Provide ventilation for containers. Avoid storage near extreme heat, ignition sources or open flame. Store away from foodstuffs.

SECTION 8: Exposure controls/personal protection

Control Parameters:

7664-38-2, Phosphoric Acid, ACGIH TLV: 1 mg/m³ as TWA
7664-38-2, Phosphoric Acid, ACGIH TLV 3 mg/m³ as STEL

7664-38-2, Phosphoric Acid, OSHA PEL†: TWA 1 mg/m3 (See 29 CFR1910.1000 Appendix G)

7664-38-2, Phosphoric Acid, NIOSH REL: TWA 1 mg/m37664-38-2, Phosphoric Acid, NIOSH REL ST: 3 mg/m3 7664-38-2, Phosphoric Acid, NIOSH IDLH: 1000 mg/m3

Appropriate Engineering controls: Emergency eye wash fountains and safety showers should be available in the immediate vicinity of use/ handling. Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapor or dusts (total/respirable) below the applicable workplace exposure limits(Occupational Exposure Limits-OELs) indicated above.

Respiratory protection: Use suitable respiratory protective device when high concentrations are present. Use suitable respiratory protective device when aerosol or mistis formed. For spills,

respiratory protection may be advisable.

Protection of skin: The glove material has to be impermeable and resistant to the product/ the substance/ the preparation being used/ handled. Selection of the glove material on consideration of the penetration times, rates of diffusion and the degradation.

Eye protection: Safety glasses with side shields or goggles.

General hygienic measures: The usual precautionary measures are to be adhered to when handling chemicals. Keep away from food, beverages and feed sources. Immediately remove all soiled and contaminated clothing. Wash hands before breaks and at the end of work. Do not inhale gases /fumes/ dust/ mist/ /vapor/aerosols. Avoid contact with the eyes and skin.

SECTION 9: Physical and chemical properties

Appearance (physicalstate, color):	Clear, colorless liquid	**Explosion limit lower**:**Explosion limit upper**:	Not determined Not determined
Odor:	Odorless	**Vapor pressure**:	Not determined
Odor threshold:	Not determined	**Vapor density**:	3.4
pH-value:	Not determined	**Relative density**:	1.680
Melting/Freezing point:	21°C	**Solubilities**:	Soluble in water
Boiling point/Boiling range:	158°C	**Partition coefficient (n-octanol/water)**:	Not determined
Flash point (closedcup):	Not determined	**Auto/Self-ignition temperature**:	Not determined
Evaporation rate:	Not determined	**Decomposition temperature**:	300°C
Flammability (solid, gaseous):	Not applicable	**Viscosity**:	a. Kinematic: Not determined b. Dynamic: Not determined
Density : Not determined **Additional property:** Hygroscopic. **Specific Gravity** :1.680 **Molecular Weight: :** 98.00 g/mol			

SECTION 10 : Stability and reactivity

Reactivity:

Chemical stability: This hygroscopic substance pulls moisture from air. No decomposition if used and storedaccording to specifications.

Possible hazardous reactions:

Conditions to avoid: Metals. Exposure to moist air or water. Incompatible materials. Excess heat. Store away from oxidizing agents, strong acids or bases.

Incompatible materials: Metals. Bases . Alcohols. Amines. Halogenated agents. Organic peroxides. Amides. Azo. Diazo. Hydrazines. Chlorates. Carbamates. Esters. Fluorides. Phenols. Cresols . Organophosphates.Phosphothioates. Epoxides. Combustible and flammable materials. Explosives. Alkalines. Nitromethane. Sodium tetrahydroborate. Mercaptans. Aldehydes. Ketones. Glycols. Cyanides. Sulfides. Caustics. Strong acids.Carbides. Strong bases.Fulminates. Reducing agents. Nitrates. Acetic acid. Oxidizing agents

Hazardous decomposition products: Phosophine. Oxides of phosphorus. Hydrogen gas is released in contact with most metals.

SECTION 11 : Toxicological information

Acute Toxicity:		
Oral:	2600 mg/kg bw	LD50 for a 10% solution of 75.4% thermalphosphoric acid (rat)
Oral:	1530 mg/m3	LD50 oral-rat: (7764-38-2)
Inhalation:	>850mg/m3	LC50 inhalation-rat (1h) (7664-38-2)
Chronic Toxicity: No additional information.		
Corrosion Irritation:		
Dermal:	Section 2	Classified as a skin corrosion
Ocular:	Section 2 (eye damage is presumed withSkin 1 classification)	Eye Damage
Dermal:		May cause severe burns and ulcerations.
Ocular:		May cause severe burn and irreversible eyedamage.
Sensitization:		No additional information.
Single Target Organ (STOT):		No additional information.
Numerical Measures:		No additional information.

Carcinogenicity:	IARC: Not listed NTP: Not listed
Mutagenicity:	No additional information.
Reproductive Toxicity:	No additional information.

SECTION 12 : Ecological information

Ecotoxicity

Do not release to water: May release phosphates which will result in algae growth, increased turbidity, and depleted oxygen in the marine environment; at extremely high concentrations and/or quantities, this may be hazardous to fish or other marine organisms.

LpH50 (median lethal pH) (96h) phosphoric acid (bluegill sunfish): 3-3.25

Adult brook trout survived 5 months exposure to pH levels of 5.0 and above. Total egg production was not affected, but viability was significantly less at pH 5.0. Hatchability was significantly less at levels below pH 6.5. Growth and survival of alevins was reduced at the lower pH levels. : The data indicate that continuous exposure to pH levels below 6.5 result in significant reductions in egg hatchability and growth.

Algae: NOEC (EC50 >100 mg/l, the upper limit of toxic range) D. subspicatus : 100 mg/l

Persistence and degradability: Readily degradable in the environment.

Bio accumulative potential: The phosphorus element is an essential nutrient for flora and fauna

Mobility in soil:

Other adverse effects:

SECTION 13 : Disposal considerations

Waste disposal recommendations:

Product/containers must not be disposed together with household garbage. Do not allow product to reach sewage system or open water. It is the responsibility of the waste generator to properly characterize all waste materials according to applicable regulatory entities (US 40CFR262.11). Consult federal state/ provincial and local regulations regarding the proper disposal of waste material that may incorporate some amount of this product.

SECTION 14 : Transport information

UN-Number :1805

UN proper shipping name: Phosphoric Acid Solution

Transport hazard class(es)

Class:
8 Corrosive substances

Packing group: III

Environmental hazard: Not listed as a Marine Pollutant
Transport in bulk:

SECTION 15 : Regulatory information

Special precautions for user:

Factories (C. Of M.A.H.) Rules, 2001 ,Schedule I

See rule 2- and 3-part II List of Hazardous Chemicals

SECTION 16: Other information

This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the SDS contains all the information required by the Controlled Products Regulations. Note: The responsibility to provide a safe workplace remains with the user. The user should consider the health hazards and safety information contained herein as a guide and should take those precautions required in an individual operation to instruct employees and develop work practice procedures for a safe work environment. The information contained herein is, to the best of our knowledge and belief, accurate. However, since the conditions of handling and use are beyond our control, we make no guarantee of results, and assume no liability for damages incurred by the use of this material. It is the responsibility of the user to comply with all applicable laws and regulations applicable to this material.

GHS Full Text Phrases:

Abbreviations and acronyms:

IMDG: International Maritime Code for Dangerous Goods
PNEC: Predicted No-Effect Concentration (REACH)
CFR: Code of Federal Regulations (USA)
SARA: Superfund Amendments and Reauthorization Act (USA)
RCRA: Resource Conservation and Recovery Act (USA)
TSCA: Toxic Substances Control Act (USA)
NPRI: National Pollutant Release Inventory (Canada)
DOT: US Department of Transportation
IATA: International Air Transport Association
GHS: Globally Harmonized System of Classification and Labelling of Chemicals
ACGIH: American Conference of Governmental Industrial Hygienists
CAS: Chemical Abstracts Service (division of the American Chemical Society)
NFPA: National Fire Protection Association (USA)
HMIS: Hazardous Materials Identification System (USA)
WHMIS: Workplace Hazardous Materials Information System (Canada)
DNEL: Derived No-Effect Level (REACH)

PRODUCT NAME : SODIUM HYDROXIDE

1. IDENTIFICATION OF THE SUBSTANCE / PREPARATION AND THE

Product Name : Sodium Hydroxide (User : CDU, VBU, Laboratory)		Chemical Designation: Sodium Hydroxide	
Trade Name: Sodium Hydroxide		Synonyms: Caustic Soda, Soda Lye, Lye	
Formula: NaOH		CAS Number: 1310-73-2	UN Number: 1823/24

2. HAZARDS IDENTIFICATION

OSHA/HCS status: This material is considered hazardous by the OSHA Hazard Communication Standard

Classification of the substance or mixture: SKIN CORROSION/IRRITATION - Category 1A
SERIOUS EYE DAMAGE/ EYE IRRITATION - Category 1

AQUATIC HAZARD (ACUTE) - Category 3

Signal word: Danger

Hazard statements

Causes severe skin burns and eye damage. Very toxic to aquatic life.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Composition:

Name	CAS #	% by Weight
Sodium Hydroxide	1310-73-2	100

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

4. FIRST AID MEASURES

Description of necessary first aid measures

Inhalation: Prompt medical attention is mandatory in all cases of Overexposure. Rescue personnel should be equipped with Self-contained breathing apparatus. Quick removal from the contaminated area is most important. Unconscious persons should be moved to an uncontaminated area, given mouth-to-mouth resuscitation and supplemental oxygen. Keep the person warm and quiet. Assure that mucus or vomited material does not obstruct the airway by positional drainage. Keep the patient under medical observation for at least 24 hours.

Skin contact: Immediately flush skin with water for at least 20 minutes, Remove contaminated clothing, jewelry, and shoes. If irritation persists, repeat flushing. Obtain medical attention immediately. Discard contaminated clothing and shoes in a manner which limits further exposure.

Eye contact: Immediately flush eyes with lukewarm water for at least 20 minutes, hold eyelids open during flushing. If irritation persists, repeat flushing. Obtain medical attention IMMEDIATELY. Do not transport victim until the recommended flushing period is completed unless flushing can be continued during transport.

I**ngestion:** Do not give anything by mouth to an unconscious person. Do not induce vomiting unless told to do so by doctor.

Most important symptoms/effects, acute and delayed

Eye contact: Causes serious eye damage. Contact with rapidly expanding gas may cause burns or frostbite.

Inhalation: Fatal if inhaled. May cause respiratory irritation.

Frostbite: Try to warm up the frozen tissues and seek medical attention.

Skin contact: Causes severe burns. Contact with rapidly expanding gas may cause burns or frostbite.

5. FIRE FIGHTING MEASURES

Extinguishing media

Suitable extinguishing media: Use extinguishing media suitable for the surrounding fire. If water is used, care should be taken, since it can generate heat and cause spattering if applied directly to sodium hydroxide.

Hazardous decomposition products: Sodium hydroxide will not burn or support combustion. The reaction of sodium hydroxide with water can generate sufficient heat to ignite nearby combustible materials. Sodium hydroxide can react with metals, such as aluminum, tin and zinc, to form flammable hydrogen gas.

Special firefighting procedure: Cool tanks/drums with water spray/remove them into safety. When cooling/extinguishing: no water in the substance. Take account of toxic firefighting water. Use water moderately and if possible, collect or contain it.

Precaution to Fire Fighters:

- Exposure to fire/heat: keep upwind.
- Exposure to fire/heat: consider evacuation.
- Exposure to fire/heat: have neighborhood close doors and windows.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

- Restrict access to affected area.
- Use personal protective equipment.
- Use approved cartridge type respiratory protection.

• Keep people away from and upwind of spill/leak.

Environmental precautions: Prevent soil and water pollution. Prevent spreading in sewers. Corrosive liquid. Poisonous liquid. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Use water spray curtain to divert vapor drift. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Neutralize the residue with a dilute solution of acetic acid.

7. HANDLING AND STORAGE

Precautions for safe handling

People working with this chemical should be properly trained regarding its hazards and its safe use. Use smallestpossible amounts in designated areas with adequate ventilation. Keep containers closed when not in use. Empty containers may contain hazardous residues. Avoid generating mists. Transfer solutions usingequipment, which is corrosion-resistant. Cautiously transfer into sturdy containers made of compatible materials.Never return contaminated material to its original container. Considerable heat is generated when diluted with water.Proper handling procedures must be followed to prevent vigorous boiling, splattering or violent eruption of the diluted Solution. Never add water to a sodium hydroxide solution. ALWAYS ADD SODIUM HYDROXIDE TO WATER and provide agitation When mixing with water, stir small amounts in slowly. Use cold water to prevent excessive heat generation.

Conditions for safe storage, including any incompatibilities

• EXTREMELY CORROSIVE!
• Have emergency equipment (for fires, spills, leaks, etc.) readily available.
• Store in a cool, dry, well-ventilated area.
• Keep containers tightly closed when not in use and when empty
• Protect from damage. Store away from incompatible materials such as strong acids, nitro aromatic, nitro paraffinic or organ halogen compounds.

Incompatibilities- Acids, alkalies, reducing agents and combustibles.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Control parameters

- **ACGIH TLV-TWA (ppm): 1.22**
- **OHSA PEL TWA (mg/m3): 2 mg/m3**
- **OHSA PEL TWA (ppm): 1.22**

Environmental exposure controls

Engineering Controls: Emergency eye wash fountains and safety showers should be available in the immediate vicinity of any potential exposure. Provide adequate general and local exhaust ventilation.

Eye protection: Wear full face-shield or chemical safety goggles when there is potential for contact.

Skin and Body Protection: Chemical resistant Suit gloves (e.g., butyl rubber, neoprene, polyethylene and safety shoes are recommended when dealing with emergency.

Respiratory Protection: Use cartridge type gas mask to evacuate from area. To attend emergency wear self-contained breathing apparatus or supplied airline.

9. PHYSICAL & CHEMICAL PROPERTIES

Physical State: Solid

Appearance: white

Odor: Odorless

pH: 14 (5% aq soln)

Vapor Pressure: 1 mm Hg @739 deg C

Vapor Density: Not available.

Evaporation Rate: Not available.

Viscosity: Not available.

Boiling Point: 1390 deg C @ 760 mmHg

Freezing/Melting Point: 318 deg C

Decomposition Temperature: Not available.

Solubility: Soluble.

Specific Gravity/Density: 2.13 g/cm3

Molecular Formula: NaOH

Molecular Weight: 40

10. STABILITY & REACTIVITY

Chemical Stability: Stable at room temperature in closed containers under normal storage and handling conditions.

Conditions to Avoid: Moisture, contact with water, exposure to moist air or water, prolonged exposure to air.

Incompatibilities with Other Materials: Water, metals, acids, aluminum, zinc, tin, nitromethane, leather, flammable liquids, organic halogens, wool.

Hazardous Decomposition Products: Toxic fumes of sodium oxide.

11. TOXICOLOGICAL INFORMATION

Information on toxicological effects

Routes of exposure: Ingestion, Eyes, Inhalation, Skin Absorption

Target Organ Effects: Eyes, skin and respiratory tract.

Symptoms related to physical, chemical & toxicological characteristics: Causes severe skin burns. Causes serious eye damage. Corrosion of the eye tissues. Permanent eye damage.

12. ECOLOGICAL INFORMATION

Information on Ecological Effects

Mobility in Soil: No (test)data on mobility of the substance available.
Persistence & degradability: Biodegradability: not applicable
Effects on fish: Sodium hydroxide (50 % solution) is slightly toxic to aquatic organisms on an acute basis. The harmful effect may be due to pH shifts outside of 5 – 10.

13. DISPOSAL CONSIDERATION

Disposal methods

Review federal, state and local government requirements prior to disposal. Do not dispose of waste with normal garbage, or to sewer systems. Whatever cannot be saved for recovery or recycling, including containers, should be managed in an appropriate and approved waste disposal facility.

14. TRANSPORT INFORMATION

Shipping Name	SODIUM HYDROXIDE
Marine Pollutant	Yes (Slightly)
Labels Required	Corrosive, Class - 8

15. REGULATORY INFORMATIONS

National Regulations	**LABELING**: **PHRASES R:** R22 Harmful if swallowed. R35 Causes severe burns. R41 Risk of serious damage to eyes. **PHRASES S:** S1/2 Keep locked up, out of the reach of children. S24/25 Avoid contact with skin and eyes. S26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S27 Take off immediately all contaminated clothing. S28 After contact with skin, wash immediately with plenty of water. S36/37/39 Wear suitable protective clothing, gloves and eye/face protection. S45 In case of accident or if you feel unwell seek medical attention immediately

16. OTHER INFORMATION

The information provided in this Material Safety data sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with other materials.

PRODUCT NAME : HIGH SPEED DIESEL

1. IDENTIFICATION OF THE SUBSTANCE / PREPARATION AND THE COMPANY

Product Name: High Speed Diesel		Chemical Designation: A Complex Mixture ofHydrocarbons.	
Trade Name: HSD Bharat-II, HSD Bharat-III, High flash HSD, Export HSD		Synonyms: HSD, Gas Oil	
Formula: A Complex mixture of Hydrocarbons	Label: Category Class: 3	CAS Number:	UN Number: 1202
Regulated Identification:UN Number 1202	Shipping Name Codes / Label: Class BFlammable liquid.		Hazchem Code: 3Z

2. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW CAUTION !

OSHA/NFPA COMBUSTIBLE LIQUID - SLIGHT TO MODERATE IRRITANT - EFFECTS CENTRALNERVOUS SYSTEM - HARMFUL OR FATAL IF SWALLOWED

Moderate fire hazard. Avoid breathing vapors or mists. May cause dizziness and drowsiness. May cause moderate eye irritation and skin irritation (rash). Long-term, repeated exposure may cause skin cancer. If ingested, do NOT induce vomiting, as this may cause chemical pneumonia (fluid in the lungs).

EYES

Contact with liquid or vapor may cause mild irritation.

SKIN

May cause skin irritation with prolonged or repeated contact. Practically non-toxic if absorbed followingacute (single) exposure. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are repeatedly exposed.

INGESTION

The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs),severe lung damage, respiratory failure and even death. Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest,and death may occur.

INHALATION

Excessive exposure may cause irritations to the nose, throat, lungs and respiratory tract. Central nervoussystem (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.

WARNING: the burning of any hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of combustion products, including carbon monoxide, and inadequate oxygen levels which may cause unconsciousness, suffocation, and death.

CHRONIC EFFECTS and CARCINOGENICITY

Similar products produced skin cancer and systemic toxicity in laboratory animals following repeated applications. The significance of these results to human exposures has not been determined - see

Section 11 Toxicological Information. IARC classifies whole diesel fuel exhaust particulates as probably carcinogenic to humans (Group 2A). NIOSH regards whole diesel fuel exhaust particulates as a potential cause of occupational lung cancer based on animal studies and limited evidence in humans.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE

Irritation from skin exposure may aggravate existing open wounds, skin disorders, and dermatitis (rash).

3. COMPOSITION / INFORMATION ON INGREDIENTS

Composition:

Name	CAS #	% by Weight
Diesel Fuel	68476-34-6	100

A complex mixture of hydrocarbons with carbon numbers in the range C9 and higher. Premium Diesel fuel contains a multifunctional additive

4. FIRST AID MEASURES

EYES

In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Holdeyelids open to ensure adequate flushing. Seek medical attention.

SKIN

Remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or waterlesshand cleanser. Obtain medical attention if irritation or redness develops.

INGESTION

DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Monitor for breathing difficulties.

Small amounts of material which enter the mouth should be rinsed out until the taste is dissipated.

INHALATION

Remove person to fresh air. If person is not breathing provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

5. FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES:

FLASH POINT	: 54 ^{o}C minimum with ASTM D – 93
AUTOIGNITION POINT	: 494 ^{o}F (257 ^{o}C) OSHA / NFPA
FLAMMABILITY CLASS	: 2 (COMBUSTIBLE)LOWER EXPLOSIVE
LIMIT (%)	: 0.6
UPPER EXPLOSIVE LIMIT (%)	: 7.5

FIRE AND EXPLOSION HAZARDS

Vapors may be ignited rapidly when exposed to heat, spark, open flame or other source of ignition. Whenmixed with air and exposed to an ignition source, flammable vapors can burn in the open or explode in confined spaces. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Runoff to sewer may cause fire or explosion hazard.

EXTINGUISHING MEDIA

SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO2, water spray, fire fightingfoam, or Halon.

LARGE FIRES: Water spray, fog or firefighting foam. Water may be ineffective for fighting the fire, butmay be used to cool fire-exposed containers.

FIRE FIGHTING INSTRUCTIONS

Small fires in the incipient (beginning) stage may typically be extinguished using handheld portable fireextinguishers and other firefighting equipment.

Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA- approved pressure-demand self-contained breathing apparatuswith full face piece and full protective clothing.

Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied firefighting foam.

6. ACCIDENTAL RELEASE MEASURES

ACTIVATE FACILITY'S SPILL CONTINGENCY OR EMERGENCY RESPONSE PLAN.

Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to confirm spill areas. Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact. Carefully contain and stop the source of the spill, if safe to do so. Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of firefightingfoam may be useful in certain situations to reduce vapors. The proper use of water spray may effectivelydisperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection. Take up with sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal - caution, flammable vapors may accumulate in closed containers. Response and clean-up crews must be properly trained and must utilize proper protective equipment.

7. HANDLING AND STORAGE

HANDLING PRECAUTIONS

Handle as a combustible liquid. Keep away from heat, sparks, and open flame! Electrical equipment should be approved for classified area. Bond and ground containers during product transfer to reduce thepossibility of static-initiated fire or explosion.

Special slow load procedures for "switch loading" must be followed to avoid the static ignition hazard that can exist when higher flash point material (such as fuel oil) is loaded into tanks previously containing low flash point products (such as this product) - see API Publication 2003, "Protection Against Ignitions ArisingOut of Static, Lightning and Stray Currents.

STORAGE PRECAUTIONS

Keep away from flame, sparks, excessive temperatures and open flame. Use approved vented containers. Keep containers closed and clearly labeled. Empty product containers or vessels may containexplosive vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition.

Store in a well-ventilated area. This storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". Avoid storage near incompatible materials. The cleaning of tanks previouslycontaining this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks".

WORK / HYGIENIC PRACTICES

Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure. Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Do not use as a cleaning solvent on the skin. Do not use solvents or harsh abrasive skin cleaners for washing this product from exposed skin areas. Waterless hand cleaners are effective. Promptly remove contaminated clothing and launder before reuse. Use care when laundering to prevent the formation of flammable vapors which could ignite via washer or dryer. Consider the need to discard contaminated leather shoes and gloves.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

ENGINEERING CONTROLS

Use adequate ventilation to keep vapor concentrations of this product below occupational exposure andflammability limits, particularly in confined spaces.

EYE/FACE PROTECTION

Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.

SKIN PROTECTION

Gloves constructed of nitrile, neoprene, or PVC are recommended.

Note: resistance of specific material may vary from product to product as well as with degree of exposure.Consult manufacturer specifications for further information.

RESPIRATORY PROTECTION

A NIOSH/MSHA-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited. Refer to OSHA 29 CFR 1910.134, ANSI Z88.2-1992, NIOSH Respirator Decision Logic, and the manufacturer foradditional guidance on respiratory protection selection.

Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifyingrespirator may not provide adequate protection.

9. PHYSICAL & CHEMICAL PROPERTIES

APPEARANCE

Clear, straw-yellow liquid

ODOR

Mild, petroleum distillate odor

BASIC PHYSICAL PROPERTIES

BOILING RANGE	: 320 to 690 oF (160 to 366 oC)
VAPOR PRESSURE	: 0.009 psia @ 70 oF (21 oC)
VAPOR DENSITY (air = 1)	: > 1.0
SPECIFIC GRAVITY (H2O = 1) @ 60 oF (16 oC)PERCENT VOLATILES	: 0.83 to 0.86 :100 %
EVAPORATION RATE	: Slow; varies with conditions
SOLUBILITY (H2O)	: Negligible

10. STABILITY & REACTIVITY

STABILITY **:** Stable. Hazardous polymerization will not occur.

CONDITIONS TO AVOID and INCOMPATIBLE MATERIALS

Avoid high temperatures, open flames, sparks, welding, smoking and other ignition sources. Keep awayfrom strong oxidizers;

HAZARDOUS DECOMPOSITION PRODUCTS

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke).

11. TOXICOLOGICAL INFORMATION

ACUTE TOXICITY

Acute dermal LD50 (rabbits): > 5 ml/kg Acute oral LD50 (rats): 9 ml/kg

Primary dermal irritation: extremely irritating (rabbits) Draize eye irritation: non-irritating (rabbits)Guinea pig sensitization: negative

CHRONIC EFFECTS AND CARCINOGENICITY

Carcinogenic: OSHA: NO IARC: NO NTP: NO ACGIH: 1997 NOIC: A3

Studies have shown that similar products produce skin tumors in laboratory animals following repeated applications without washing or removal. The significance of this finding to human exposure has not been determined. Other studies with active skin carcinogens have shown that washing the animal's skin with soap and water between applications reduced tumor formation.

MUTAGENICITY (genetic effects)

This material has been positive in a mutagenicity study.

12. ECOLOGICAL INFORMATION

Keep out of sewers, drainage areas, and waterways. Report spills and releases, as applicable, under

13. DISPOSAL CONSIDERATION

Federal and State regulations.

Consult federal, state and local waste regulations to determine appropriate disposal options.

14. TRANSPORT INFORMATION

PROPER SHIPPING NAME: Diesel Fuel

HAZARD CLASS and PACKING GROUP: 3, PG III
DOT IDENTIFICATION NUMBER: NA 1993

DOT SHIPPING LABEL: None

15. REGULATORY INFORMATIONS

This product and its constituents listed herein are on the EPA TSCA Inventory. Any spill or uncontrolled release of this product, including any substantial threat of release, may be subject to federal, state and/or local reporting requirements. This product and/or its constituents may also be subject to other regulations at the state and/or local level. Consult those regulations applicable to your facility/operation.

CLEAN WATER ACT (OIL SPILLS)

Any spill or release of this product to "navigable waters" (essentially any surface water, including certainwetlands) or adjoining shorelines sufficient to cause a visible sheen or deposit of a sludge or emulsion must be reported immediately to the if not practical.

CERCLA SECTION 103 and SARA SECTION 304 (RELEASE TO THE ENVIRONMENT)

The CERCLA definition of hazardous substances contains a –petroleum exclusionll clause which exempts crude oil, refined, and unrefined petroleum products and any indigenous components of such. However, other federal reporting requirements (e.g., SARA Section 304 as well as the Clean Water Act if the spill occurs on navigable waters) may still apply.

16. OTHER INFORMATION

NFPA® HAZARD RATING

HEALTH: 0
Negligible

FIRE: 2 Moderate

REACTIVITY: 0 Negligible

PRODUCT NAME : FUEL OIL

1. IDENTIFICATION OF THE SUBSTANCE / PREPARATION AND THE COMPANY

Product Name: Fuel Oil (FO-180 CST, FO-380CST, LSHS) (Producer/User : VBU, CPP,OM&S, Marketing)		**Chemical Designation:** A complex Mixture of Hydrocarbons	
Trade Name: FO(180 CST),FO(380 CST), LSHS	**Synonyms**: Bunkers, Black Fuel Oil, MFO, Industrial Fuel Oil,6 Oil, Slurry Fuel Oil, RFO, Refinery Fuel Oil, High Sulfur Fuel Oil, HSFO, IFO-30, IFO-180, IFO-380, IFO- 510, IFO-700, Bunker C, Bunker Fuel Oil, Marine Fuel Oil, Decant Oil, Utility Fuel Oil, LSFO, Six Oil, 888100008793		
Formula: A complex mixture of Hydrocarbons	**Label** : Category Class : 3	**CAS Number**: 68476– 33.5	**UN Number** : 1223
Regulated Identification: UNno-1223	Shipping Name Codes / Label: Class C Flammable Liquid..		**Hazchem Code** :2PE

2. HAZARDS IDENTIFICATION

Classifications

Flammable Liquid – Category 4,
Carcinogenicity –Category 1B
Toxic to Reproduction – Category 1B
Specific Target Organ Toxicity (Repeated Exposure) – Category 2 Acute Toxicity – Inhalation–Category 4
Acute Aquatic Toxicity– Category 3

Signal Word

DANGER

Hazard Statements

Combustible liquid.
May cause cancer from prolonged and repeated skin contact.
May damage fertility or the unborn child.
May cause damage to liver, kidney and nervous system throughprolonged or repeated exposure.
Harmful if inhaled.
Harmful to aquatic life
Skin and eye irritant.
May contain and release toxic hydrogen sulfide (H_2S) gas.

Precautionary Statements

Prevention

Obtain special instructions before use.
Do not handle until all safety precautions have been read andunderstood.
Keep away from flames and hot surfaces. No smoking.

Wear gloves, eye protection and face protection as needed to prevent skin and eye contact with liquid.

Wash hands or liquid-contacted skin thoroughly after handling.Do not eat, drink or smoke when using this product.

Do not breathe vapors or mists.

Use only outdoors or in a well-ventilated area.

Response

In case of fire:
Use dry chemical, CO_2, water spray or fire fighting foam to extinguish.

Get medical advice or attention if you feel unwell, are exposed, or become concerned. If on skin (or hair):Take off immediately all contaminated clothing. Rinse skin with water or shower.

If in eye: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do.Continue rinsing. If skin or eye irritation persists, get medical attention.

If inhaled:

Remove person to fresh air and keep comfortable for breathing. Immediately call or doctor or emergencymedical provider

Storage Store in a well-ventilated place. Keep cool. Store locked up. Keep container tightly closed. Use only approved containers.

Disposal Dispose of contents/containers to approved disposal site in accordance withlocal, regional, national, and/or international regulations.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Composition:

Name	CAS #	% by Weight
Clarified oils (petroleum), catalytic cracked; Heavy Fuel oil	64741-62-4	100
Polycyclic aromatic compounds (PACs or PNAs)		Typically 1.5%
Benzo [a] pyrene; Benzo [def] chrysene	50-32-8	Trace to 0.2%
Hydrogen Sulfide	7783-06-4	Trace to 0.2%
Sulfur (for waters within 25 miles of California shores)	17704-34-9	Trace to 0.1%
Sulfur (for waters within 200 miles of American shores)	17704-34-9	Trace to 1.0%
Sulfur (for International waters)	17704-34-9	Trace to 3.5%

4. FIRST AID MEASURES

Inhalation : Move to fresh air. Give oxygen. If breathing is irregular or stopped, administer artificial respiration. Seek medical attention immediately.

Skin contact : Take off all contaminated clothing immediately. Wash off immediately with soap and plenty of water. Wash contaminated clothing before re-use. If skin irritation persists, call a physician.

Eye contact : Remove contact lenses. Rinse immediately with plenty of water, also under the eye lids, for atleast 15 minutes. If eye irritation persists, consult a specialist.

Ingestion : Do NOT induce vomiting. Do not give liquids. Seek medical attention immediately. If vomiting does occur naturally, keep head below the hips to reduce the risks of aspiration. Monitor for breathing difficulties. Small amounts of material which enter the mouth should be rinsed out until the taste isdissipated.

Notes to physician : Symptoms: Dizziness, Discomfort, Headache, Nausea, Disorder, Vomiting, Liver disorders, Kidney disorders, Aspiration may cause pulmonary edema and pneumonitis.

5. FIRE FIGHTING MEASURES

Suitable extinguishing media : Carbon dioxide (CO2), Water spray, Dry chemical, Foam, Keep containers and surroundings cool with water spray.

Specific hazards during firefighting

Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied firefighting foam.

Special protective equipment for fire-fighters

Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA- approved pressure demand self-contained breathing apparatus with full face piece and full protective clothing.

Further information : Flammable vapor production at ambient temperature in the open is expected to be minimal, as the material is generally wet. However, depending on oil content and conditions, it is possible flammable vapors could accumulate in the headspace of storage containers, presenting a flammability and explosion hazard. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Run off to sewer may cause fire or explosion hazard.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions : Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to contain spill areas.

Environmental precautions : Carefully contain and stop the source of the spill, if safe to do so Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material.

Methods for cleaning up : Take up with sand or oil absorbing materials. Carefully vacuum, shovel, scoop or sweep up into a waste container for reclamation or disposal

7. HANDLING AND STORAGE

Precautions for safe handling : Keep away from fire, sparks and heated surfaces. No smoking near areas where material is stored or handled. The product should only be stored and handled in areas with intrinsically safe electrical classification. Hydrocarbon liquids including this product can act as a non- conductive flammable liquid (or static accumulators), and may form ignitable vapor-air mixtures in storage tanks or other containers. Precautions to prevent static-initiated fire or explosion during transfer, storage or handling, include but are not limited to these examples:

(1).Ground and bond containers during product transfers. Grounding and bonding may not be adequate protection to prevent ignition or explosion of hydrocarbon liquids and vapors that are static accumulators.

(2). Special slow load procedures for "switch loading" must be followed to avoid the static ignition hazardthat can exist when higher flash point material (such as fuel oil or diesel) is loaded into tanks previously containing low flash point products (such gasoline or naphtha).

(3).Storage tank level floats must be effectively bonded. For more information on precautions to prevent static-initiated fire or explosion, see NFPA 77, Recommended Practice on Static Electricity (2007), and API Recommended Practice 2003, Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents (2008).

Conditions for storage, including any incompatibilities

Keep away from flame, sparks, excessive temperatures and open flame. Use approved containers. Keep containers closed and clearly labeled. Empty or partially full product containers or vessels may containexplosive vapors. Do not pressurize, cut, heat, weld or expose containers to sources of ignition. Store in a well-ventilated area. The storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". The cleaning of tanks previously containing this product should follow API Recommended Practice

(RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks". Hydrogen sulfide may accumulate in tanks and bulk transport compartments. Consider appropriate respiratory protection (see Section 8). Stand upwind. Avoid vapors when opening hatches and dome covers. Confined spaces should be ventilated and gas tested prior to entry. Keep away from food, drink and animal feed. Incompatible with oxidizing agents. Incompatible with acids. No decomposition if stored and applied as directed.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Guidelines

List	Components	CAS-No.	Type:	Value
OSHA	Polycyclic aromatic compounds (or coal tar pitch volatile– benzene soluble)		PEL	0.2 mg/m3
	Clarified oils (petroleum), catalytic cracked; Heavy Fuel oil		PEL	5 mg/m3 (as mineral oil mist)
	Hydrogen Sulfide	7783-06-4	STEL	20 ppm
ACGIH	Hydrogen Sulfide	7783-06-4	TWA	1 ppm
		7783-06-4	STEL	5 ppm
	Clarified oils (petroleum), catalytic cracked; HeavyFuel oil	64741-62-4	TWA	0.2 mg/m3 (as mineral oil) Sum of 15 NTP-listed polynuclear aromatic hydrocarbons 0.005 mg/m3
	Polycyclic aromatic compounds (or coal tar pitch Volatiles- benzene soluble)		TWA	0.2 mg/m3

Engineering measures : Use adequate ventilation to keep gas and vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces.

Eye protection: Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.

Hand protection: Gloves constructed of nitrile, neoprene, or PVC are recommended.

Skin and body protection : Chemical protective clothing such as DuPont Tyvek QC, TyChem® or equivalent, recommended based on degree of exposure. The resistance of specific material may vary from product to product as well as with degree of exposure.

Respiratory protection : If hydrogen sulfide concentration may exceed permissible exposure limit, a positive-pressure SCBA or Type C supplied air respirator with escape bottle is required as respiratory protection. If hydrogen sulfide concentration is below H_2Spermissible

exposure limit a NIOSH /MSHA-approved air-purifying respirator with acid gas cartridges may be acceptable for odor control, but continuous air monitoring for H2S is recommended. Protection provided by air-purifying respirators is limited. Use a NIOSH/ MSHA-approved positive-pressure supplied air respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air purifying respirator may not provide adequate protection. Refer to OSHA 29 CFR1910.134, ANSI Z88.2-1992, NIOSH Respirator Decision Logic, and the manufacturer for additional guidance on respiratory protection selection.

Work / Hygiene practices : Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure. Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Do not use as a cleaning solvent on the skin. Do not use solvents or harsh abrasive skin cleaners for washing this product from exposed skin areas. Waterless hand cleaners are effective. Promptly remove contaminated clothing and launder before reuse. Use care when laundering to prevent the formation of flammable vapors which could ignite via washer or dryer. Consider the need to discard contaminated leather shoes and gloves.

9. PHYSICAL & CHEMICAL PROPERTIES

Appearance	Dark green to brown or black liquid
Odor	Petroleum asphalt odor
Odor threshold	No data available
pH	Not applicable
Melting point/freezing point	32° - 80°C (89.6° - 176°F)
Initial boiling point & range	154 - 372 °C (310° - 702 °F)
Flash point	60°C (140°F) minimum
Evaporation rate	Higher initially and declining as lighter components evaporate
Flammability (solid, gas)	Flammable vapor released by heated liquid
Upper explosive limit	No data available
Lower explosive limit	No data available
Vapor pressure	210 Pa at 25°C
Vapor density (air = 1)	>5
Relative density (water = 1)	>0.9 to 1.2 g/mL
Solubility (in water)	6 to 1400 mg/L at 25°C
Partition coefficient (n-octanol/water)	3.4 to 5 as log Pow at 25°C
Auto-ignition temperature	>176°C (>350 °F)
Decomposition temperature	Will evaporate or boil and possibly ignite before decomposition occurs.
Kinematic viscosity	>300 cST typical at 40°C

10. STABILITY & REACTIVITY

Reactivity : Vapors may form explosive mixtures with air. Hazardous polymerization does not occur.
Chemical Stability : Stable under normal conditions.

Possibility of hazardous reactions
Can react with strong oxidizing agents and peroxides. Keep away from strong acids and bases.
Conditions to avoid : Avoid high temperatures, open flames, sparks, welding, smoking and other ignitionsources. Keep away from strong oxidizers.
Hazardous decomposition products
Carbon monoxide, carbon dioxide and non combusted hydrocarbons (smoke).

11. TOXICOLOGICAL INFORMATION

Inhalation : Because of its low vapor pressure, this product presents a minimal inhalation hazard at ambient temperature. Upon heating, fumes may be evolved. Inhalation of fumes or mist may result in respiratory tract irritation and central nervous system (brain)effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death. The burning of any

hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of combustion products, including carbon monoxide, and inadequate oxygen levels, which may cause unconsciousness, suffocation, and death. Irritating and toxic hydrogen sulfide gas may be present. Greater than 15 – 20ppm continuous exposure can cause mucous membrane and respiratory tract irritation. 50 - 500 ppm can cause headache, nausea, and dizziness. Continued exposure at these levels can lead to loss of reasoning and balance, difficulty in breathing, fluid in the lungs, and possible loss of consciousness. Greater than 500ppm can cause rapid unconsciousness due to respiratory paralysis and death by suffocation unless the victim is removed from exposure and successfully resuscitated. Greater than 1000 ppm can cause immediate unconsciousness and death if not promptly revived. After-effects from overexposure are not anticipated except what would be expected if the victim was without oxygen for more than 3 to 5minutes (asphyxiation). The "rotten egg" odor of hydrogen sulfide is not a reliable indicator for warning of exposure, since olfactory fatigue (loss of smell) readily occurs, especially at concentrations above 50 ppm. At high concentrations, the victim may not even recognize the odor before becoming unconscious.

Skin irritation May cause skin irritation with prolonged or repeated contact. Practically non-toxic if absorbed following acute (single) exposure. Exposure may cause a photo toxicity reaction: liquid or mist on the skin may produce a painful sunburn reaction when exposed to sunlight. Product may be hot which could cause 1st, 2nd, or 3rd degree thermal burns.

Eye irritation May cause irritation, experienced as mild discomfort and seen as slight excess redness of theeye.

Ingestion This material has a low order of acute toxicity. If large quantities are ingested, nausea, vomiting and diarrhea may result. Ingestion may also cause effects similar to inhalation of the product. Could present an aspiration hazard if liquid is inhaled into lungs, particularly from vomiting after ingestion. Aspiration may result in chemical pneumonia, severe lung damage, respiratory failure and even death.

Further information This material contains polynuclear aromatic hydrocarbons (PNAs), some of which are animal carcinogens. Studies have shown that similar products produce skin cancer or skin tumors in laboratory animals following repeated applications without washing or removal. The significance of this finding to human exposure has not been determined. Other studies with active skin carcinogens have shownthat washing the animal's skin with soap and water between applications reduced tum or formation. The presence of carcinogenic PNAs indicates that precautions should betaken to minimize repeated and prolonged inhalation of fumes or mists. Dermal application of gas oil to rats resulted in limited evidence of liver damage (i.e., increased liver weight and changes in hepatic serum enzyme activity) and bone marrow toxicity (hypoplasia and decreased hemoglobin.) Petroleum industry experience indicates that a

program providing for good personal hygiene, proper use of personal protective equipment, and minimizing the repeated and prolonged exposure to liquids and fumes, is effective in reducing or eliminatingthe carcinogenic risk of high boiling aromatic oils (polynuclear aromatic hydrocarbons) to humans. Liver and kidney injuries may occur. Components of the product may affect the nervous system.

Component:

Clarified oils (petroleum), catalytic cracked; Heavy Fuel oil
64741-62-4 Acute oral toxicity: LD50 ratDose: 4,320 mg/kg

Acute dermal toxicity: LD50 rabbit Dose: 2,001 mg/kg

Skin irritation: Classification: Irritating to skin.

Result: Mild skin irritation

Eye irritation: Classification: Irritating to eyes.
Result: Mild eye irritation

Carcinogenicity: Animal experiments showed a statistically significant number of tumors.

Carcinogenicity

NTP Benzo[a]pyrene; Benzo[def]chrysene (CAS-No.: 50-32-8)

IARC Benzo[a]pyrene; Benzo[def]chrysene (CAS-No.: 50-32-8)

OSHA No component of this product present at levels greater than or equal to 0.1% isidentified as a carcinogen or potential carcinogen by OSHA.

CA Prop 65 WARNING! This product contains a chemical known to the State of California to cause cancer. Benzo[a]pyrene; Benzo[def]chrysene (CAS-No.: 50-32-8)

12. ECOLOGICAL INFORMATION

Additional ecological information

Keep out of sewers, drainage areas, and waterways. Report spills and releases, as applicable, under Federaland State regulations.

13. DISPOSAL CONSIDERATION

Disposal : Consult federal, state and local waste regulations to determine appropriate waste characterization of material and allowable disposal methods

14. TRANSPORT INFORMATION

CFR

Proper shipping name : Not regulated if shipped below 140°F (60°C)
Elevated temperature liquid, flammable (if shipped above
140°F(60°C)).UN-No. : Not regulated if shipped below 140°F (60°C)
3256 if shipped above
140°F (60°C) Class : 9
Packing group : III
Hazard inducer : (Clarified oils (petroleum), catalytic cracked; Heavy Fuel oil)

TDG

Proper shipping name : Not regulated if shipped below 140°F (60°C) Elevated temperature liquid, flammable (if shipped above 140°F(60°C)).

UN-No. : Not regulated if shipped below 140°F (60°C)3256 if shipped above 140°F (60°C)Class : 9

Packing group : III
Hazard inducer : (Clarified oils (petroleum), catalytic cracked; Heavy Fuel oil)

IATA Cargo Transport

UN-No. : Not regulated if shipped below 140°F (60°C)3256 if shipped above 140°F (60°C)
Class : Not regulated if shipped below 140°F (60°c)
Not permitted for transport (at 140°F (60°C) or higher temperature)

IATA Passenger Transport

UN-No. : Not regulated if shipped below 140°F (60°C)3256 if shipped above 140°F (60°C)
Class : Not regulated if shipped below 140°F (60°c)
Not permitted for transport (at 140°F (60°C) or higher temperature)

IMDG-Code

UN-No. : Not regulated if shipped below 140°F (60°C)3256 if shipped above 140°F (60°C)
Description of the goods : Elevated temperature liquid, n.o.s. (Clarified oils (petroleum), catalytic cracked; Heavy Fuel oil)
Class : Not regulated if shipped below 140°F (60°c) Not permitted for transport (at 140°F (60°C) or higher temperature)
Packaging group : III
IMDG-Labels : 9

EmS Number : F-A S-P
Marine **pollutant** : No

15. REGULATORY INFORMATIONS

CERCLA SECTION 103 and SARA SECTION 304 (RELEASE TO THE ENVIROMENT)

The CERCLA definition of hazardous substances contains a –petroleum exclusionǁ clause which exempts crude oil. Fractions of crude oil, and products (both finished and intermediate) from the crude oil refining process and any indigenous components of such from the CERCLA Section103 reporting requirements. However, other federal reporting requirements, including SARA Section 304, as well as the Clean Water Act may still apply**.**

TSCA Status : On TSCA Inventory

DSL Status : All components of this product are on the Canadian
DSL list.SARA 311/312 Hazards : Fire Hazard

Acute Health Hazard Chronic Health Hazard

SARA III US. EPA Emergency Planning and Community Right-To-Know Act (EPCRA) SARA Title IIISection 313 Toxic Chemicals (40 CFR 372.65) - Supplier Notification Required

Components CAS-No.

Benzo[a]pyrene; Benzo[def]chrysene 50-32-8

SARA III US. EPA Emergency Planning and Community Right-To-Know Act (EPCRA) SARA Title IIISection 302 Extremely Hazardous Substance (40 CFR355, Appendix A)

Components CAS-No.
PENN RTK US. Pennsylvania Worker and Community Right-to-Know Law (34 Pa. Code Chap. 301-323)

Components CAS-No.
Clarified oils (petroleum), catalytic cracked; Heavy Fueloil 64741-62-4

Benzo[a]pyrene; Benzo[def]chrysene 50-32-8

MASS RTK US. Massachusetts Commonwealth's Right-to-Know Law (Appendix A to 105 Code of Massachusetts Regulations Section 670.000)

Components CAS-No.

Benzo[a]pyrene; Benzo[def]chrysene 50-32-8

NJ RTK US. New Jersey Worker and Community Right-to-Know Act (New Jersey Statute AnnotatedSection 34:5A-5)

Components CAS-No.
Clarified oils (petroleum), catalytic cracked; Heavy Fuel oil

64741-62-4

Benzo[a]pyrene; Benzo[def]chrysene 50-32-8

California Prop. 65 : WARNING! This product contains a chemical known in the State of California tocause cancer. Benzo[a]pyrene; Benzo [def]chrysene

16. OTHER INFORMATION

Further information

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in thetext.

PRODUCT NAME : TRANSFORMER OIL

1. IDENTIFICATION OF THE SUBSTANCE / PREPARATION AND THE COMPANY

Product Name: Transformer Oil		**Chemical Designation:** A complex Mixture of Hydrocarbons	
Trade Name: -	**Synonyms**: - Insulating Oil for transformers		
Formula: A complex mixture of Hydrocarbons	**Label:** -	**CAS Number**: 64742-53-6	**UN Number:** -
Regulated Identification: -	Shipping Name Codes / Label: Class C Flammable Liquid.		**Hazchem Code:** -

2. HAZARDS IDENTIFICATION

GHS Classification: ASPIRATION HAZARD - Category 1
GHS label elements
Hazard pictograms

Signal Word: Danger

Hazard statements: H304 - May be fatal if swallowed and enters airways.

Precautionary statements
Prevention Not applicable.
Response P301 + P310 + P331 - IF SWALLOWED: Immediately call a physician. Do NOT induce vomiting.
Storage P405 - Store locked up.
Disposal P501 - Dispose of contents and container in accordance with all local, regional, national and international regulations.

Other hazards which do not result in classification:
Defatting to the skin.
USED OILS FROM TRANSFORMERS AND SWITCH GEAR:
Because polychlorinated biphenyls (PCBs) were often used in older transformers and switchgear equipment, there is a possibility that oil drained from older equipment may have become contaminated with PCB.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Composition:

Name	CAS #	% by Weight
Distillates (petroleum), hydrotreated, light naphthenic	64742-53-6	≥75 - <90
Base oil - unspecified	Varies	≥10 - <25

4. FIRST AID MEASURES

Inhalation: If inhaled, remove to fresh air. Get medical attention if symptoms occur.

Skin contact: Wash skin 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 symptoms occur.

Eye contact: 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.

Ingestion: Do not induce vomiting. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Aspiration hazard if swallowed. Can enter lungs and cause damage. Get medical attention immediately.

Notes to physician: Treatment should in general be symptomatic and directed to relieving any effects. Product can be aspirated on swallowing or following regurgitation of stomach contents, and can cause severe and potentially fatal chemical pneumonitis, which will require urgent treatment. Because of the risk of aspiration, induction of vomiting and gastric lavage should be avoided. Gastric lavage should be undertaken only after endotracheal intubation. Monitor for cardiac dysrhythmias.

5. FIRE FIGHTING MEASURES

Suitable extinguishing media: Carbon dioxide (CO2), Water spray, Dry chemical, Foam, Keep containers and surroundings cool with water spray.

Specific hazards during firefighting: Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.

Special protective equipment for fire-fighters

Special protective equipment for fire-fighters: Fire-fighters should wear positive pressure self-contained breathing apparatus (SCBA) and full turnout gear.

Further information: In a fire or if heated, a pressure increase will occur and container may burst.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions: Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to contain spill areas. Wear self-contained breathing apparatus. Wear a suitable chemical protective suit.

Environmental precautions: Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods for cleaning up: Take up with sand or oil absorbing materials. Carefully vacuum, shovel, scoop or sweep up into a waste container for reclamation or disposal.

7. HANDLING AND STORAGE

Precautions for safe handling: Keep away from fire, sparks and heated surfaces. 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.

Conditions for storage, including any incompatibilities: Store in accordance with local regulations. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials and food and drink. Store locked up. Keep container tightly closed and sealed until ready for use. Store and use only in equipment/ containers designed for use with this product. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate containment to avoid environmental contamination.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Guidelines

List	Components	CAS-No.	Type:	Value
ACGIH	Distillates (petroleum), hydrotreated, light naphthenic	7783-06-4	TWA	5 mg/m³ for 8 hours

	Base oil - unspecified	64741-62-4	TWA	5 mg/m³ for 8 hours

Engineering measures: All activities involving chemicals should be assessed for their risks to health, to ensure exposures are adequately controlled. Personal protective equipment should only be considered after other forms of control measures (e.g. engineering controls) have been suitably evaluated. Personal protective equipment should conform to appropriate standards, be suitable for use, be kept in good condition and properly maintained. Provide exhaust ventilation or other engineering controls to keep the relevant airborne concentrations below their respective occupational exposure limits. The final choice of protective equipment will depend upon a risk assessment. It is important to ensure that all items of personal protective equipment are compatible.

Eye protection: Safety glasses or goggles are recommended where there is a possibility or splashing or spraying.

Hand protection: Wear protective hand gloves, Chemical resistant or Nitrile hand gloves.

Skin and body protection: Use of protective clothing is good industrial practice. Protective apron / suit/ overalls will only provide protection against light superficial contamination that will not soak through to the skin.

Respiratory protection: Avoid breathing of vapors, mist or spray. Use respirator with organic vapor filters or dust/mist filters.

Work / Hygiene practices: Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure. Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Do not use as a cleaning solvent on the skin. Do not use solvents or harsh abrasive skin cleaners for washing this product from exposed skin areas. Waterless hand cleaners are effective. Promptly remove contaminated clothing and launder before reuse. Use care when laundering to prevent the formation of flammable vapors which could ignite via washer or dryer. Consider the need to discard contaminated leather shoes and gloves.

9. PHYSICAL & CHEMICAL PROPERTIES

Appearance	Yellow: Pale colour
Odor	Odorless
Odor threshold	No data available
pH	Not applicable
Melting point/freezing point	32° - 80°C (89.6° - 176°F)
Initial boiling point & range	>290
Flash point	145°C (293°F) minimum
Evaporation rate	No data available
Flammability (solid, gas)	Not applicable. Based on - Physical state
Upper explosive limit	No data available
Lower explosive limit	No data available

Vapor pressure	No data available
Vapor density (air = 1)	No data available
Relative density (water = 1)	0.883 g/mL
Solubility (in water)	insoluble in water.
Partition coefficient (n-octanol/water)	No data available
Auto-ignition temperature	>242°C (>467.6 °F)
Decomposition temperature	No data available
Kinematic viscosity	(10 cSt) at 40°C

10. STABILITY & REACTIVITY

Reactivity: No specific test data available for this product. Refer to Conditions to avoid and Incompatible materials for additional information.

Chemical Stability Stable under normal conditions.

Possibility of hazardous reactions: Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to avoid: Avoid all possible sources of ignition (spark or flame).

Incompatible materials: Reactive or incompatible with the following materials: oxidising materials.

Hazardous decomposition products: Under normal conditions of storage and use, hazardous decomposition products should not be produced.

11. TOXICOLOGICAL INFORMATION

Information on toxicological effects

Aspiration hazard

Name: Distillates (petroleum), hydrotreated, light naphthenic **Result:** ASPIRATION HAZARD - Category 1

Information on the likely routes of exposure	Routes of entry anticipated: Dermal, Inhalation.

Potential acute health effects

Eye contact	No known significant effects or critical hazards.
Inhalation	Vapour inhalation under ambient conditions is not normally a problem due to low vapour pressure.
Skin contact	Defatting to the skin. May cause skin dryness and irritation.
Ingestion	Aspiration hazard if swallowed -- harmful or fatal if liquid is aspirated into lungs

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact	No specific data.

Inhalation	May be harmful by inhalation if exposure to vapour, mists or fumes resulting from thermal decomposition products occurs.
Skin contact	Adverse symptoms may include the following: Irritation dryness cracking
Ingestion	Adverse symptoms may include the following: nausea or vomiting

Delayed and immediate effects and also chronic effects from short- and long-term exposure

Eye contact	Potential risk of transient stinging or redness if accidental eye contact occurs.
Inhalation	Overexposure to the inhalation of airborne droplets or aerosols may cause irritation of the respiratory tract.
Skin contact	Prolonged or repeated contact can defat the skin and lead to irritation, cracking and/ or dermatitis.
Ingestion	Ingestion of large quantities may cause nausea and diarrhea.
Potential chronic health effects	
General	No known significant effects or critical hazards.
Carcinogenicity	No known significant effects or critical hazards.
Mutagenicity	No known significant effects or critical hazards.
Teratogenicity	No known significant effects or critical hazards.
Developmental effects	No known significant effects or critical hazards.
Fertility effects	No known significant effects or critical hazards.

12. ECOLOGICAL INFORMATION

Environmental effects : No known significant effects or critical hazards.

Persistence and degradability: Not expected to be rapidly degradable.

Bio accumulative potential: This product is not expected to bioaccumulate through food chains in the environment.

Mobility: Spillages may penetrate the soil causing ground water contamination.

Other adverse effects: No known significant effects or critical hazards.

Other ecological information: Spills may form a film on water surfaces causing physical damage to organisms. Oxygen transfer could also be impaired.

13. DISPOSAL CONSIDERATION

Disposal: The generation of waste should be avoided or minimized wherever possible. Significant quantities of waste product residues should not be disposed of via the foul sewer but processed in a suitable effluent treatment plant. Consult federal, state and local waste regulations to determine appropriate waste characterization of material and allowable disposal methods.

14. TRANSPORT INFORMATION

	IMDG	IATA
UN number	Not regulated.	Not regulated.
UN proper shipping name	-	-
Transport hazard class(es)	-	-
Packing group	-	-
Environmental hazards	No.	No.
Additional information	-	-
Special precautions for user	Not available.	

15. REGULATORY INFORMATIONS

Regulation according to other foreign laws	
Australia inventory (AICS)	All components are listed or exempted.
Canada inventory status	All components are listed or exempted.
China inventory (IECSC)	All components are listed or exempted.
REACH Status	The company, as identified in Section 1, sells this product in the EU in compliance with the current requirements of REACH.
Japan inventory (ENCS)	All components are listed or exempted.
Korea inventory (KECI)	All components are listed or exempted.
Philippine's inventory (PICCS)	All components are listed or exempted.
United States inventory (TSCA 8b)	All components are listed or exempted.
Taiwan inventory (CSNN)	All components are listed or exempted.
Harmful Chemicals List	Not listed

16. OTHER INFORMATION

Further information

PRODUCT NAME : OXYGEN

1. IDENTIFICATION OF THE SUBSTANCE / PREPARATION AND THE COMPANY

Product Name: Oxygen		Chemical Designation: Oxygen	
Trade Name: ----		Synonyms: Molecular oxygen; Oxygen molecule; Pure oxygen; O2; UN 1072; Dioxygen; Oxygen USP, Aviator's Breathing Oxygen (ABO)	
Formula: O2	Label: Category Class: 2.2	CAS Number: 7782-44-7	UN Number: 1072/1073
Regulated Identification: UN Number 1072/1073	Shipping Name Codes / Label: Oxidizer, Nonflammable gas		Hazchem Code: ---

2. HAZARDS IDENTIFICATION

Physical hazards: Oxidizing gases Gases under pressure

Signal word: Danger.

Hazard statement: May cause or intensify fire; oxidizer. Contains gas under pressure; may explode if heated.

Precautionary statement

Prevention: Keep/Store away from clothing and other combustible materials. Keep reduction valves / valves and fittings free from oil and grease.

Response: In case of fire: Stop leak if safe to do so.

Storage: Protect from sunlight. Store in a well-ventilated place.

Disposal: Dispose of waste and residues in accordance with local authority requirements.

Hazard(s) not otherwise classified (HNOC): Contact with liquefied gas may cause frostbite.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Name	Amount	CAS Number
Oxygen	100%	7782-44-7

4. FIRST AID MEASURES

Inhalation If breathing is difficult, remove to fresh air and keep at rest in a position comfortable for breathing. Call a physician if symptoms develop or persist.

Skin contact If frostbite occurs, immerse affected area in warm water (not exceeding 105°F/41°C). Keep immersed for 20 to 40 minutes. Get medical attention immediately.

Eye contact Rinse with water. Get medical attention if irritation develops and persists.

Ingestion Rinse mouth. If ingestion of a large amount does occur, call a poison control center immediately.

Most important symptoms/effects, acute and delayed.

Direct contact with the eyes may cause temporary irritation. Contact with liquefied gas might cause frostbite, in some cases with tissue damage.

Indication of immediate medical attention and special treatment needed.

Provide general supportive measures and treat symptomatically.

General information Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

5. FIRE FIGHTING MEASURES

Suitable extinguishing media Use fire-extinguishing media appropriate for surrounding materials.
Unsuitable extinguishing media

Do not use water jet as an extinguisher, as this will spread the fire.

Specific hazards arising from the chemical.

Contents under pressure. Pressurized container may explode when exposed to heat or flame.

Greatly increases the burning rate of combustible materials. Fire may produce irritating, corrosive and/or toxic gases. During fire, gases hazardous to health may be formed.

Special protective equipment and precautions for firefighters

Firefighters must use standard protective equipment including flame retardant coat, helmet with face shield, gloves, rubber boots, and in enclosed spaces, SCBA. In the event of fire, wear self-contained breathing apparatus.

Fire-fighting equipment/instructions.

In case of fire: Stop leak if it is safe to do so. Allow gas to burn if flow cannot be shut off immediately. Apply water from safe distance to cool container and protect surrounding area. Cylinders can burst violently when heated, due to excess pressure build-up. Remove pressurized gas cylinders from the immediate vicinity. Move containers from fire area if you can do so without risk. Do not direct water at source of leak or safety devices as icing may occur. Use water spray to cool unopened containers. Evacuate area and fight fire from a safe distance.

General fire hazards Greatly increases the burning rate of combustible materials.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Keep out of low areas. Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). Wear appropriate personal protective equipment. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ventilate closed spaces before entering them. Local authorities should be advised if significant spillages cannot be contained.

Methods and materials for containment and cleaning up

Extinguish all flames in the vicinity. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Stop leak if you can do so without risk. If possible, turn leaking containers so that gas escapes rather than liquid. Isolate area until gas has dispersed. Water may be used to flush spills away from sources of ignition. Do not get water inside container. Prevent entry into waterways, sewer, basements or confined areas. Following product recovery, flush area with water.

Environmental precautions Runoff from fire control or dilution water may cause pollution.

7. HANDLING AND STORAGE

Precautions for safe handling Do not handle, store or open near an open flame, sources of heat or sources of ignition. Protect material from direct sunlight. Keep away from combustible material. Keep reduction valves free from grease and oil. Provide adequate ventilation. Wear appropriate personal protective equipment. Observe good industrial hygiene practices. Use care in handling/storage.

Conditions for safe storage, including any incompatibilities.

Keep away from heat and sources of ignition. Store in original tightly closed container. Store in a cool, dry place out of direct sunlight. Store in a well-ventilated place. Secure cylinders in an upright position at all times, close all valves when not in use. Store away from incompatible materials. Do not store near combustible materials.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational exposure limits No exposure limits noted for ingredient(s).
Biological limit values No biological exposure limits noted for the ingredient(s).
Appropriate engineering controls: Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.
Individual protection measures, such as personal protective equipment

Eye/face protection Not normally needed. If contact is likely, safety glasses with side shields are recommended.

Hand protection Not normally needed. For prolonged or repeated skin contact use suitable protective gloves.

Other Wear suitable protective clothing.

Respiratory protection No personal respiratory protective equipment normally required.

Thermal hazards Wear appropriate thermal protective clothing, when necessary.

General hygiene considerations

When using, do not eat, drink or smoke. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. PHYSICAL & CHEMICAL PROPERTIES

Appearance & Physical state:	Gas.
Form:	Compressed gas.
Colour:	Not available.
Odour:	Not available.
Odour threshold:	Not available.
pH:	Not available.
Melting point/freezing point:	-361.12 °F (-218.4 °C)
Initial boiling point and boiling range:	-297.33 °F (-182.96 °C)
Flash point:	Not available.
Evaporation rate:	Not available.
Flammability (solid, gas):	Not available.
Vapour pressure:	4053 kPa at -124.1 °C
Critical temperature:	-181.48 °F (-118.6 °C)
Molecular formula:	O_2
Molecular weight:	32 g/mol
Oxidizing properties:	Oxidizing.

10. STABILITY & REACTIVITY

Reactivity: The product is stable and non-reactive under normal conditions of use, storage and transport.

Chemical stability: Material is stable under normal conditions.
Possibility of hazardous reactions: Hazardous polymerization does not occur.

Conditions to avoid Keep away from combustible material. Greatly increases the burning rate of combustible materials.

Keep away from heat/sparks/open flames/hot surfaces. - No smoking.

Incompatible materials: Strong reducing agents.

Hazardous decomposition products: No hazardous decomposition products are known.

11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure

Ingestion : No adverse effects due to ingestion are expected.

Inhalation : No adverse effects due to inhalation are expected.

Skin contact : No adverse effects due to skin contact are expected. Exposure to rapidly expanding gas or vaporizing liquid may cause frostbite ("cold burn").

Eye contact : Direct contact with eyes may cause temporary irritation.
Symptoms related to the physical, chemical and toxicological characteristics : Direct contact with eyes may cause temporary irritation.
Information on toxicological effects

Acute toxicity: Human evidence indicates that the product has very low acute oral, dermal or inhalation toxicity.

Skin corrosion/irritation: Prolonged skin contact may cause temporary irritation. Contact with liquefied gas might cause frostbite, in some cases with tissue damage.

Serious eye damage/eye irritation:

Direct contact with eyes may cause temporary irritation.

Respiratory or skin sensitization

Respiratory sensitization : Not a respiratory sensitizer.
Skin sensitization : This product is not expected to cause skin sensitization.
Germ cell mutagenicity : No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

Carcinogenicity : This product is not considered to be a carcinogen by IARC, ACGIH, NTP, or OSHA.

Reproductive toxicity This product is not expected to cause reproductive or developmental effects.
Specific target organ toxicity -single exposure

Not classified.

Specific target organ toxicity
- repeated exposure

Not classified.

Aspiration hazard Not likely, due to the form of the product.

12. ECOLOGICAL INFORMATION

Eco toxicity : Not expected to be harmful to aquatic organisms.

Persistence and degradability: No data is available on the degradability of this product.
Bio accumulative potential : No data available.
Mobility in soil : No data available.
Other adverse effects : No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

13. DISPOSAL CONSIDERATION

Disposal instructions : Consult authorities before disposal. This material and its container must be disposed of as hazardous waste. Do not allow this material to drain into sewers/water supplies. Do not contaminate ponds, waterways or ditches with chemical or used container. Dispose of contents/container in accordance with local/regional/national/international regulations.

Local disposal regulations: Dispose in accordance with all applicable regulations.
Hazardous waste code: The waste code should be assigned in discussion between the user, the producer and the waste disposal company.

Waste from residues / unused products: Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner**.**

Contaminated packaging Empty containers should be taken to an approved waste handling site for recycling or disposal. Since emptied containers may retain product residue, follow label warnings even after container is emptied.

14. TRANSPORT INFORMATION

DOT

UN number UN1072
UN proper shipping name Oxygen, compressed
Class 2.2
Transport hazard class(es)
Subsidiary risk 5.1
Packing group -
Special precautions for user Read safety instructions, SDS and emergency procedures before handling.
ERG number 122

IATA

UN number UN1072
UN proper shipping name Oxygen, compressed
Class 2.2
Transport hazard class(es)
Subsidiary risk 5.1
Label(s) 2.2, 5.1

Packing group -
Environmental hazards No.
Special precautions for user Read safety instructions, SDS and emergency procedures before handling.

IMDG

UN number UN1072
UN proper shipping name Oxygen, compressed
Class 2.2
Transport hazard class(es)
Subsidiary risk 5.1
Label(s) 2.2, 5.1

Packing group - Marine pollutant No. Environmental hazards EmS F-C, S-W
Special precautions for user Read safety instructions, SDS and emergency procedures before handling.
Transport in bulk according to Not applicable.

15. REGULATORY INFORMATIONS

US federal regulations All components are on the U.S. EPA TSCA Inventory List.

This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

16. OTHER INFORMATION

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^{0}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.

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

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^{0}C
2.	High Speed Diesel		Specific Gravity = 0.85 Flash Point = >32^{0}C Pour Point = 60^{0}C Viscosity = 2 to 7.5 cst Sulphur Content = 1%
3.	Furnace Oil		Specific Gravit = 0.92 – 0.96 Flash Point = 66^{0}C Pour Point = 18^{0}C Viscosity = 180 cst Sulphur Content = 4 %
4.	Sulphuric Acid	98.6 %	Specific Gravity = 1.846 Temperature = 40^{0}C
5.	Phosphoric Acid	26% 58%	Specific Gravity = 1.32 Temperature = 30^{0}C Specific Gravity = 1.7 Temperature = 30^{0}C
6.	Sulphur	99%	Specific Gravity = 1.84 Temperature = 35^{0}C
7.	Transformer oil	99.9 %	Specific Gravity = 0.88 Temperature = 35^{0}C
8.	Caustic soda	48.9 %	Specific Gravity = 1.53 Temperature = 35^{0}C
9.	Oxygen	99.99 %	Specific Gravity = NA Boiling Point (oC) = -183°C Melting / Freezing Point (Oc) = - 219°C Vapour Density(air =1) = 1.11 Solubility in water @ 300C= 0.039 g/l

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 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

3. Furnace Oil Storage Tank

(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

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. 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. 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 . 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 individuals 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).3. 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 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 Iodine Oxide, and such reactions may lead to explosions. When mixed with metals like powered 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).4. 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, were 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) HSD Storage Tanks
(iii) 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.

Chapter – 6

6. DESCRIPTION OF SAFETY RELEVANT UNITS, AMONG OTHERS

6.(a) SPECIAL DESIGN CRITERIA

Ammonia Storage Tanks are designed to store liquid ammonia at atmospheric pressure under refrigerated conditions (Storage Temperature = - 33^0C).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.

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 -33^0C.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 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.

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^3.

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^3/hr at a discharge pressure of 8.0 kg/cm^2.

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.

Chapter - 7

7. 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. Fire in HSD storage tank
3. 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

a. Full Failure of Liquid Ammonia Outlet Line (after first flange)
b. Partial Failure of Liquid Ammonia Outlet Line (after first flange)
c. Ammonia Pumps' Seal failure
d. Partial Failure of Discharge Line of Ammonia Pumps.
e. Catastrophic Failure of one of the Ammonia Storage Tanks

C. Furnace Oil Storage Tank

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. 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.

Sl.No.	Failure Scenario	Probable Failure Frequency (per year) (Approximately)
1.0	**During Ammonia Unloading from Ship Tankers**	
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}
1.5	Guillotine Rupture of the Cross-country Pipeline	10^{-6}
2.0	**Ammonia Storage Tanks**	
2.1	Full (100%) Failure of Bottom Outlet Nozzle	9.29×10^{-5}
2.2	Partial (20%) Failure of Bottom Outlet Nozzle	3.41×10^{-3}
2.3	Ammonia Transfer Pump Seal Failure	3.10×10^{-3}
2.4	Partial (20%) Failure of Ammonia Transfer Pump Discharge Line	2.19×10^{-4}
2.5	Catastrophic Failure of one of the Storage Tanks	10^{-12}
3.0	**HSD Storage Tank**	
4.1	Storage Tank Top Fire	10^{-4}
4.2	Full (100%) Failure of Bottom Outlet Nozzle	8.76×10^{-6}
4.3	Partial (20%) Failure of Bottom Outlet Nozzle	2.54×10^{-5}
4.4	Transfer Pump Seal Failure	7.11×10^{-3}
4.0	**Furnace Oil Storage Tank**	
5.1	Storage Tank Top Fire	10^{-4}
5.2	Full (100%) Failure of Bottom Outlet Nozzle	8.76×10^{-6}
5.3	Partial (20%) Failure of Bottom Outlet Nozzle	2.54×10^{-5}
5.4	Transfer Pump Seal Failure	**7.11** 10^{-3}
5.0	**Oxygen Plant**	
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 Jt. General Manager (F&S), who is qualified and is well experienced in the field. He is presently supported by 03 Deputy Managers (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

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.

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.

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 32 nos 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

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.

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 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 HAZRDOUS 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' 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.

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. 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 in 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 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 market 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 he 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 5Te.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 takes 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

<u>Damage Caused at Different Incident Levels of Thermal Radiation</u>

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:

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

INCIDENT RADIATION INTENSITY (kW / m^2)	EXTENT OF DAMAGE
117.0	50% lethally after 4 secs. exposure
66.0	1% lethally after 4 secs. exposure
37.5	Sufficient to cause damage to process 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 (1st 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
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 = 32^0C (305^0K)
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.

9.(b) POSSIBLE DISPERSION OF RELEASED CHEMICALS:

9. (b).1 Case-1

Leakage of Ammonia from Ammonia Storage Tank

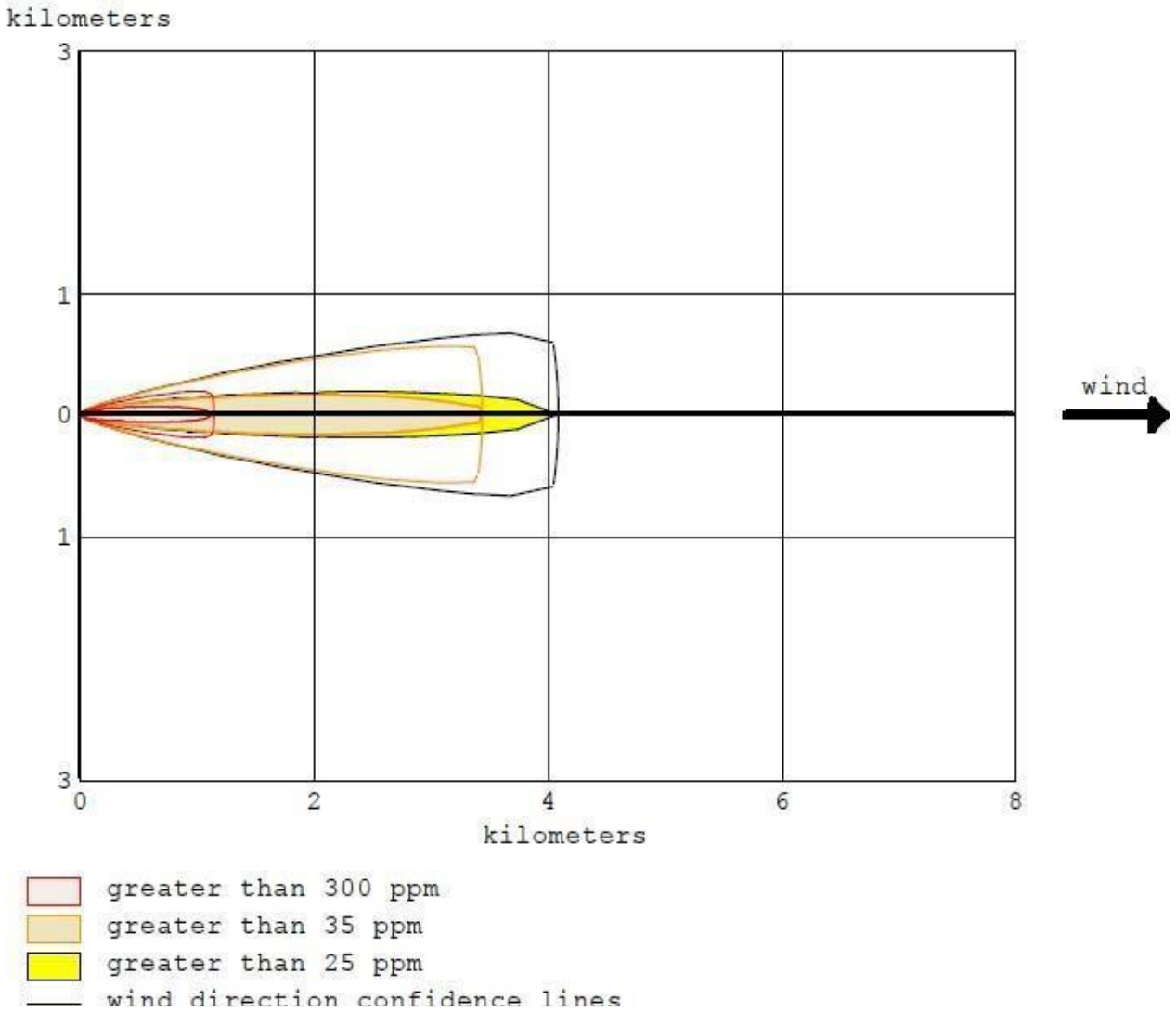
RAINY SEASON

Text Summary ALOHA® 5.4.7

```
 SITE DATA:
   Location: PARADIP, INDIA
   Building Air Exchanges Per Hour: 1.33 (unsheltered single storied)
   Time: March 30, 2024  1548 hours DST (using computer's clock)

 CHEMICAL DATA:
   Chemical Name: AMMONIA
   CAS Number: 7664-41-7                    Molecular Weight: 17.03 g/mol
   AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100
ppm
   IDLH: 300 ppm      LEL: 150000 ppm      UEL: 280000 ppm
   Ambient Boiling Point: -33.4° C
   Vapor Pressure at Ambient Temperature: greater than 1 atm
   Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

 ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
   Wind: 7 meters/second from WSW at 10 meters
   Ground Roughness: open water             Cloud Cover: 5 tenths
   Air Temperature: 24° C                   Stability Class: D
   No Inversion Height                      Relative Humidity: 99%

 SOURCE STRENGTH:
   Leak from hole in vertical 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: -33.3° C
   Chemical Mass in Tank: 18500 tons        Tank is 75% 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: 201 kilograms/min
      (averaged over a minute or more)
   Total Amount Released: 12,042 kilograms
   Note: The chemical escaped as a mixture of gas and aerosol (two phase
flow).

 THREAT ZONE:
   Model Run: Heavy Gas
   Red    : 1.1 kilometers --- (300 ppm)
   Orange: 3.4 kilometers --- (35 ppm)
   Yellow: 4.1 kilometers --- (25 ppm)
```

Toxic Threat Zone ALOHA® 5.4.7

```
Time: March 30, 2024  1548 hours DST (using computer's clock)

Chemical Name: AMMONIA

Wind: 7 meters/second from WSW at 10 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 1.1 kilometers --- (300 ppm)
  Orange: 3.4 kilometers --- (35 ppm)
  Yellow: 4.1 kilometers --- (25 ppm)
```



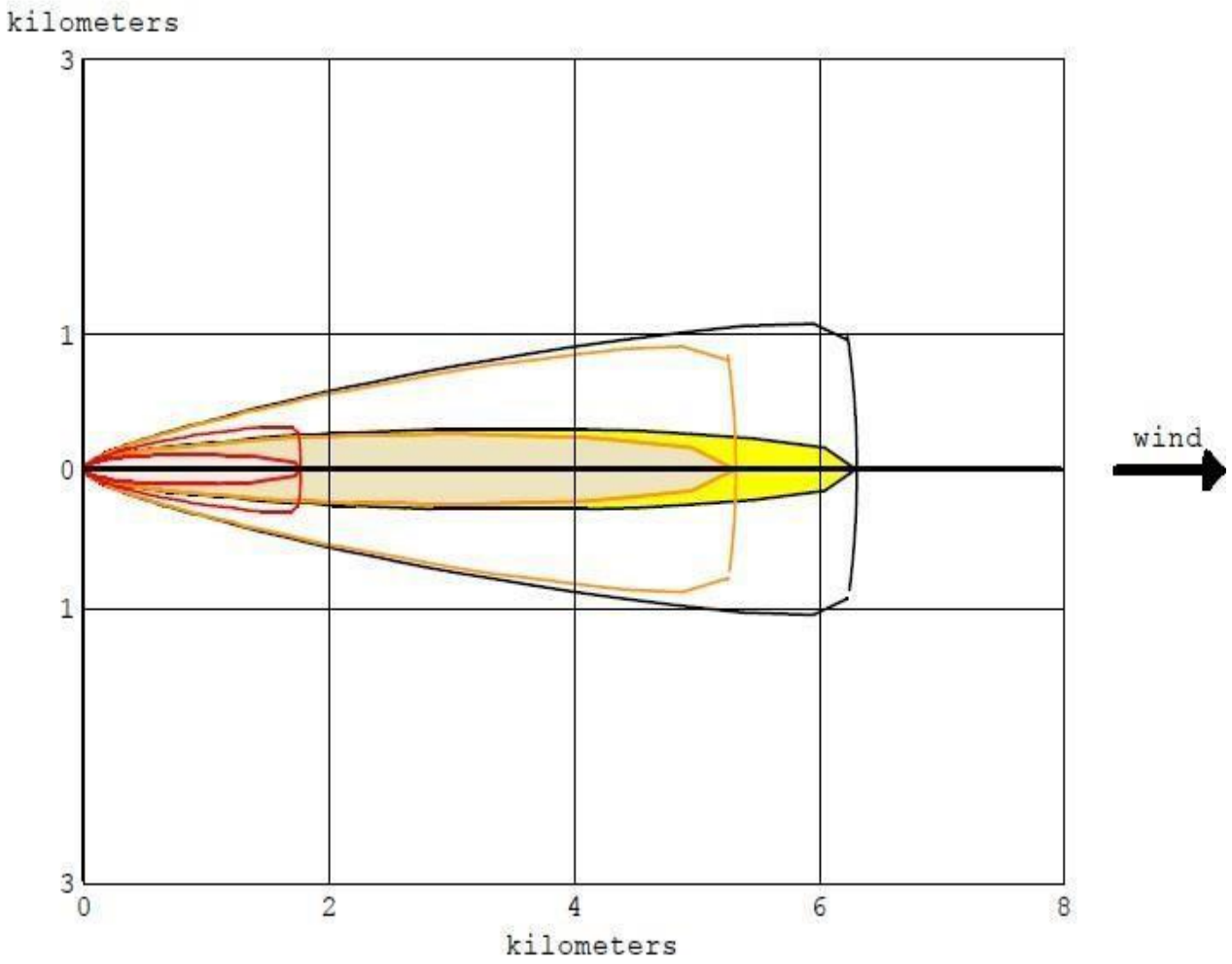
WINTER SEASON

Text Summary ALOHA® 5.4.7

```
 SITE DATA:
   Location: PARADIP, INDIA
   Building Air Exchanges Per Hour: 0.97 (unsheltered single storied)
   Time: March 30, 2024  1032 hours DST (using computer's clock)

 CHEMICAL DATA:
   Chemical Name: AMMONIA
   CAS Number: 7664-41-7                    Molecular Weight: 17.03 g/mol
   AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100
ppm
   IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm
   Ambient Boiling Point: -33.4° C
   Vapor Pressure at Ambient Temperature: greater than 1 atm
   Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

 ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
   Wind: 5 meters/second from NNE at 10 meters
   Ground Roughness: open water            Cloud Cover: 10 tenths
   Air Temperature: 16° C                  Stability Class: D
   Inversion Height: 11 meters             Relative Humidity: 75%

 SOURCE STRENGTH:
   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: -33.3° C
   Chemical Mass in Tank: 18000 tons       Tank is 73% 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: 298 kilograms/min
      (averaged over a minute or more)
   Total Amount Released: 17,889 kilograms
   Note: The chemical escaped as a mixture of gas and aerosol (two phase
flow).
```

Toxic Threat Zone ALOHA® 5.4.7

```
Time: March 30, 2024  1032 hours DST (using computer's clock)

Chemical Name: AMMONIA

Wind: 5 meters/second from NNE at 10 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 1.8 kilometers --- (300 ppm)
  Orange: 5.3 kilometers --- (35 ppm)
  Yellow: 6.3 kilometers --- (25 ppm)
```



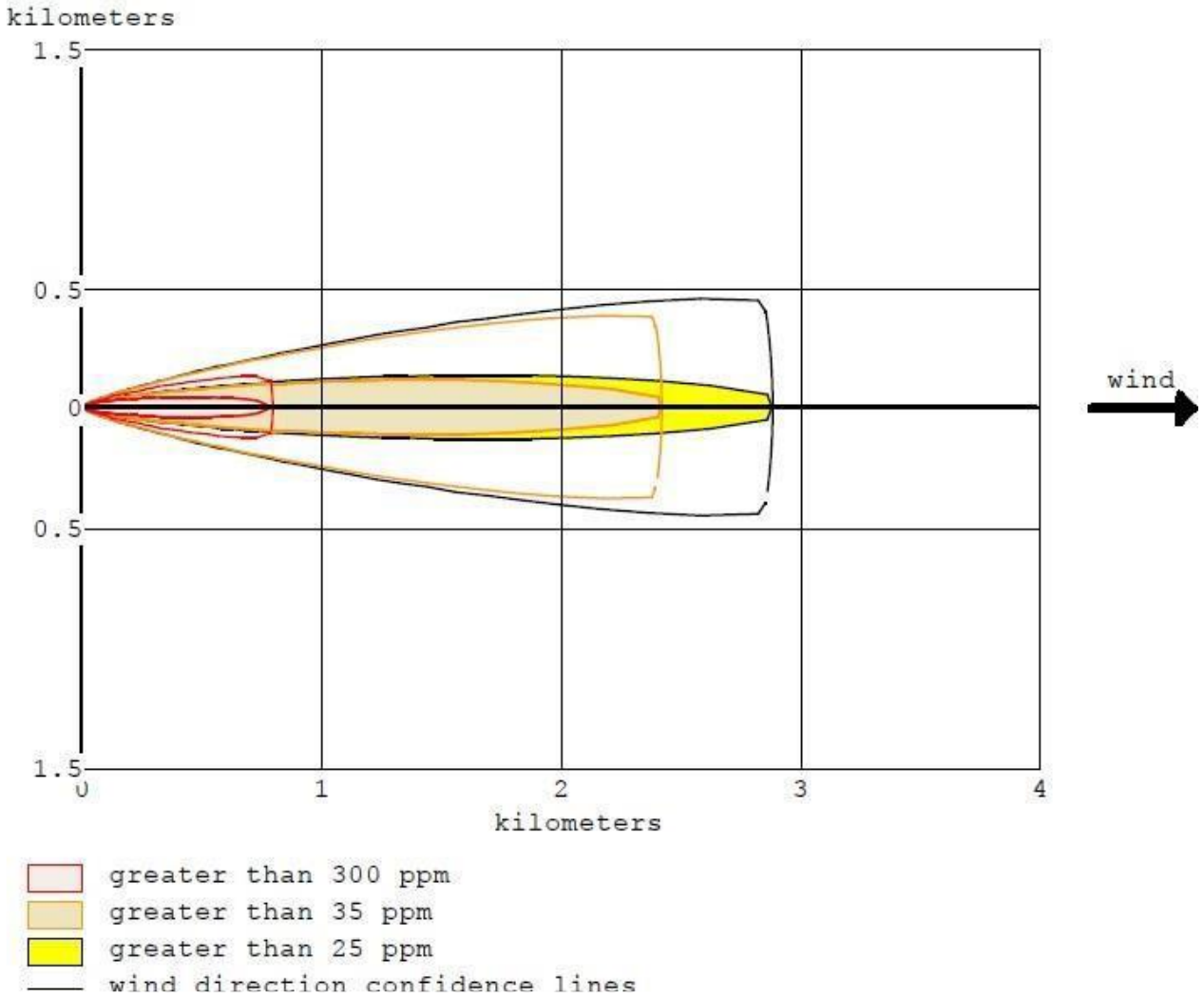
SUMMER SEASON

Text Summary ALOHA® 5.4.7

```
 SITE DATA:
   Location: PARADIP, INDIA
   Building Air Exchanges Per Hour: 2.24 (unsheltered single storied)
   Time: April 2, 2024  1453 hours DST (using computer's clock)

 CHEMICAL DATA:
   Chemical Name: AMMONIA
   CAS Number: 7664-41-7                    Molecular Weight: 17.03 g/mol
   AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100
ppm
   IDLH: 300 ppm      LEL: 150000 ppm      UEL: 280000 ppm
   Ambient Boiling Point: -33.4° C
   Vapor Pressure at Ambient Temperature: greater than 1 atm
   Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

 ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
   Wind: 12 meters/second from sw at 10 meters
   Ground Roughness: open water            Cloud Cover: 0 tenths
   Air Temperature: 39° C                  Stability Class: D
   No Inversion Height                     Relative Humidity: 90%

 SOURCE STRENGTH:
   Leak from hole in vertical 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: -33.3° C
   Chemical Mass in Tank: 18500 tons       Tank is 75% 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: 201 kilograms/min
      (averaged over a minute or more)
   Total Amount Released: 12,042 kilograms
   Note: The chemical escaped as a mixture of gas and aerosol (two phase
flow).

 THREAT ZONE:
   Model Run: Heavy Gas
   Red    : 790 meters --- (300 ppm)
   Orange: 2.4 kilometers --- (35 ppm)
   Yellow: 2.9 kilometers --- (25 ppm)
```

Toxic Threat Zone ALOHA® 5.4.7

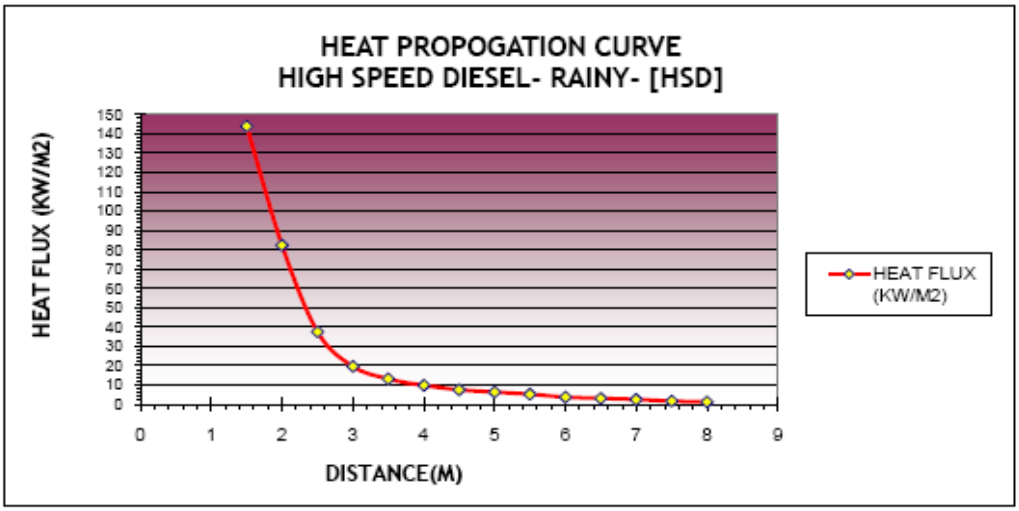
```
Time: April 2, 2024  1453 hours DST (using computer's clock)

Chemical Name: AMMONIA

Wind: 12 meters/second from sw at 10 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 790 meters --- (300 ppm)
  Orange: 2.4 kilometers --- (35 ppm)
  Yellow: 2.9 kilometers --- (25 ppm)
```



9.(b).2 Case-2

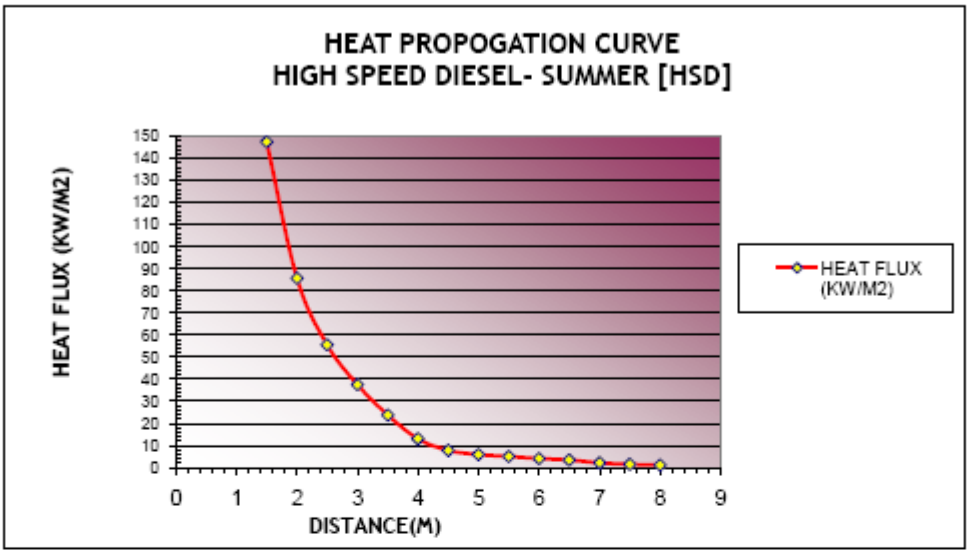
Fire on HSD Storage Tank

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

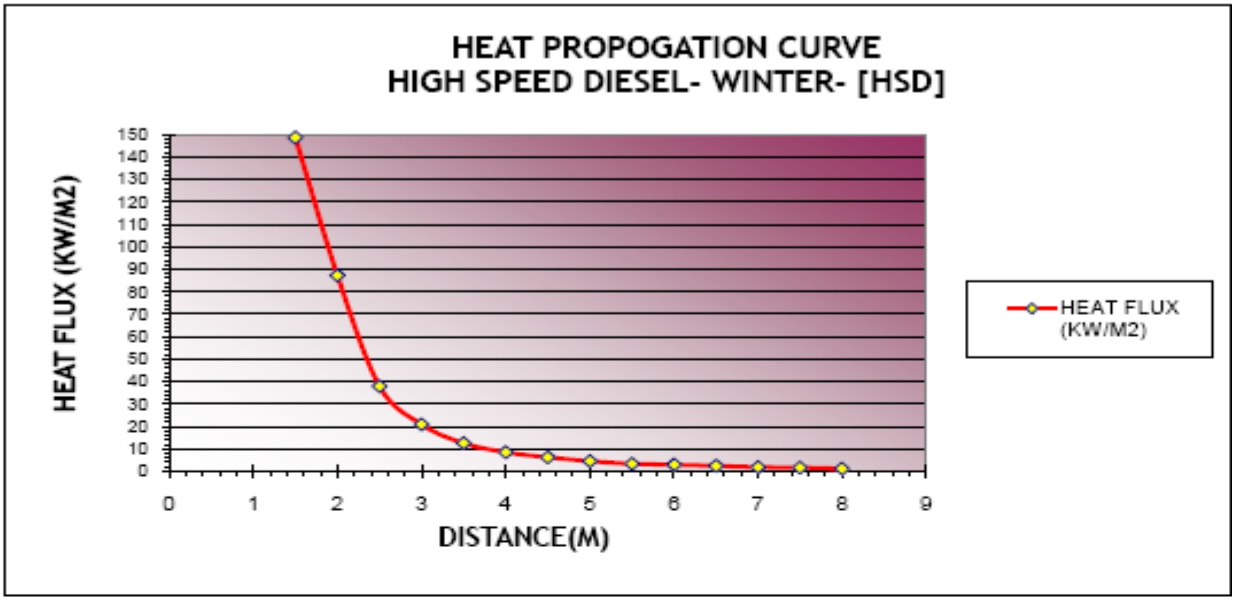
MODELING OF *HIGH SPEED DIESEL (HSD)*
IN SUMMER SEASON



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

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

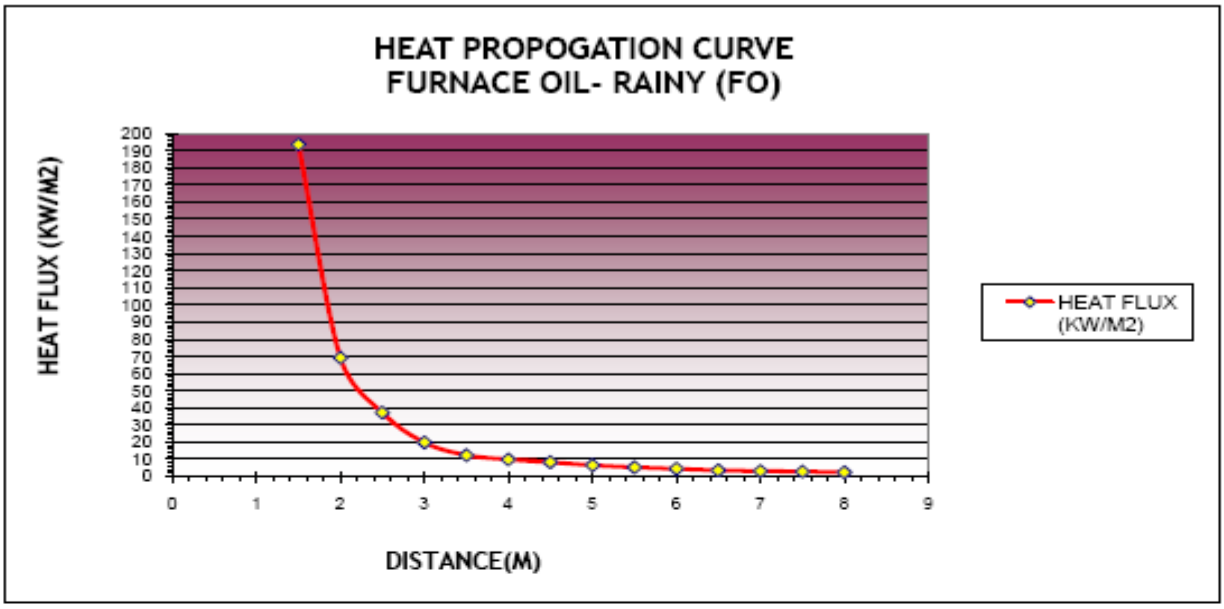


POOLFIRE MODEL - HIGH SPEED DIESEL- WINTER- [HSD]	
DISTANCE(M)	HEAT FLUX (KW/M2)
1.5	148.6
2	87.2
2.5	37.9
3	20.8
3.5	12.5
4	8.4
4.5	6.2
5	4.5
5.5	3.3
6	2.9
6.5	2.4
7	1.8
7.5	1.6
8	1.1

9.(b) 3. Case-3

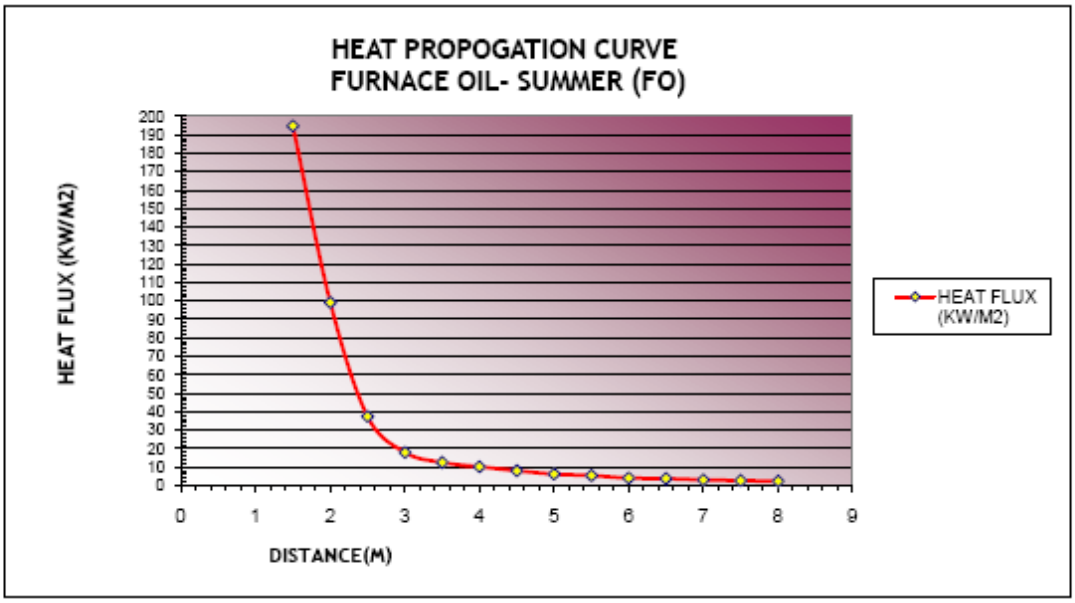
Fire on FO Storage Tank

MODELING OF *FURNACE OIL (FO)* RAINY SEASON



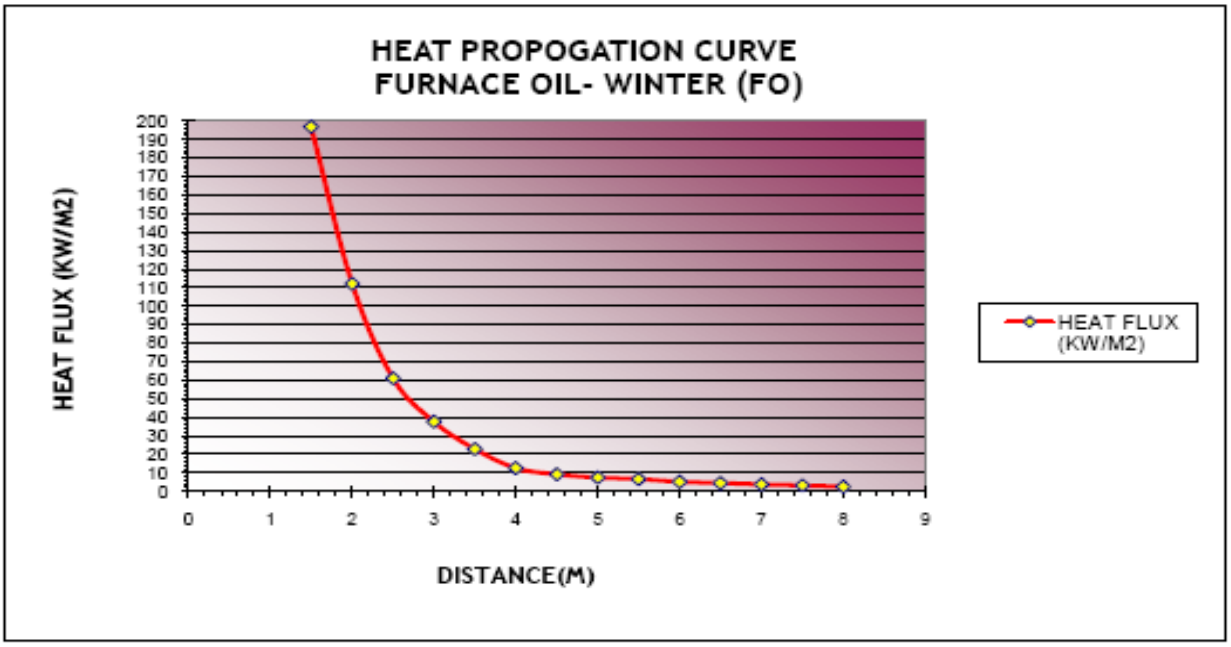
POOLFIRE MODEL - FURNACE OIL- RAINY (FO)	
DISTANCE(M)	HEAT FLUX (KW/M2)
1.5	193.5
2	69.3
2.5	37.2
3	19.8
3.5	12.5
4	9.9
4.5	8.3
5	6.6
5.5	5.4
6	4.5
6.5	3.6
7	3.2
7.5	2.9
8	2.4

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

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

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	2.9	4.1	6.3	No adverse effect
	STEL (15 Min Exposure) 30 PPM	2.4	3.4	5.3	No adverse effect
	IDLH (30 min Exposure) 300 PPM	0.79	1.1	1.8	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;
  Materials corrosive to living tissue or toxic by skin absorption.

9.(c)2 Fire on HSD Storage Tank:

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 > 66^0C and auto ignition temperature of 225^0C 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 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°F (37.8°C), but not exceeding 200°F (93.4°F);
- Solids and semisolids which readily give off flammable vapors.

9.(c) 3 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^{o}C and auto ignition temperature of 220-300^{0} 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 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°F (37.8°C), but not exceeding 200°F (93.4°F);
- Solids and semisolids which readily give off flammable vapors.

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

Chapter – 10

10 INFORMATION ON THE MITIGATION OF MAJOR ACCIDENTS

10. (a) Fire Brigade

Presently, the Fire & Safety Department of IFFCO is led by Jt. G.M. (Fire & Safety), who is qualified and is well experienced in the field. He is presently supported by 03 nos Deputy Managers (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 trained, qualified & experinced fire fighting squad led by three qualified, trained & experienced Fire Engineers for controlling major fire emergencies inside the plant premises. About eight trained & experienced firefighting personnel (including Fire Inspector ,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 Authority in the event of major fire emergencies.

Fire Station

A Fire Station, manned by trained,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.

Fire Tenders (Water Tender & Water cum-Foam Tender) : 04 nos
Fire Jeeps : 03 nos

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

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 m3/hr.

Storage Tank Capacity

There is one fire water storage tank of 6600 M^3 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.

Fire water Pumps

Fire Water Pump Data
4 Nos of Electrical driven Main Pumps with a capacity of 273 M^3/Hr at a head of 88 mts
2 Nos of Diesel driven Main Pumps with a capacity of 273 M^3/Hr at a head of 88 mts

Jockey Pumps

2 Nos of Electrical driven Jockey Pumps with a capacity of 35 M^3/Hr at a head of 88 mts

Details of Fire Fighting Systems Plant Wise

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^2

S. No.	Plant	Hydrant		Monitor	No. of Risers	Manual Water Spray System
		1 way	2 way			
1.	Sulphuric Acid Plant	45	04	12	02	02
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 Conveyor**	**114**	**-**	**-**	**-**	**-**
Total		**332**	**10**	**35**	**09**	**02**

❖ **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_2 flooding system for Turbine generator I & II.
- Smoke detection system in Plant buildings and offices.
- Automatic modular type fire extinguisher in UPS battery rooms.

❖ **Other Fire Protection Systems:**

➢ **Fire Protection Facilities in HSD & FO Storage Tank Area**

The HSD (High-Speed Diesel) and FO (Furnace Oil) storage tank area is categorized as a high fire-risk zone due to the flammable nature of the stored petroleum products. To ensure adequate fire prevention, detection, and control, a comprehensive fire protection system has been implemented in accordance with the guidelines prescribed by the Oil Industry Safety Directorate (OISD), Petroleum and Explosives Safety Organisation (PESO), and relevant IS/NFPA standards.

1. Fixed Fire Fighting System

Foam-Based Fire Suppression System

- Fixed foam chambers are installed on all tanks to deliver Aqueous Film Forming Foam (AFFF) effectively over the tank surface in the event of a surface fire.
- Foam concentrate tanks and inline proportioning systems are provided to ensure reliable and efficient foam generation and distribution.

MVWS (Medium Velocity Water Spray) System

- An automatic water spray system is installed around the tanks to reduce radiant heat and minimize the risk of fire escalation to adjacent tanks and equipment.

2. Hydrant and Monitor System

Hydrant Ring Main

- A dedicated fire water ring main system encircles the tank farm area, ensuring continuous water supply during fire emergencies.
- Hydrants are strategically located to ensure comprehensive coverage of the tank area and associated facilities.

HVLR Monitors

- High Volume Long Range (HVLR) water-cum-foam monitors are ground-mounted at key locations.

- These are designed to provide effective fire suppression for large surface areas and critical equipment zones.

3. Portable and Mobile Firefighting Equipment

- Adequate numbers of DCP (Dry Chemical Powder) and CO_2-type portable fire extinguishers are installed at key operational points across the storage area.
- Portable firefighting equipment is regularly inspected and maintained to ensure readiness at all times.

4. Additional Safety Measures

- Dyke walls and drainage systems are constructed around each tank to contain potential spills and prevent fire spread.
- Flame arrestors and breather valves are installed on tank vents to control flammable vapours and prevent flashback.
- No smoking zones, spark control measures, and restricted access areas are clearly marked and strictly enforced.
- Regular mock drills, fire safety training, and internal fire safety audits are conducted to assess and improve emergency preparedness.

➢ **Fire Protection Facilities in Transformer Area**

The transformer area is categorized as a high fire-risk zone due to the presence of flammable insulating oil and high-voltage electrical equipment. In the event of internal faults or external thermal stress, transformer oil can catch fire, posing serious risks to life, equipment, and facility operations.
To mitigate this risk, the following fixed fire protection systems are implemented in accordance with the provisions of the National Electrical Code (NEC) 2023 and the National Building Code (NBC) 2016) of India.

As per NEC 2023 and NBC 2016 guidelines, transformers with a rating above 10 MVA shall be provided with either a High Velocity Water Spray (HVWS) System or a Nitrogen Injection Fire Protection System (NIFPS).

1. High Velocity Water Spray (HVWS) System

The HVWS system is a fixed fire suppression system designed to rapidly cool the external surfaces of the transformer and suppress oil fires. It targets the transformer radiators, conservator tank, and main body using directional spray nozzles. The system is activated automatically through a Quick-Response Bulb Detector (QBD) or manually via a local control panel. It effectively cools the transformer surface and suppresses surface oil fires to prevent escalation.

2. Nitrogen Injection Fire Protection System

The Nitrogen Injection System is a specialized fire suppression system suitable for large power transformers, particularly those critical to continuous operation. It extinguishes fire by displacing oxygen inside the transformer tank through the injection of high-pressure nitrogen, thereby stopping the combustion process internally. This method is minimally invasive to internal components and allows for faster restoration after a fire incident.

❖ **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.
4.	AFFF Foam (3%)	4500 Lts.
5.	Portable Water Monitor	05 Nos.
6.	B.A. Set	60 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 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)	200 Nos.
16.	Hot Liquid Resistance Suit	50 Nos.
17.	Arch Flash Suit	03 Nos.
18.	Refractive Jacket	400 Nos.
19.	Multi Gas Detector/Explosimeter (LEL/O2)	09 Nos.
20.	Heat Resistant Blanket	10 Nos.
21.	Ear Plug	400 Nos.
22.	Ear Muff	50 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.

❖ **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**

---------- 0FF----------OFF----------OFF---------- 0FF----------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**

---------- 0FF----------OFF---------- OFF---------- 0FF----------OFF **(Ten Times)**
(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
- 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
- Portable Fire extinguishers of different types including DCP, CO_2, 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_2 Extinguisher	Fixed Modular Type	Clean agent	Fire Ball	
		6 Kg	2 Kg/4.5 Kg	**5 kg**	**2 kg**	**1.3 kg**	**Total**
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
	TOTAL	**291**	**499**	**56**	**130**	**150**	**1126**

❖ **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
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 updated On-site Emergency Plan was approved and accepted by Director of Factories & Boilers on dt. 10.07.2024.

10.(d) COORDINATION WITH THE DISTRICT COLLECTOR OR DISTRIC 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.

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.

*****