REPORT ON

Assessment of Hazardous Waste Management and Air Quality Management at M/s Madras Fertilizer Limited

Prepared by

Dr. S. Mathava Kumar

Environmental & Water Resources Engg. Division

Department of Civil Engineering

Indian Institute of Technology Madras

Chennai - 600036, India

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INTRODUCTION

1.1.General

Madras fertilizer limited (MFL) has been serving the nation for the past 41 years since plant commissioning in 1971 and is a part of India's green revolution. MFL is one of the largest fertilizer companies in the country which engages in the manufacture of urea, ammonia, and NPK complex fertilizer. The factory is a state-owned enterprise with the Government of India holding 67.55% of the equitable share capital. MFL has its plant and headquarters in Manali industrial complex, on the outskirts of Chennai.

The Manali industrial complex (MIC) is one of the largest petrochemical complexes in the country and has been listed in the critically polluted industrial clusters of India by the central pollution control board (CPCB). The comprehensive Environmental Pollution Index (CEPI) score for this complex is 76.32 (CPCB, 2009). The complex host many medium to large scale industries of which 14 industries belong to highly polluting red category industries (TNPCB,2010). The land use of the Manali area is covered with 45% industries, 29% built up, 16% fallow region, and 10% vegetation (Panda et al., 2017). The average temperature is around 29°C. The average annual rainfall lies between 100-120 cm and the relative humidity varies between 70-80%.

Table.1.1 Red category industries and their principal air pollutants in the Manali complex.

Sl. No	Name of the Industry	Type	Industry principal air pollutants
1.	Chennai Petroleum Corporation Ltd.	Petroleum Refinery	VOC & HC
2.	Madras Fertilizers Ltd	Fertilizer	NH_3 & HF
3.	Tamilndu Petro Products Ltd (LAB)	Petrochemical	CO
4.	Tamilnadu Petro Products Ltd-ECH	Petrochemical	VOC
5.	Tamilnadu Petro Products Ltd-HCD	Caustic Soda.	NH_3 (NH_4Cl_2)
6.	Manali Petro Chemical Ltd-I	Petrochemical	VOC
7.	Manali Petro Chemical Ltd-II	Petrochemical	VOC
8.	Balmer & Lawrie & Co Ltd	Leather chemical	Cl_2
9.	Supreme Petrochemicals Ltd	Petrochemical	VOC
10.	Indian additives Ltd	Additives	H_2S & VOC
11.	Kothari Petrochemicals Ltd.	Petrochemical	VOC
12.	NATCO Organics Ltd.	Bulk Drug	VOC
13.	CETEX Petrochemicals Ltd	Petrochemical	VOC
14.	Petro Araldite Private Ltd	Adhesives	VOC

The complex host many petrochemical industries which derives petroleum products and petrochemical intermediates from crude oil. Hence the air pollutants in this locality will be mostly in the form of smoke, particulate matter (PM), hydrocarbons, oxides of sulphur and nitrogen, carbon monoxide, and VOC. The details of the highly polluting red category industries and their principal air pollutants in MIC are highlighted in Table.1.1.

Spillage of chemical raw material and hazardous/non-hazardous waste during handling and storage are the main sources of soil contamination. This may also leach during rains causing contamination to ground and surface water.

According to TNPCB, 2010, the soil texture in this complex is silty loam and its pH value was ranging between 7.54 to 8. The electrical conductivity and sodium absorption ratio of the soil was in the range of 1.38 to 1.68 ds/m and 2.14-2.98 respectively which indicates that the soil is slightly saline. The concentration of heavy metals (As, Cd, Co, Cr, Cu, Mn, Ni, Pb, Zn) in the soil was found in acceptable limits.

The air quality in MIC is monitored by CPCB and Tamil Nadu pollution control board (TNPCB) using the continuous ambient air quality monitoring (CAAQM) stations installed at Chinnasekadu and Periya Thoppu respectively (Figure.1.1).

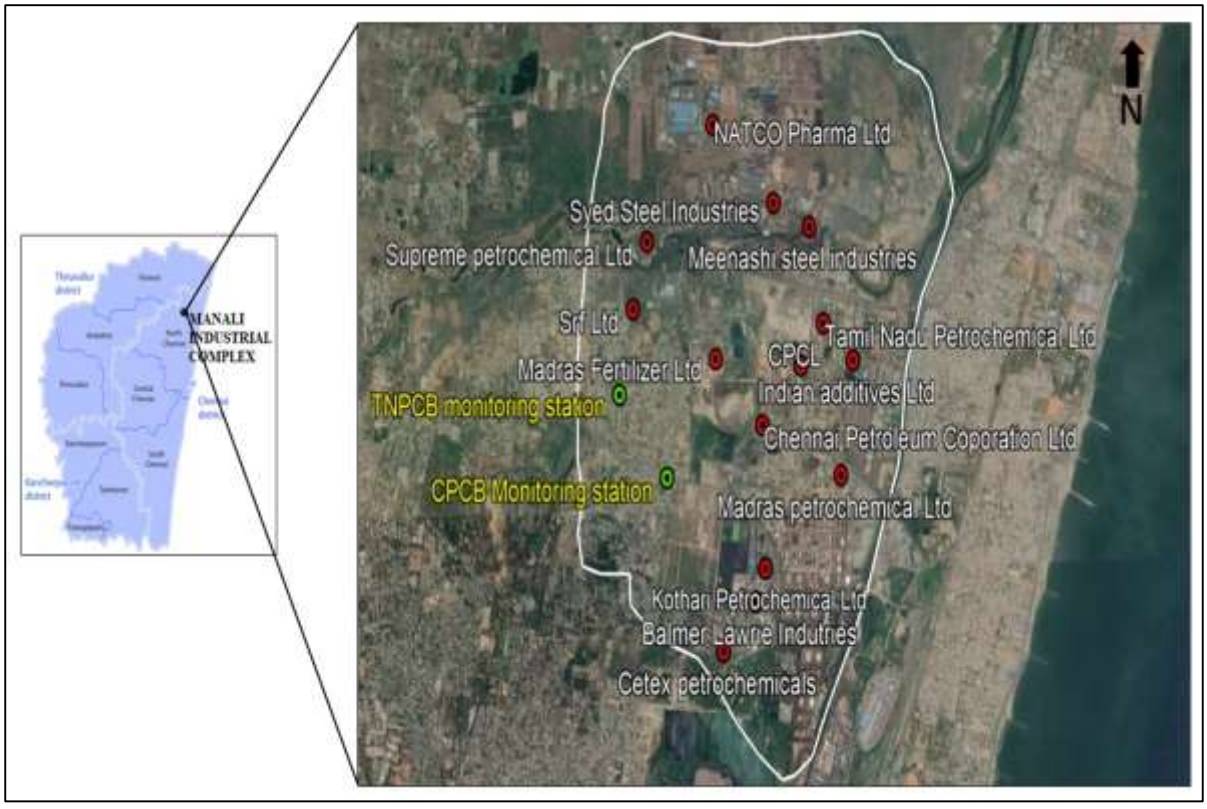

Figure.1.1 Location of major industries in Manali

The pollutants such as SO_2, NO_2, O_3, CO, $PM_{2.5}$, NH_3, CH_4, and meteorological parameters such as wind speed, wind direction, relative humidity, and temperature were monitored at 15-minutes time resolution. The time series of 24-hr average pollutant concentrations taken from CPCB and TNPCB stations during May-August 2020 were assessed to understand the trend of air quality in Manali complex. The assessment indicated that concentrations of SO_2, NO_2, O_3, CO, NH_3 were within the National Ambient Air Quality Standards (NAAQS) limit (zero exceedance days). The $PM_{2.5}$ concentration showed 8% exceedance while CH_4 showed 100% violation of NAAQS limits. Figure 1.2 shows the time series analysis of the 24-hour average concentration of pollutants measured at Manali. Table1.2 presents the descriptive statistics of the pollutants measured at Manali.

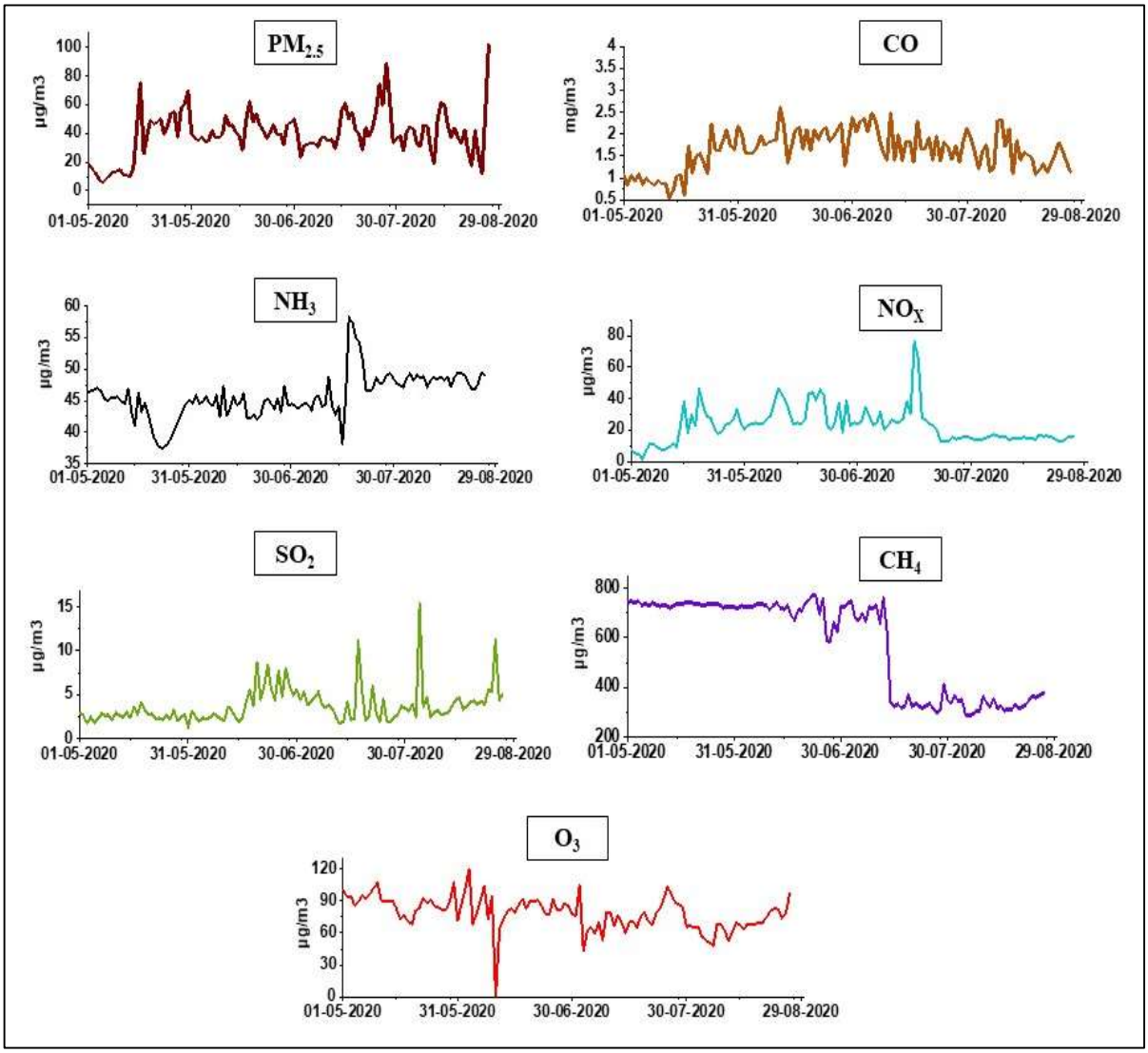

Figure 1.2 Time series analysis of the 24-hour average concentration of pollutants measured at Manali (CPCB and TNPCB data, May-August 2020).

Table.1.2 The descriptive statistics of the pollutants measured at Manali (CPCB and TNPCB data, May-August 2020)

Pollutants	$PM_{2.5}$	CO	NH_3	NO_X	SO_2	CH_4	O_3
Unit	$\mu g/m^3$	mg/m^3	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$
Minimum	6.06	0.54	38.16	1.53	1.24	288.4	43.45
25^{th} percentile	32.1	1.335	44.41	14.98	2.405	337.1	68.68
Median	39.38	1.65	45.85	22.26	3.1	712.5	79.45
Mean	39.47	1.628	46.29	22.81	3.698	575	79.31
75^{th} percentile	47.51	1.955	48.19	26.98	4.353	732.4	89.78
Maximum	101.65	2.62	58.21	76.25	15.41	774	119.88
24-hr NAAQS limit	60	4	400	200	80	60	180

NAAQS- National ambient air quality standards

MFL spread over an area of 320 acres in the revenue village of Manali at 13.10°N and 80.16°E and it comes under the red category industries. The MFL is bounded by petrochemical industries in the east and densely populated villages in the west and south as shown in figure1.3. The factory is connected with Manali high road in the east and Jawaharlal Nehru road in the west. The Ennore port is suited at a distance of 15km from the factory. The factory consists of ammonia, NPK, and urea production plant. The average ammonia, urea, NPK produced every year is around 27533, 468438, 48895 MT respectively. The average specific energy consumption is around 18.8 Gcal/MT every year. The MFL works continuously (24x7) with three shifts per day. The details of the employees at MFL are highlighted in Table1.3.

Figure.1.3 Location of MFL neighborhoods

Table.1.3 Details of the employees at MLF

Permanent employees	
Administration building	92
Technical services	69
Maintenance	128
Plant	165
Employees hired on contract basis	
Personnel and administration	123
Maintenance	43
Plant	716

1.2.Sensitive receptors

Mathur, Sekkadu, Appolo Amstrong Nagar, Salaimanagar, and Periyathoppu are the nearest residential areas located on the western side of the factory (Figure1.3). Chinnasekadu and Elandhacheri are the residential areas covering the south of the factory (Figure1.3). Educational institutes and hospitals were found within a radius of 2.5km from the factory. No ecological features and historical structures were present within 2.5km radius from the factory.

1.3.MFL ambient monitoring stations

The unit uses CAAQM stations (Figure1.4) installed at five selected locations around its periphery to monitor the air quality. Besides CAAQM stations, electrochemical sensors installed at 11 selected locations were used to monitor the ammonia concentration. The layout of CAAQM stations and electrochemical ammonia sensors installed at MFL are shown in Figure.1.5.

1.4.MFL plant

MFL consist of ammonia and urea production plant in single streams and NPK plant in three streams. Utility plant supplies treated water, cooling water, off-site steam, instrument air, captive power, and emergency power. The utility plant consists of two boilers (50 MT/hr each) fuelled by furnace oil. Both the boilers are provided with a common stack. The height of the stack is 70m (Figure1.6a).

Figure.1.4 MFL CAAQM station at a) ETP b) Maintenance work shop

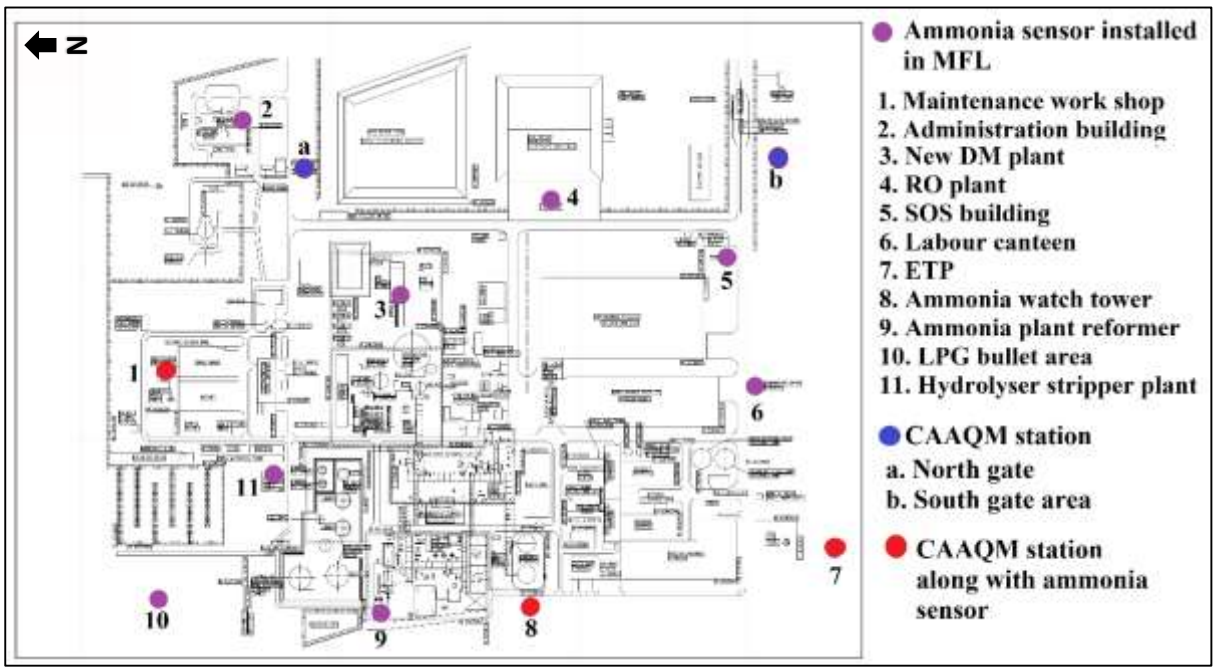

Figure.1.5 Layout of CAAQM stations and electrochemical ammonia sensors installed at MFL

1.4.1.Ammonia plant

Ammonia is critical in the manufacturing of fertilizers and is one of the largest-volume synthetic chemicals produced in the world. The modern ammonia-producing plant involves five steps namely desulphurisation, catalytic steam reforming, CO shift, CO_2 removal, methanation, and ammonia synthesis. The plant uses natural gas as the feed to produce ammonia.

The first step involves a process of desulphurisation to remove sulphur compounds from the feedstock, as it deactivates the catalyst used in the later stages. Catalytic steam reforming is generally employed for the production of hydrogen from the raw materials. This process uses nickel as a catalyst to convert the methane present in the feed to H_2, CO, and CO_2. The next step uses catalyst shift conversion to convert carbon monoxide to carbon dioxide using zinc-copper as the catalyst. The CO_2 is then removed by wet scrubbing, where monoethanolamide (MEA) or potassium hydroxide (KOH) is used as the scrubbing liquids. The CO_2 separated from this process is used as the feed to the urea plant. Further, residual amounts of carbon dioxide or carbon monoxide is removed by catalytic methanation process. To produce the end-product ammonia, the hydrogen is catalytically reacted with nitrogen (derived from process air) to form anhydrous liquid ammonia. The ammonia produced is sent to the urea and NPK production plants and the excess ammonia is stored in two storage tanks that act as the reserve (Figure.1.7). The ammonia plant consists of two boilers (110 ATA (100 MT/ hr) & process condensate boiler (70 MT/ hr)) fuelled by Natural gas. Both the boilers are provided with a common stack. The height of the stack is 117m (Figure.1.6b). Figure.1.8 represents the process flow diagram of the ammonia plant.

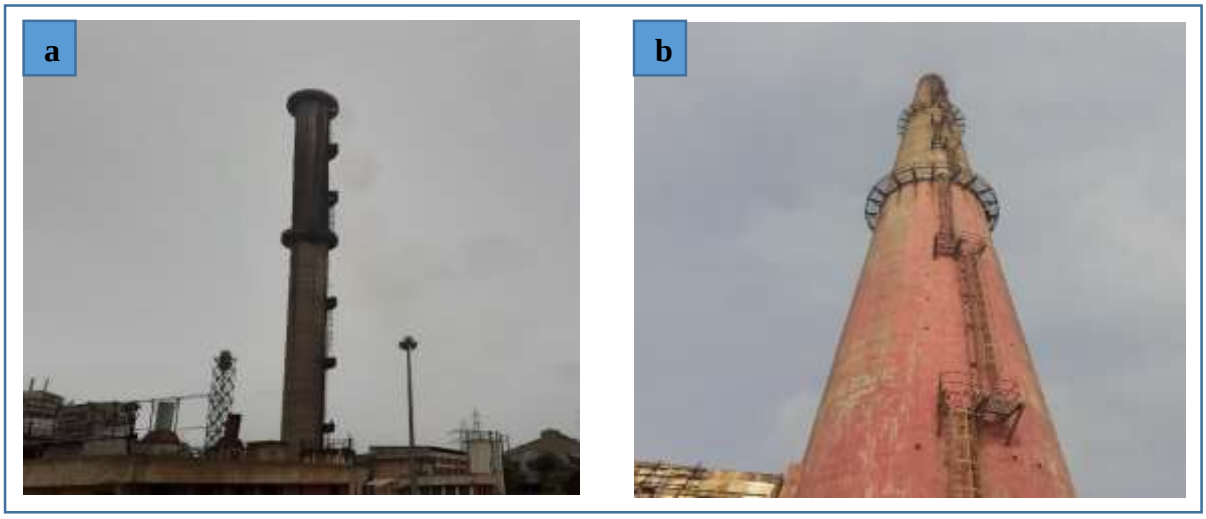

Figure.1.6 a) Utility stack b) 110 ATA & PCB common stack

The reforming of hydrocarbons to produce the hydrogen and carbon dioxide feed can result in the production of nitrogen oxides (NO_x) and sulphur oxides (SO_x). However, usage of natural gas in this plant as the raw material, the production of sulphur oxides is greatly reduced by removing the low levels of sulphur in the natural gas by passing it through a zinc oxide bed.The fugitive emission of ammonia was observed in the plant refrigeration and ammonia reaction

unit during the operation hours. In addition, air emissions from the boilers can include carbon monoxide (CO), nitrogen oxides (NOx), and sulphur oxides (SOx).

Figure.1.7 Ammonia storage tanks at MFL

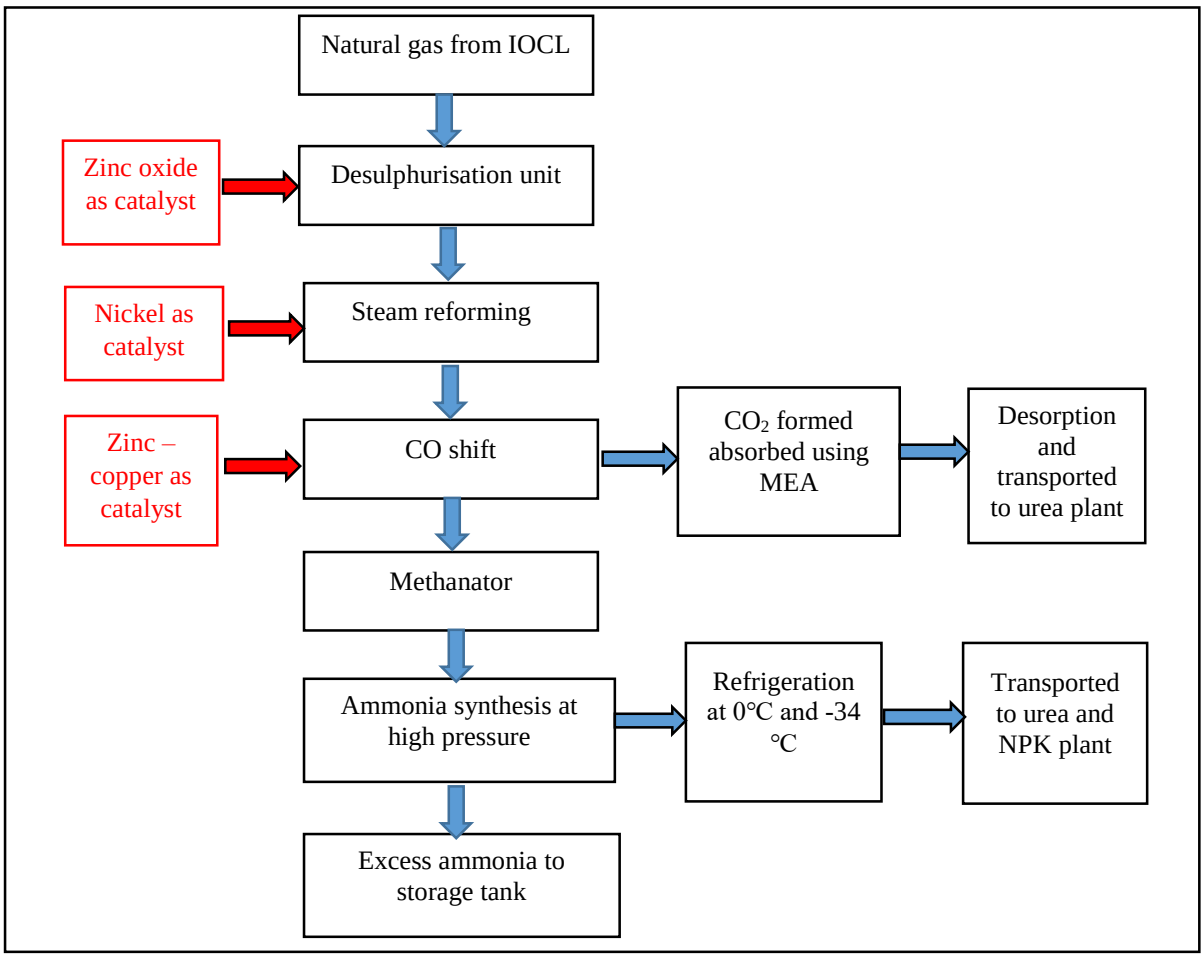

Figure.1.8 Process flow diagram of ammonia plant

1.4.2.Urea plant

Urea is produced by reacting liquid ammonia with carbon dioxide. The feed (liquid NH_3 and CO_2) is compressed separately and sent into the reactor to form ammonium carbamate which is dehydrated to form urea. The reaction is reversible, and therefore urea and ammonium carbamate exit the reactor along with carbon dioxide and ammonia. The component of this mixture is passed through a stripper to remove carbon dioxide and ammonia and recycled back into the reactor. The resultant mixture passes through a number of decomposers operating at progressively reduced pressures. Here the unconverted carbamate is decomposed back to ammonia and carbon dioxide and recycled to the reactor. The urea solution produced is concentrated by an evaporator to form molten urea. The urea crystals or prills are produced by spraying the molten urea from the top of a prill tower (220 feet) (Figure.1.9) through the counter-current air stream. Figure.1.10 represents the process flow diagram of the urea plant.

The solidification of urea results in the formation of particulate matter, particularly in the prill tower. In addition, the air stream used in the prilling process may contain unreacted ammonia. This air stream is passed through a demister column (2 Nos.) where the unreacted ammonia is removed before discharging into the atmosphere. The air emissions from the prill tower can include carbon monoxide (CO) and nitrogen oxides (NOx).

The process water and wash water from the ammonia and urea plant may contain ammonia and have high pH values. This may lead to stripping of ammonia from water when discharged without treatment. However, in this plant, the process and wash water is sent to a stripping plant where ammonia is stripped out and recycled back into the process. The treated water is then used as the cooling source in the plant.

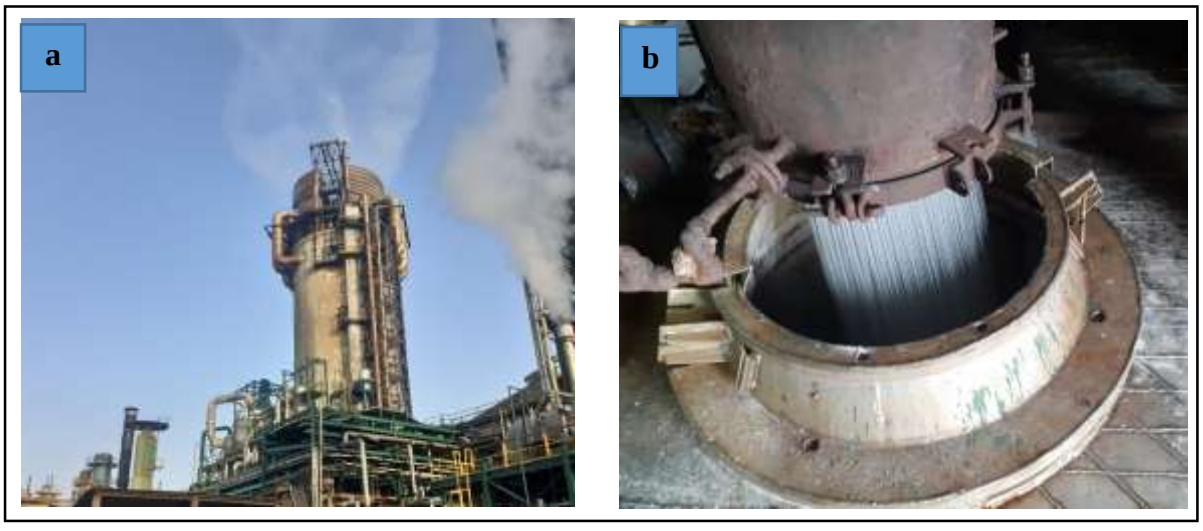

Figure.1.9 a) Prill tower b) Spraying of molten urea from the top of a prill tower

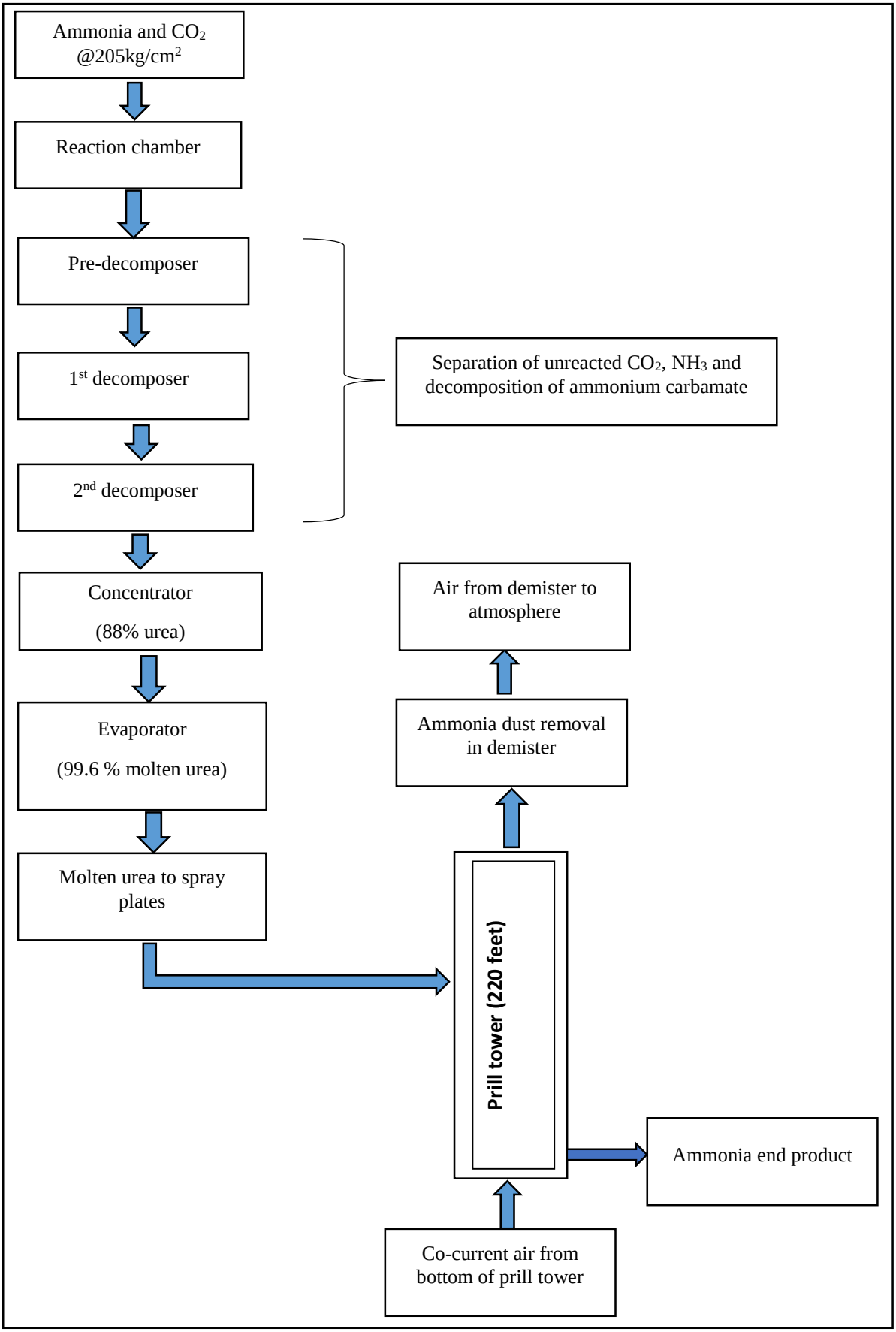

Figure.1.10 Process flow diagram of urea plant

1.4.3.NPK plant

The raw materials for NPK fertilizers include ammonia (99.5%) and urea (46% of nitrogen), phosphoric acid (liquid), and potash (60%). NPK fertilizers are produced by mixing anhydrous ammonia and phosphoric acid in a pre-neutralizers to produce a slurry. Potassium, urea, and river sand are added to the slurry subsequently in the process. The slurry is then sprayed onto a bed of a rotating granulator and ammonia is sparged into the bed from underneath to form granules. Granules are then allowed to pass through a rotary dryer with co-current flow of hot air to remove the moisture and followed by a rotary cooler. The dried granules are screened and sent to storage. Figure.1.11 represents the process flow diagram of the NPK plant.

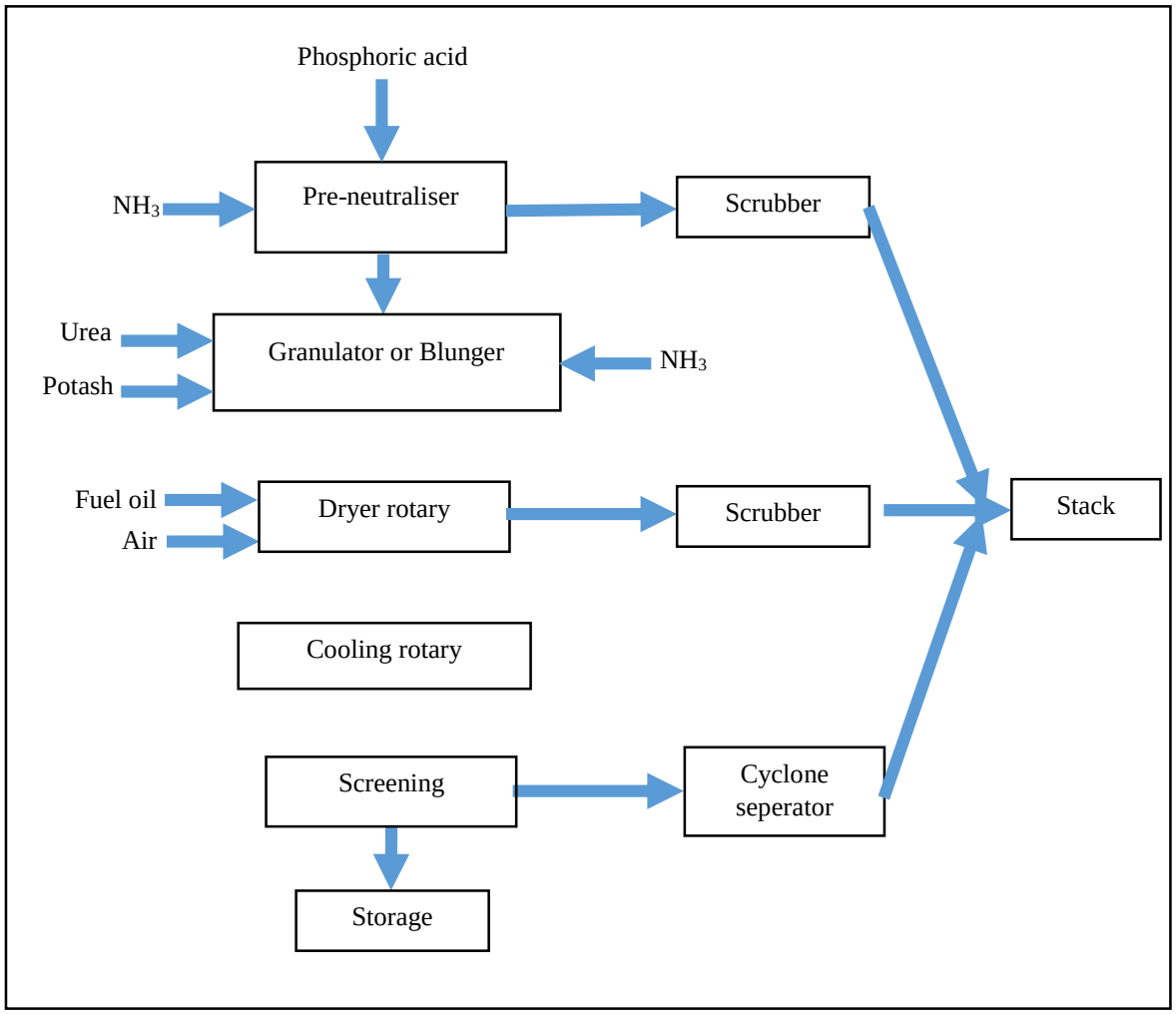

Figure.1.11 Process flow diagram of NPK plant

Scrubbing is used in the unit of pre-neutralizers and rotary dryer to remove the gases coming out from the process. Cyclone separator is used to control the particulate matter emission generated during the screening process. The outlet of the cyclone separator and the scrubbers are connected to a common stack that discharges the mixed stream into the atmosphere. The

height of the stack is 42m (Figure1.12). The principal pollutants from the production of NPK are ammonia and fluorides, which are given off in the steam from the reaction. Table.4 presents the trend of air pollution load from different stacks monitored from 2007-2009 at MFL.

Figure1.12 NPK stack at MFL

Table1.4 The trend of air pollution load from different stacks at MFL monitored from 2007-2009 (TNPCB, 2010).

	Parameter mg/m^3	Year		
		2007	2008	2009
Ammonia plant	SPM	107-121	130-134	128-132
	SO_2	348-391	169-201	166-209
	NO_X	17.5-32	65-134	59-89
Urea plant	SPM	32.5-48	30-42	35-44
	NH_3	47-82	64-82	69-78
Utility plant	SPM	113-124	132-148	125-143
	SO_2	372-446	322-391	364-428
	NO_X	31-35	28-46	25-35

1.5 Effluent treatment plant (ETP) at MFL

The process wash water from urea and NPK plant were collected in an ETP effluent sump located on the western side of NPK bagging as shown in figure.1.13. The effluent is pumped into an equalizer tank of capacity 126 m^3 where agitator is provided to maintain uniformity. The effluent is fed equally (7.5 m^3/hr) to the clarifier I and III (with detention time of 8.37 hrs) through distribution chamber and allowed to overflow into clarifier II and IV (with detention time 8.30 hrs). The overflow from clarifier II and IV is pumped to the clear water tank of capacity 125 m^3. At present, effluent generation is around 2 m^3/hr and clear water consumption is around 1.5-1.75 m^3/hr. The settled nutrient sludge from clarifier is periodically blowdown to solar sludge pit where it is dried and used as the feed to NPK plant. The treated water is again used in the plant process. The process flow diagram of ETP is shown in figure.1.14. ETP plant at MFL is shown in figure.1.15. The quality of the treated effluent (September 2020) is summarised in Table.1.5.

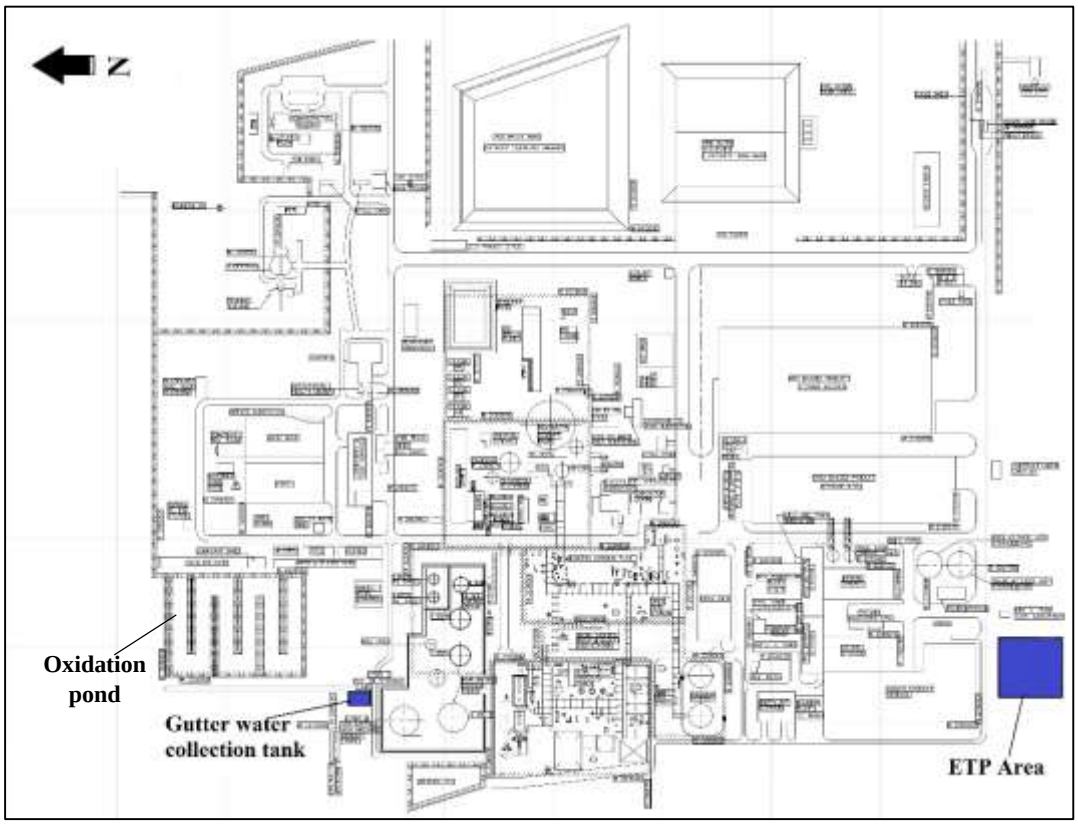

Figure.1.13. Location of ETP and gutter water collection tank at MFL

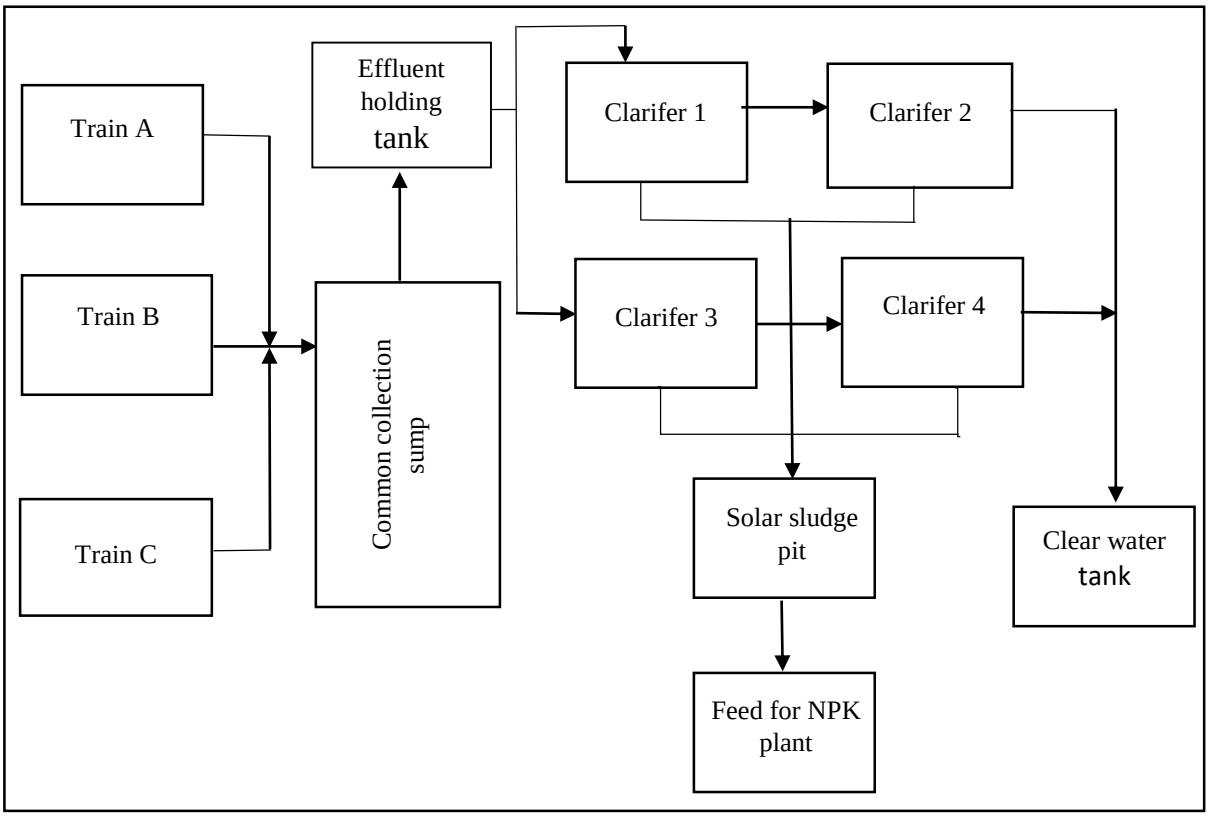

Figure 1.14. Process flow diagram of ETP in MFL

Figure. 1.15. ETP components a) Equalizer tank b) Clarifier

Table.1.5. Quality of treated effluent from MFL ETP (September, 2020).

Parameter	Outlet
pH	6.9
Suspended Solid	1-2%
Total Nitrogen	16500 ppm
Ammoniacal Nitrogen	7500 ppm
Phosphate	9000 ppm

1.6 Recent addition for collection of gutter water

The storm water run-off generated in the industrial premises were sent to an oxidation pond located near the bullet train area as shown in figure.1.13. There were two open channels that carries the runoff into the oxidation pond (Figure.1.16a). Recently, there were directions from SPCB to close the oxidation pond. Owing to this a sump was built in the same area which serves this purpose (Figure.1.16b). The tank has the following dimensions length –10 m; breadth –5 m; depth –3 m and the capacity of the tank ranges around 100 KL. The water collected in the sump will be treated and reused in the process.

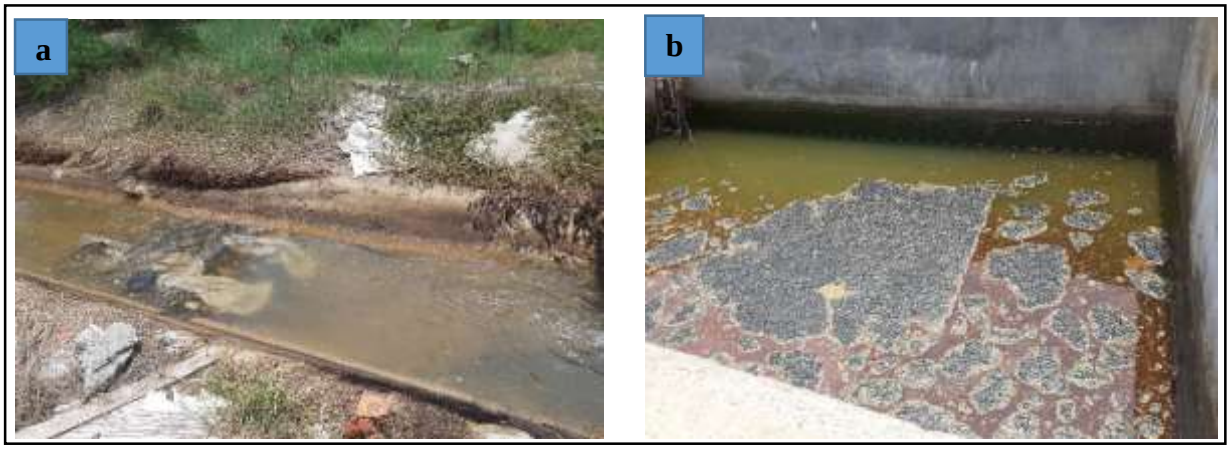

Figure 1.16 a) Gutter carrying runoff b) concrete tank holding surface runoff

1.7 Kick off meeting

A kick off meeting was held between the teams from IIT Madras and G-lens Lab and officials from MFL. The details of the manufacturing process followed in all the plants were presented. Site inspection was carried out at MFL plants and air quality monitoring stations. Based on the inspection and the wind pattern in the Manali area, 11 sampling points were chosen for ambient

monitoring. Dates for carrying out the sampling was also fixed after discussion with MFL officials and Glens team.

Figure.1.17.a) Kick off meeting between MFL, Glens and IITM officials b) Inspection at control room and c) Inspection at urea plant.

Chapter 2

AIR QUALITY ASSESSMENT

2.1 Predominant wind direction

The wind speed and direction play an important role in atmospheric transport and dispersion of pollutants. The day and night wind rose was plotted to know the predominant wind direction at the study site. The plots were made using 15-minutes average wind speed and direction data taken from CPCB continuous monitoring station, Manali from 24th to 26th August 2020. Figure.2.1 and 2.2 presents the night and day wind-rose plot for the study site. During the day, winds were dominantly from NE and NW direction with the predominant wind speed in the range of 0.5-1 m/s. During the night, winds were traveling from SE to NW direction with the predominant wind speed in the range of 0.5-1 m/s. The average wind speed at night was observed higher than the day.

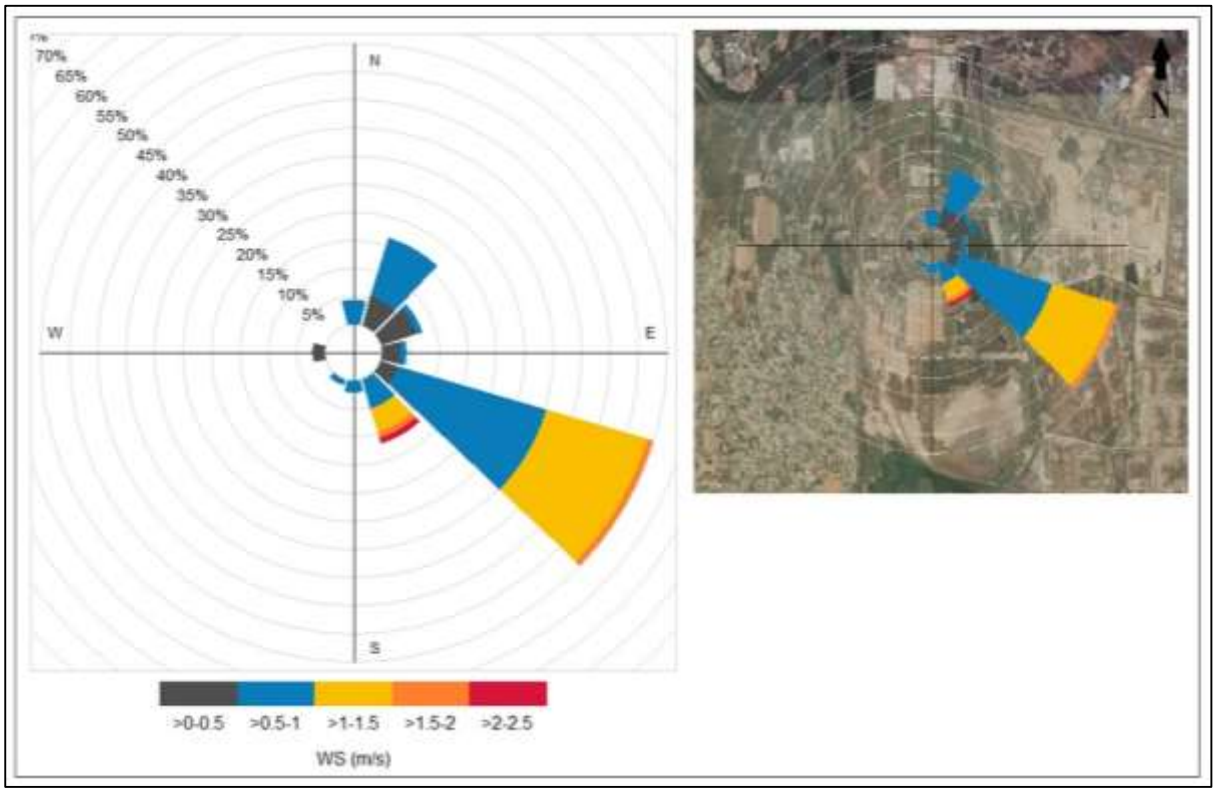

Figure.2.1. Wind rose plot for study site during the night

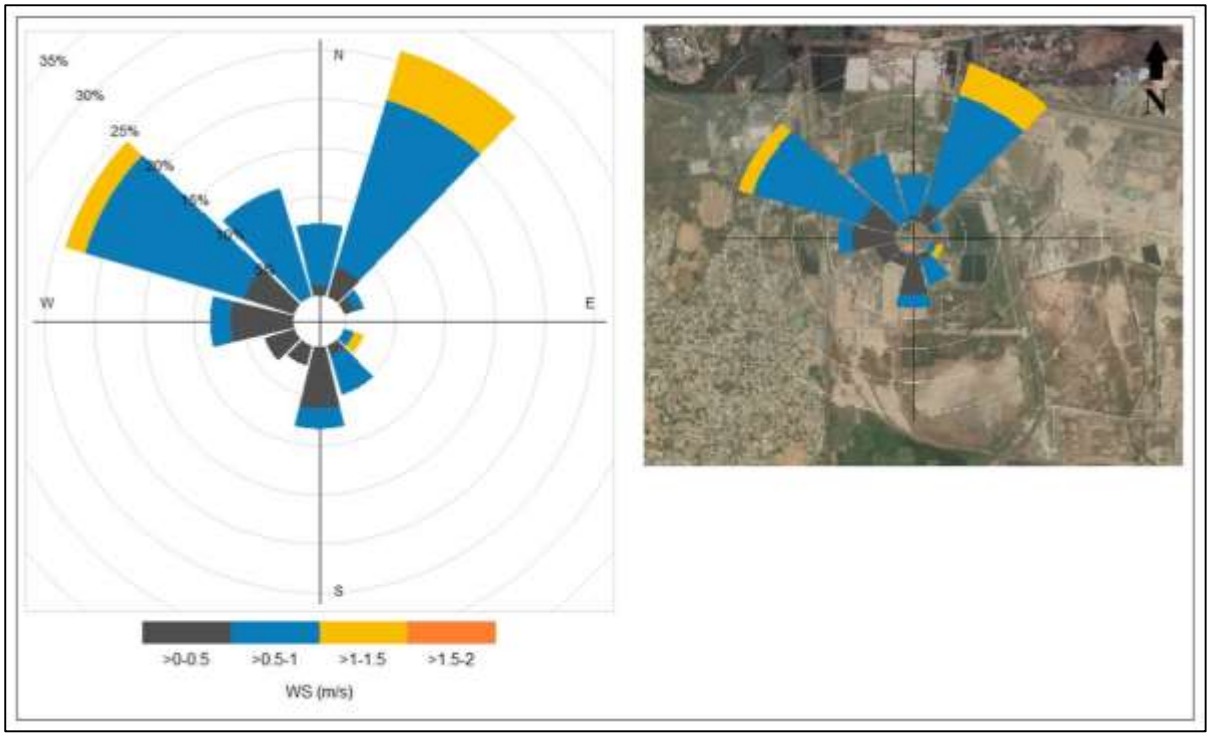

Figure.2.2. Wind rose plot for study site during the day

2.2 Ambient air quality monitoring

To assess the impact of plant operation on the ambient, air quality monitoring (Figure.2.3) was carried out in **11 selected locations of MFL as shown in figure.2.4**. Monitoring locations were selected based on the predominant wind direction and physical observance of the location. The **24-hr average concentrations of PM_{10}, $PM_{2.5}$, SO_2, NH_3, HF, and NO_2, and 1-hr average concentration of CO was measured**. Details of the ambient monitoring locations are highlighted in Table.2.1. The ambient monitoring campaign was carried out during 26th - 28th August 2020.

Figure.2.3 Installation of ambient monitoring equipment at a) DM plant b) Admin building

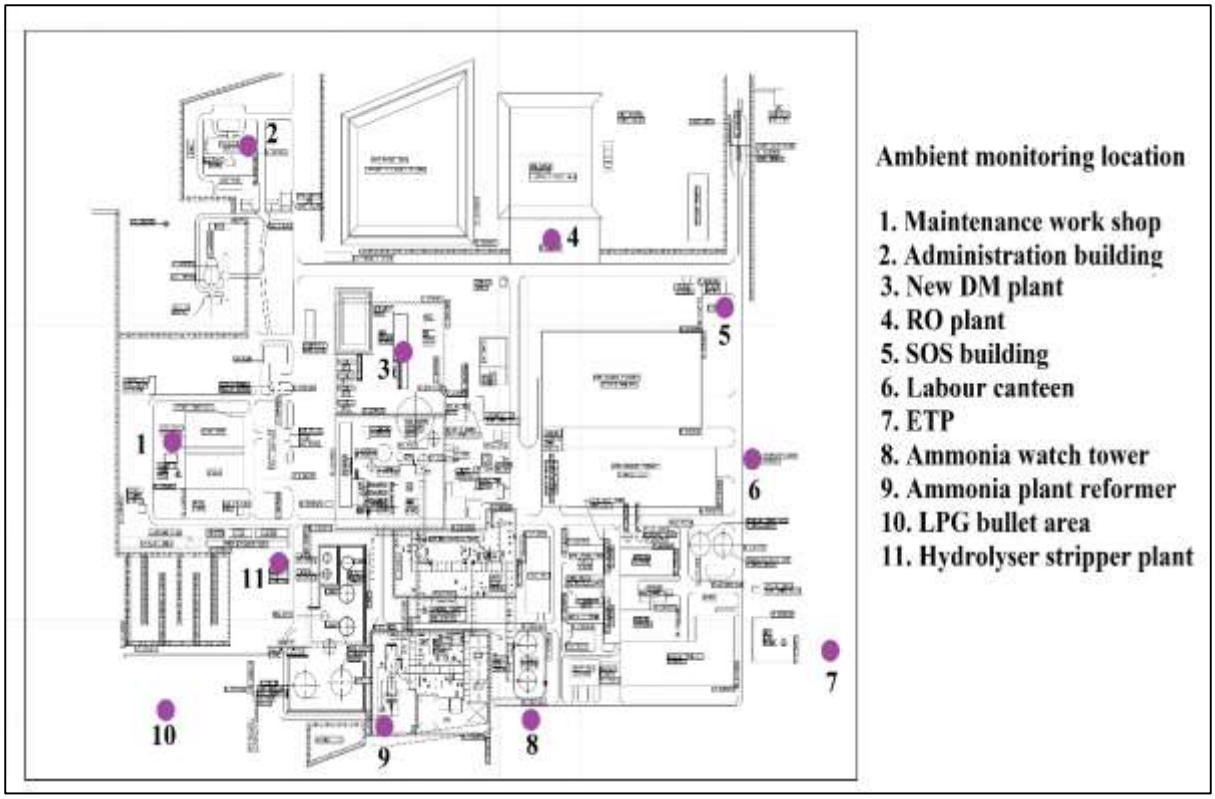

Figure.2.4 Layout of ambient monitoring location at MFL

Table.2.1 Details of the ambient monitoring locations

Location No.	Name	Latitudes	Longitudes	Location description
1	Maintenance workshop	13°10.545	80°16.085	Located to the North of the plant and crosswind of the NE winds.
2	Administration building	13°10.523	080°16.191	Located at North-Eastern side of the plant and upwind of the NE winds (reference point). The location is very close to the major district road.
3	New DM plant	13°10.416	80°16.089	Located to the South-Eastern side of the plant and located upwind and downwind of the SE and NW winds respectively.
4	RO plant	13°10.324	80°16.117	Located at South-Eastern side of the plant and located upwind and downwind of the SE and NW winds respectively.
5	SOS building	13°10.187	80°16.103	Located almost to the south of the plant and crosswind of the NE winds.
7	Labour canteen	13°10.4184	80°15.998	Located to the south of the plant and crosswind of the NE and SE winds.

6	ETP	13°10.4131	80°15.911	Located at South-Western side of the plant and downwind of the NE winds. Chinnasekadu and Elandhacheri are the nearest residential areas to this monitoring location.
8	Ammonia tank watch tower	13°10.312	80°15.863	Located at South-Western side of the plant and downwind of the NE winds. Salaimanagar is the nearest residential area to this monitoring location.
9	Ammonia plant reformer	13°10.422	80°15.858	Located to the west of the plant and crosswind of the NW winds. Harikrishnapuram is the nearest residential area to this monitoring location.
10	LPG bullet area	13°10.581	80°15.883	Located at North-Western part of the plant and located upwind and downwind of the NW and SE winds respectively.
11	Stripping plant	13°10.494	80°15.951	Located at North-Western part of the plant and located upwind and downwind of the NW and SE winds respectively.

2.2.1 Measurement of ambient PM_{10} and $PM_{2.5}$ concentrations

The 24-hr average PM_{10} mass was collected using a high volume sampler (HVS), TEI 121 DFM (Thermo Environmental Instruments Pvt. Ltd. India) as shown in figure.2.5a. Glass microfiber filter of size 20.3 x 25.4 cm (Whatman International Limited, USA) was used to collect the PM_{10} mass with an average flow rate of 1.1 m^3 /min. The 24-hr average $PM_{2.5}$ mass was collected using TEI 108 BL (Thermo Environmental Instruments Pvt. Ltd. India) (figure.2.5a) with an average flow rate of 16.7 m^3 /min. Polytetrafluoroethylene (PTFE) membrane filters of diameter 46.2 mm with a pore size of 0.2 μm (Whatman International Limited, USA) were used to collect the $PM_{2.5}$ mass. Filters were placed in aluminium foil sealed cassette while carrying from the field. Filters were weighed twice before and after the sampling to determine the PM_{10} and $PM_{2.5}$ concentrations. Before weighing, the samples were equilibrated in a desiccator at room temperature at a relative humidity of 30-40% for 24 hours. The sampling was carried out as per CPCB, 2011 guidelines.

2.2.2 Measurement of ambient gaseous pollutants (SO_2, NO_2, NH_3, HF)

A gaseous sampling attachment, TEI-110 (Thermo Environmental Instruments Pvt. Ltd, India) was used to collect **gaseous pollutants such as SO_2, NO_2, NH_3, and HF at the flow rate of 1**

L min^{-1}. The gaseous sampling was carried out as per CPCB, 2011 protocol. The midget impingers with suitable absorption media were used to collect the samples.

Modified West and Gaeke method (CPCB, 2011) was used for SO_2 analysis. The SO_2 from the air was absorbed in a solution of potassium tetrachloromercurate (TCM) to form dichlorosulphitomercurate complex, the complex formed was made to react with para-rosaniline and formaldehyde to form the intensely coloured pararosaniline methyl sulfonic acid. The absorbance of the solution was measured using a UV–visible spectrophotometer at 560 nm.

Modified Jacobs and Hochheiser method (CPCB, 2011) was used for NO_2 analysis. NO_2 was collected by bubbling air through a solution of sodium hydroxide and sodium arsenite. The concentration of nitrite ion (NO_2^-) produced during sampling was determined colorimetrically by reacting the nitrite ion with phosphoric acid, sulphanilamide, and N-(1-naphthyl)-ethylenediamine di-hydrochloride (NEDA) and measuring the absorbance of the highly coloured complex at 540 nm using UV–visible spectrophotometer.

Indophenol method (CPCB, 2011) was used to quantify NH_3 concentration. Ammonia in the atmosphere is collected by bubbling a measured volume of air through a dilute solution of sulphuric acid to form ammonium sulphate. The ammonium sulphate formed was made to react with phenol and alkaline sodium hypochlorite to produce indophenol. The reaction is accelerated by the addition of Sodium Nitroprusside as a catalyst. The absorbance of the solution was measured using a UV–visible spectrophotometer at 630 nm.

Zirconium SPADNS method (IS 5152 (Part 13): 2004) was used for HF analysis. Fluoride ions in ambient were collected by bubbling air through a solution of sodium fluoride. The solution is then allowed to react with the metal dye complex like zirconium-SPADNS reagent which results in fading in the absorbance of the solution. Measure the absorbance value at 570 nm with the spectrophotometer adjusted to read zero absorbance on the SPADNS reference solution. HF concentration is then computed indirectly from the fluoride ion concentration.

Portable gas detector, HQ 210 (Kimo instruments) was used to measure carbon monoxide levels in ambient air (figure.2.5b). The instrument uses infrared light at a specific wavelength, which is absorbed by the gas, measuring the amount of infra-red absorbed by the gas using infra-red detector, the volumetric concentration of gas can be quantified. The flow rate of the instrument was kept as 1 litre/min. The sampling is carried out as per IS 5182 (Part

10):1999. Table.2.2 presents the instrumentation and analytical methods adopted for air quality monitoring at MFL.

Table.2.2. Instrumentation and analytical methods adopted for air quality monitoring in MFL

Particular	Sampling instrument	Sampling principle	Flow rate	Analytical Instruments	Analytical method	Minimum detection Limit
PM_{10}	High Volume Sampler	Filtration of aerodynamic sizes with a size cut by impaction	0.8-1.2 m^3/min	Electronic Balance	Gravimetric	1 μg/m^3
$PM_{2.5}$	High Volume Sampler	Filtration of aerodynamic sizes with a size cut by impaction	16.7 LPM	Electronic Micro Balance	Gravimetric	1 μg/m^3
NO_2	Impingers attached to HVS	Chemical adsorption in suitable media	1 LPM	Spectro photometer	Colorimetric Improved West & Gaeke method	0.04 μg/m^3
SO_2	Impingers attached to HVS	Chemical adsorption in suitable media	1 LPM	Spectro photometer	Colorimetric Modified Jacobs & Hochheise method	0.03 μg/m^3
HF	Impingers attached to HVS	Chemical adsorption in suitable media	1 LPM	Spectro photometer		0.02 mg/m^3
NH_3	Impingers attached to HVS	Chemical adsorption in suitable media	1 LPM	Spectro photometer	Indophenol blue method	0.112 μg/m^3

CO	Infrared detector	Non dispersive infrared absorbance	1 LPM	-	-	1.14 mg/m^3

Figure.2.5 a) PM_{10} and $PM_{2.5}$ monitoring using HVS b) CO monitoring using NDIR analyser at LPG bullet area

2.3 Stationary source monitoring

Besides, ambient air quality monitoring, **emissions from stationary sources of the plant were also quantified. The pollutants such as PM, SO_2, NO_2, HF, and CO** were measured. Details of the stack monitoring are presented in Table.2.3. The stack monitoring campaign was carried out on 27th and 28th August 2020. Stack sampler kit, TE1-401 (Thermo Environmental Instruments Pvt. Ltd, India) was used to measure the pollutant emission under isokinetic condition. A typical sampling system comprises of sampling probe, sample collection module, sampling control module, and a sampling pump. The condition of sampling under isokinetic conditions is not mandatory for the sampling of gaseous pollutants.

Table.2.3. Details of the stack monitoring locations

Location No.	Stack name with dimensions	Latitudes	Longitudes	Stack Description
1.	Utility plant (Dia 4.96 m)	13°10.249	80°16.063	Two boilers (50 MT/hr each) provided with common stack

				Principal pollutant: PM and NO_X
2.	110 ATA & PCB common stack (Dia 6.25 m)	13°10.230	80°15.520	Two boilers -110 ATA (100 MT/ hr) & process condensate boiler (70 MT/ hr) provided with common stack. Principal pollutant: NOx
3.	Urea prill tower (Dia 8.4 m)	13°10.240	80°16.023	Attached with demister column (2 Nos.). Principal pollutant: Fine Urea dust and ammonia
4.	NPK stack (Dia 2.5 m)	13°10.121	80°15.577	Outlet of the cyclone separator and the scrubbers are provided with common stack Principal pollutant: NPK dust, HF and ammonia

2.3.1 Measurement of PM from stationary sources

The measurement of particulates emission from the stacks was carried out by collecting particulate samples and determining parameters like flue temperature, pressure, velocity, and flow rate at selected traverse sampling points using a stack monitoring kit (Figure.2.6a). The number of traverse points required for sampling was selected as per Indian Standard Method for Air Pollution, IS 11255 (Part 3):2008 rules. The velocity and flowrate were determined as per IS 11255 (Part 3):2008 guidelines. For the sampling of PM, IS 11255 (part 1):2008 was used. All the particulate samplings were carried out isokinetically for suitable periods under normal operational conditions. The PM concentrations were estimated by gravimetric analysis of particulate collection thimbles and subsequently, the emission rates of particulates were determined. The removal of moisture from the stack effluents is mandatory before their entry into the control module.

2.3.2 Measurement of gaseous pollutants from stationary sources

The digital flue gas analyser, FEL-7 was used to measure the levels of CO_2, O_2, CO and NOx. The analyser uses infra-red light at a particular frequency which is absorbed by gases molecules, capturing the absorbance using an infra-red detector, gases concentration can be estimated. The sampling was carried out for 20 mins with a flow rate of 1.5 litres/min.

Determination of sulphur dioxide emission from the stack was carried out as per the stipulations of IS 11225 (part 2):1985 which is similar to the US EPA Method 6. In this method, a gas sample is extracted from the sampling point in the stack. The SO_2 and the sulfur trioxide, including those fractions in any sulfur acid mist, are separated. The SO_2 fraction is then measured by the barium-thorin titration method. The sampling was carried out for 30 mins with a flow rate of 2 litres/min.

The sampling of ammonia was carried out as per IS 11255 (Part–6):2008 stipulation. Ammonia is collected in dilute sulphuric acid solution in two glass impingers to form ammonium sulphate. The ammonium sulphate formed was made to react with phenol and alkaline sodium hypochlorite to produce indophenol. The reaction is accelerated by the addition of Sodium Nitroprusside as a catalyst. The absorbance of the solution was measured using a UV–visible spectrophotometer at 630 nm. The sampling was carried out for 30 minutes with a flow rate of 2 litres/min. Table.2.4 presents the instrumentation and analytical methods adopted for stack monitoring at MFL.

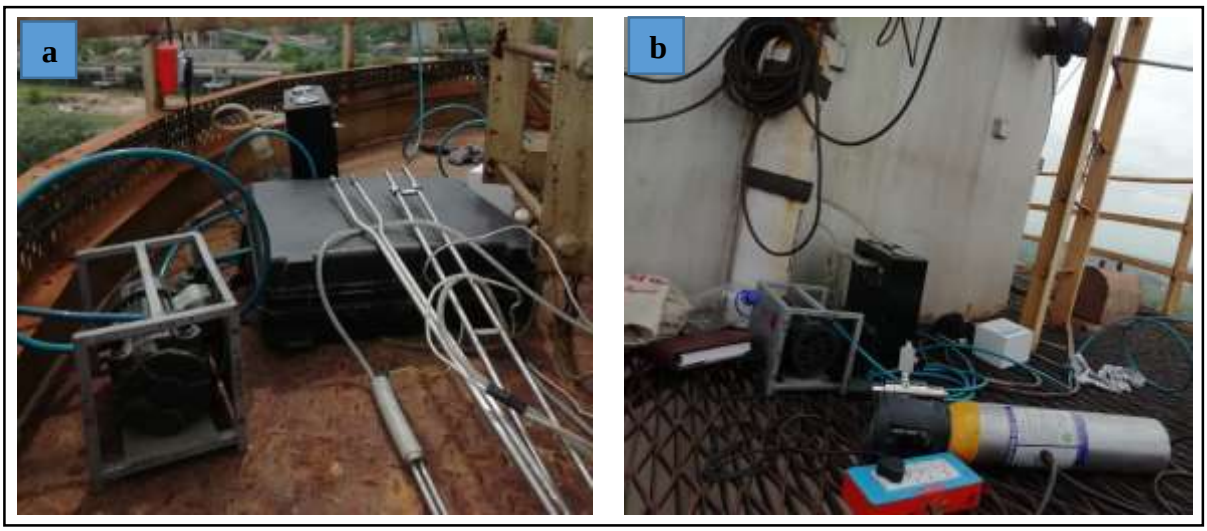

Figure.2.6. a) Stack monitoring kit b) Stack monitoring at Utility stack

Table.2.4. The instrumentation and analytical methods adopted for stack monitoring at MFL.

Particular	Sampling instrument	Sampling principle	Flow rate	Analytical Instruments	Analytical method
Velocity	S-type pitot tube	Based on differential pressure.	Isokenetic flow	-	-

Temperature	Temperature sensor.	-	-	-	-
PM	Timble sampling train	Filteration on timble	Isokenetic flow	Electronic Balance	Gravimetric
SO_2	Impinger sampling train	Chemical adsorption in suitable media	2 litres/min	-	Barium-thorin titration method
NH_3	Impinger sampling train	Chemical adsorption in suitable media	2 litres/min	Spectro photometer	Indophenol method
NOx	NDIR detector	Non-dispersive infrared absorbance	1.5 litres/min	-	-
CO	NDIR detector	Non dispersive infrared absorbance	1.5 litres/min	-	-

2.4 Workspace monitoring

Leakage of ammonia from valves, gaskets, and pipelines of the plant is very common during the operational hours. To access the ammonia levels at the work environment, **workspace monitoring of ammonia (figure.2.7) was carried out in 4 selected locations (based on physical observance) inside the plant** as shown in figure.2.8. The personal sampler, TEI-421 (Thermo Environmental Instruments Pvt. Ltd, India) was used to collect the sample. The sampling of ammonia is carried out as per NIOSH – 6015 guidelines. The midget impingers with suitable absorption media were used to collect the samples. The sampling was carried out for 8 hrs with a flow rate of 1litres/min. The sampling was carried out on 28th August 2020. Indophenol method was used to quantify the ammonia concentration.

Figure.2.7 a) Installation of personnel sampler at Urea bagging area b) workspace monitoring at Urea plant

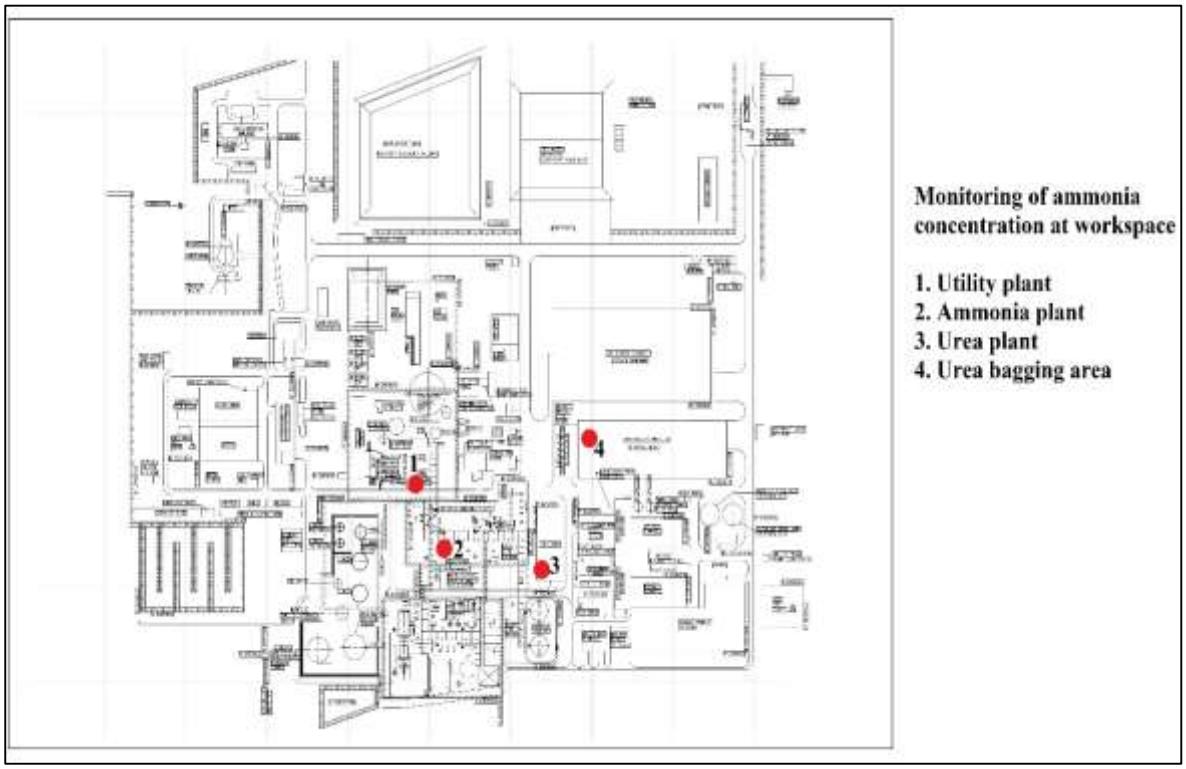

Figure.2.8 Layout of workspace monitoring location at MFL

2.5 Results and discussion

2.5.1. Ambient PM concentrations measured at selected locations of MFL

Table 2.5 presents the PM_{10} and $PM_{2.5}$ concentrations measured at selected locations in MFL. The 24-hr PM_{10} concentrations at MFL varied from 55.3 to 143.6 µg/m^3. Similarly, the 24-hr $PM_{2.5}$ concentrations at MFL varied from 27.8 to 86.4 µg/m^3. ***The PM_{10} concentration at New DM plant, RO plant, LPG bullet area, and stripping plant were exceeding the NAAQS limit***

of 100 µg/m^3. The $PM_{2.5}$ concentration at RO plant, LPG bullet area, and stripping plant were exceeding the NAAQS limit of 60 µg/m^3. The high PM concentrations at these points may be attributed to location of these points in the direction of predominant winds which brings prominent emission from the plant stacks. Also, emissions from vicinity industry (SRF) and vehicles movement might have also contributed to the PM exceedance. ***The PM_{10} and $PM_{2.5}$ concentration at New DM plant, RO plant, LPG bullet area, and stripping plant were exceeding 1.9-3.1 times the reference background concentration (PM_{10}=55.3 µg/m^3 and $PM_{2.5}$ = 27.8 µg/m^3) of MFL (refer Table.2.5).*** The average $PM_{2.5}/PM_{10}$ ratio at MFL is 0.53, which indicates that fine particles are dominant at the site.

Table 2.5 Ambient PM_{10} and $PM_{2.5}$ concentrations measured at selected locations of MFL

Location No.	Name	24-hr PM_{10} Concentration (µg/m^3)	24-hr $PM_{2.5}$ Concentration (µg/m^3)	$PM_{2.5}/PM_{10}$ ratio	Compliance with NAAQS (PM_{10}=100 µg/m^3 and $PM_{2.5}$ = 60 µg/m^3)
1	Maintenance workshop	93.7	43.6	0.46	Below NAAQS limits
2	Administration building (**reference point**)	55.3	27.8	0.50	Below NAAQS limits
3	New DM plant	106	59.2	0.56	PM_{10} level was exceeding 1.05 times and $PM_{2.5}$ level was exceeding 1.02 times
4	RO plant	143.6	86.4	0.60	PM_{10} level was exceeding 1.43 times and $PM_{2.5}$ level was exceeding 1.44 times
5	SOS building	92.2	49.4	0.53	Below NAAQS limits
6	Labour canteen	82.1	54.8	0.66	Below NAAQS limits
7	ETP	66.8	29.8	0.44	Below NAAQS limits
8	Ammonia tank watch tower	89.6	40.3	0.45	Below NAAQS limits
9	Ammonia plant reformer	74.3	31.7	0.42	Below NAAQS limits

10	LPG bullet area	112.3	63.4	0.56	PM_{10} level was exceeding 1.12 times and $PM_{2.5}$ level was exceeding 1.06 times
11	Stripping plant	123.4	65.2	0.52	PM_{10} level was exceeding 1.23 times and $PM_{2.5}$ level was exceeding 1.08 times

2.5.2. Ambient NO_2 and SO_2 concentrations measured at selected locations of MFL

Table 2.6 presents the NO_2 and SO_2 concentrations measured at selected locations in MFL. The 24-hr NO_2 and SO_2 concentrations varied in the range of 35.4-38.9 and 23.7-26.7 $\mu g/m^3$ respectively. ***The observed SO_2 and NO_2 values were well within the NAAQS limit.*** Further, the SO_2 / NO_2 ratios (mobile sources, SO_2 / NO_2 <0.5 & stationary sources, SO_2 / NO_2 > 0.5) indicate that the emissions are predominantly associated with stationary sources.

Table 2.6 Ambient NO_2 and SO_2 concentration measured at selected locations of MFL

Location No.	Name	24-hr NO_2 Concentration ($\mu g/m^3$)	24-hr SO_2 Concentration ($\mu g/m^3$)	SO_2/NO_2 Ratio	Compliance with NAAQS (NO_2=80 $\mu g/m^3$ and SO_2 = 80 $\mu g/m^3$)
1	Maintenance workshop	37.2	25.2	0.68	Below NAAQS limits
2	Administration building (reference point)	35.8	24.4	0.68	Below NAAQS limits
3	New DM plant	35.8	23.7	0.66	Below NAAQS limits
4	RO plant	36.5	26.2	0.72	Below NAAQS limits
5	SOS building	35.4	26	0.73	Below NAAQS limits
6	Labour canteen	35.7	26.4	0.74	Below NAAQS limits
7	ETP	36.4	26	0.71	Below NAAQS limits
8	Ammonia tank watch tower	36.4	25.6	0.70	Below NAAQS limits
9	Ammonia plant reformer	38.9	25.7	0.66	Below NAAQS limits
10	LPG bullet area	37.2	26.7	0.72	Below NAAQS limits
11	Stripping plant	37.8	24.6	0.65	Below NAAQS limits

2.5.3. Ambient NH_3, CO, and HF concentrations measured at selected locations of MFL

Table 2.7 presents the NH_3, CO, and HF concentrations measured at selected locations in MFL. The 24-hr NH_3 concentrations varied from 833.4 to 2977.3 µg/m^3. ***On an average NH_3 concentration was 4.3 times higher than the 24-hr NAAQS limit of 400 µg/m^3.*** The NH_3 concentration was exceeding the NAAQS limit at all the monitored locations. The maximum NH_3 concentration (2977.3 µg/m^3) was detected at Stripper plant area. During inspection it was observed that stripper plant had lot of leaks (different areas of stripper had high fugitive leaks and high NH_3 odour was noticed). This plant is one of the major contributors to ambient ammonia concentration which is located in the NW of the plant.

The AAQM location near LPG bullet area was detected with a concentration of 2190.33 µg/m^3 which is also at NW corner of the plant. The process water contains lot of ammonia and the same is liberating into the ambient atmosphere which was physically observed in the entire process drains. The process water storage area near LPG bullet area will also be the major contributor to ambient air ammonia concentration.

The NW winds carries the emissions from stripper plant and LPG bullet area to new DM plant (1416.3 µg/m^3) and RO Plant (2211.3 µg/m^3) when it crosses these location.

It was observed that the ammonia plant and urea plant had lot of fugitive leaks on the process and it is continuously emitting from process to ambient air quality. The ammonia emissions from these plant were very high (refer table.2.10) and is being emitting at different places of the plants and same have been contributed to the ambient air across all AAQM locations.

The 1-hr CO concentration at all the measured locations was found below the instrument detection limit except at LPG bullet area. The detected CO concentration was found within the limit. The 24-hr HF concentration at all the measured locations was found below the method detection limit.

Table.2.7 Ambient NH_3, CO, and HF concentration measured at selected locations of MFL.

Location No.	Name	24-hr NH_3 Concentration ($\mu g/m^3$)	24-hr CO Concentration (mg/m^3)	24-hr HF Concentration ($\mu g/m^3$)	Compliance with NAAQS NH_3=400 $\mu g/m^3$
1	Maintenance workshop	1199.4	BDL(DL:1.14)	BDL(DL:200)	NH_3 level was exceeding 3 times
2	Administration building (reference point)	1431.5	BDL(DL:1.14)	BDL(DL:200)	NH_3 level was exceeding 3.57 times
3	New DM plant	1416.3	BDL(DL:1.14)	BDL(DL:200)	NH_3 level was exceeding 3.54 times
4	RO plant	2211.5	BDL(DL:1.14)	BDL(DL:200)	NH_3 level was exceeding 5.52 times
5	SOS building	833.4	BDL(DL:1.14)	BDL(DL:200)	NH_3 level was exceeding 2.08 times
7	Labour canteen	2336.7	BDL(DL:1.14)	BDL(DL:200)	NH_3 level was exceeding 5.84 times
6	ETP	1582.8	BDL(DL:1.14)	BDL(DL:200)	NH_3 level was exceeding 3.95 times
8	Ammonia tank watch tower	1387.8	BDL(DL:1.14)	BDL(DL:200)	NH_3 level was exceeding 3.46 times
9	Ammonia plant reformer	1699.7	BDL(DL:1.14)	BDL(DL:200)	NH_3 level was exceeding 4.2 times
10	LPG bullet area	2190.3	1.7	BDL(DL:200)	NH_3 level was exceeding 5.47 times
11	Stripping plant	2977.3	BDL(DL:1.14)	BDL(DL:200)	NH_3 level was exceeding 7.44 times

2.5.4. Emissions measured from stationary sources at MFL

The flue gas characteristics measured from the stationary sources at MFL are presented in Table.2.8 and 2.9. ***The PM emissions from the stacks were exceeding the CPCB emission standard of 150 mg/Nm^3 by 3.24 times at utility boiler stack. Besides PM, oxides of nitrogen was also found exceeding the CPCB emission norms of 300 mg/Nm^3 (at 3% dry O_2) at utility boiler stack. The NO_X emissions was exceeding 1.4 at utility boiler stack.*** The high amount of excess air (utility boiler, O_2 =15.4% & ammonia boiler, O_2 =8.6%) used during the combustion process is responsible for high NO_X formation in the boilers.

The PM emission from 110 ATA & PCB common stack were within the CPCB norms, CO and NH_3 were found within the below detection limit. There is no standard specified for sulphur dioxide and oxides of nitrogen for boilers using natural gas, it is required to meet stack height criteria notified *vide* G.S.R. 176(E), dated the 2nd April 1996. The 110 ATA & PCB common stack have height greater than the prescribed height of 11m.

The NH_3 and PM emissions measured from the urea demister were found well below the CPCB emission norms and CO, NOx, and SO_2 were below the detection limit. The PM, NOx, CO, and NH_3 emission complied with the CPCB emission standards at the NPK stack. The SO_2 and HF were below the detection limit.

Table 2.8 Emissions measured from different stacks at MFL.

Stack name	CO (%)	PM (mg/Nm^3)	SO_2 (mg/Nm^3)	Oxides of Nitrogen as NO_2 (mg/Nm^3)	NH_3 (mg/Nm^3)	HF (mg/Nm^3)	Compliance with CPCB emission standards
	CPCB general standard (1% max)	CPCB general standard (150 mg/Nm^3)	CPCB industry-specific standard 1.Boilers-600 mg/Nm^3 at 3% dry O_2 for liquid fuel	CPCB industry-specific standard 1.Boilers-300 mg/Nm^3 at 3% dry O_2 for liquid fuel 2. Fertilizer industry - 400 mg/Nm^3	CPCB industry-specific standard 1. Fertilizer industry - 300 mg/Nm^3	CPCB industry-specific standard 1. Fertilizer industry - 20 mg/Nm^3	
Utility boiler	0.00017%	487.4	302 at 3% dry O_2	429.57 at 3% dry O_2	-	-	PM level was exceeding 3.24 times and NOx level was exceeding 1.4 times
110 ATA & PCB common stack	BDL	6.2	13.4	228	BDL (DL:0.02)	-	No NOx and SO_2 standard for natural gas, however stack height (117m) have met the criteria notified *vide* G.S.R. 176(E), dated the 2nd April 1996.
Urea demister	BDL	30.2	BDL (DL:3.0)	BDL (DL:2.0)	11.1	-	Below CPCB limits
NPK stack	0.01 %	29.8	BDL (DL:3.0)	2	13.7	BDL (DL:0.02)	Below CPCB limits

Table 2.9 Flue gas parameter measured from stationary sources at MFL.

Stack and its loading during monitoring	Stack temperature (°K)	Velocity (m/s)	Volume of gas discharge (Nm^3/hr)	Ammonia emission
Utility boiler	405	5.6	281146	-
boiler (86% loading)	398	4.79	390611	-
Urea demister (96% loading)	314	3.44	510664	136 kg/day
NPK stack (100% loading)	319	11.71	191255	62.9 kg/day

2.5.5. Workspace NH_3 concentration measured at selected locations of MFL

Table.2.10 presents the ammonia levels in workspace at MFL. The 8-hr ammonia levels at workspace varied between 2.97 to 4.90 ppm and were found well below the limit (25 ppm) specified by National institute of Occupational Safety and Health (NIOSH), USA. These emissions are associated with leakages from valves, gaskets, and pipelines of the plant.

Table.2.10 Workspace NH_3 concentration measured at selected locations of MFL

Location	NH_3 concentration (ppm)	Compliance with NIOSH standard (25ppm-8 hr)
Ammonia plant	4.90	Below NIOSH limit
Urea plant	3.56	Below NIOSH limit
Urea Bagging area	3.27	Below NIOSH limit
Utility plant	2.97	Below NIOSH limit

*NIOSH – National Institute of Occupational Safety and Health (USA).

CHAPTER 3

HAZARDOUS WASTE

3.1 Introduction

Hazardous waste means any waste, which by reason of characteristics such as physical, chemical, biological, reactive, toxic, flammable, explosive, or corrosive, causes danger or is likely to cause danger to health or environment, whether alone or in contact with other wastes or substances. According to Hazardous waste rules, 2016 (Ministry of Environment, Forest and Climate Change), the waste is hazardous if the:

1. Waste substances, which are generated in the process included in column 2 of Schedule-1 and consist of wholly or partly of the waste substances referred to in column-3 of the same schedule.

2. Waste substances which consist wholly or partly of substances indicated in Schedule-2 unless the concentration of the substances is less than the limit indicated in the same schedule.

3. Waste substances indicated in Part-A of the Schedule-3 unless they do not possess any of the hazardous characteristics in Part- B of the same Schedule

It is important to have a clear understanding of the nature of the materials for its effective management. The US EPA has listed different testing methods for various hazardous parameters such as corrosivity, reactivity, ignitability, and toxicity to designate hazardous waste.

3.2. Requirements for hazardous waste management

There are certain requirements that are laid down by the state pollution control board (SPCB) for the generators of hazardous waste. These requirements include applying for authorisation, fulfilling the criteria for transport, storage, treatment, and disposal, etc. This section deals with the detailing of SPCB requirements that are to be met by the generator of hazardous waste.

3.2.1 Authorisation

All industries that are engaged in handling, generation, collection, storage, packaging, transportation, use, treatment, processing, recycling, recovery, pre-processing, co-processing, utilisation, offering for sale, transfer, or disposal of the hazardous and other wastes shall be

required to make an application to the State Pollution Control Board (SPCB) and obtain an authorisation from the SPCB. Once granted, the validity of the granted authorisation will be for a period of 5 years and the industry has to apply for the consent again before 3 months to the date of expiry.

3.2.2 Storage requirements for hazardous waste

The occupier of facilities generating hazardous waste, shall design and set up the storage facility as per technical guidelines issued by the CPCB. The State Pollution Control Board (SPCB) shall monitor the setting up and operation of the storage facility regularly.

Hazardous waste generated can be stored for not more than 90 days and a maximum quantity of ten tonnes. Not more than 10 tons of hazardous waste may be stored on-site at any one time. In no instance can hazardous wastes be stored for more than one year from the time of initial storage, with authorization, as per the SPCB directives.

SPCB may relax the said duration of ninety days in the following cases:

1. Small generators (up to ten tonnes per annum) can store up to 180 days of their annual capacity.
2. Occupiers who do not have access to any Treatment, Storage, and Disposal Facilities (TSDF) in the concerned state.
3. The waste which needs to be specifically stored for the development of a process for its recycling, recovery, pre-processing, co-processing, or utilization.

3.2.2.1 Hazardous Waste storage area

Requirements for the storage areas are as follows:

1. The storage area must be locked or protected from unauthorized entry. A fence around the area is not required if it is in an area that is already restricted from unauthorized personnel.
2. There must be sufficient aisle space to allow unobstructed movement of personnel, fire protection equipment, spill control equipment, and decontamination equipment to any area of the operation.
3. The storage start date at the satellite storage area and the storage facility must be marked and visible for inspection on each storage unit.
4. Storage is in closed containers that are in good condition and compatible with the waste.

5. Keep containers securely covered at all times.
6. Place containers holding ignitable or reactive wastes at least 15m from the incompatible wastes must be separated by a berm or wall.
7. There must be appropriate signage identifying the area as hazardous waste storage, and a “No Smoking” signage.
8. Have sorbent materials on-site, if a spill or leak occurs.

The following equipment must be easily accessible, in working condition, and regularly tested:

i Internal communications or alarm system.
ii Telephone or hand-held two-way radio
iii Portable fire extinguishers and fire control equipment (portable fire extinguishers and fire control equipment)
iv Fire hydrants, foam producing equipment, automatic sprinklers, or water spray system.

3.2.2.2 Labelling Requirements

The occupier must mark the hazardous waste containers with the labels with fluorescent yellow colour background written in RED words as ‘HAZARDOUS WASTES’ and ‘HANDLE WITH CARE’ in Hindi, English, and vernacular language.

The following information should also be labelled on the container.

1. Storage start dates
    a) Full Date: The date that the drum at the satellite storage area is full.
    b) Arrival Date: The date that the full drum arrives at the long-term storage area.
2. Composition and physical state of the waste, i.e. solid, liquid.
3. Hazardous properties of the waste (e.g. flammable, reactive).
4. If the oil is stored label it as “used oil”.

3.2.2.3 Empty Container Management

Empty containers contaminated with hazardous wastes or an inner liner removed from a container that has held any hazardous waste falls under the hazardous category.

As per the Hazardous & Other Wastes (Management & Transboundary Movement) Rules, 2016, the occupiers are required to dispose of, such empty containers and liners, in an environmentally sound manner. The empty container should be sealed at all times. The empty

containers of hazardous chemicals may also be used to store the hazardous wastes generated in their industry/facility. However, the compatibility has to be looked into before storing hazardous wastes in these containers.

The container or inner liner should be rinsed thrice using a solvent capable of removing the waste and has to be disposed of in authorized transport, storage and disposal facility (TSDF). If soil is contaminated with oil, it must be removed immediately and stored in the Hazardous waste storage area and labelled properly as “Hazardous Waste”.

3.2.3 Transportation of hazardous waste

The transportation requirements given by SPCB are as follows:

Generally, the hazardous wastes are being collected by the owners of TSDF who has dedicated transportation on fleet. However, in case, the occupier wishes to transport on its own then he should follow the provisions of Motor Vehicle Act, 1980. When shipping hazardous waste on public roads, facilities/occupiers must:

1. Only use TSDF facilities that are authorized by the SPCB and have obtained an ID number.
2. The transporter must comply with the Motor Vehicle Act, 1980 as amended time to time requirements for packaging, labelling, training, and placarding as follows:
3. Hazardous waste must be packaged in containers that are in sound condition and are designed or maintained to contain hazardous waste.
4. Hazardous materials and hazardous waste containers must be marked in order to identify their contents and the hazard(s) posed by them in accordance with requirements. Placards must be placed on all four sides of the transportation vehicle. If the waste shipment includes more than one hazard class, multiple placards must be used to indicate all the hazard classes.

3.2.3.1 Manifest

Manifest is a universal colour coded travel document that will travel with the hazardous waste from the point of generation till its final disposal in TSDF. The final copy of the manifest must be sent to the waste generator from the TSDF and the generator has to sent the same to the concerned SPCB. Table 3.1 gives the colour codes of the manifest system.

Table 3.1 Colour codes of the manifest systems

Copy number with Colour code	Purpose
Copy 1 (White)	To be forwarded by the sender to the SPCB after signing all the seven copies
Copy 2 (Yellow)	To be retained by the sender after taking signature from the transporter and the rest of the five signed copies to be carried by the transporter
Copy 3 (Pink)	To be retained by the receiver (actual user or TSDF operator) after receiving the waste and the remaining four copies are to be duly signed by the received.
Copy 4 (Orange)	To be handed over to the transporter by the receiver after accepting waste.
Copy 5 (Green)	To be sent by receiver to the SPCB
Copy 6 (Blue)	To be sent by receiver to the sender
Copy 7 (Grey)	To be sent by receiver to the SPCB of the sender in case the sender is in another state

3.3 Contracts made by MFL for hazardous waste

3.3.1 Tamil Nadu waste management limited (TNWML)

The hazardous waste management contract was signed with TNWML and has to be renewed every 2 years. According to the terms of the agreement, TNMWL has agreed to collect the generated hazardous waste in MFL and process them in TSDF situated at Gumudipoondi. The charges are levied based on the quantity of the waste treated in metric tons (MT). TNMWL has agreed to collect spent catalyst and oil residue/ sludge. Spent catalyst is landfilled while oil is incinerated in TSDF.

3.3.2 Metal Scrap Trade Corporation (MSTC) Limited

Scrap material management contract was signed between MFL and MSTC Limited. This agreement deals with the management of scraped/rejected/condemned material, obsolete secondary arising (Ferrous and non- ferrous), trees etc. The documents regarding contracts made by MFL are attached separately in annaexure 2.

3.4 Raw materials storage yard in MFL

The location of the storage yard in MFL is shown in figure.3.2. The materials stored in this yard includes chemicals for water treatment, catalyst and lubricant oil. The details of the chemicals stored and their quantity are as follows: (a) corrosion inhibitor and dispersant

(quantity – 67005 kg), (b) catalyst (quantity – 47 drums) and (c) lubricant oil (quantity – 214 barrels). Table 3.2 shows the details of the chemicals stored and their hazardous characterstics. Figure 3.1 shows the raw material storage yard in MFL.

Table 3.2 Details of chemicals in storage yard and their hazardous characeteristics

S.No	Raw material	Plant in which it is used	Hazardous characteristics
1.	Corossion inhibitor	All plants	-
2.	Bio-dispersent	-	-
3.	Catalyst	Ammonia and Urea	Toxicity, Ignitablity
4.	Lubricant oil	All plants	Ignitablity

Field inspection was carried out to examine the adequacy of the storage requirements. The major inadequacies are listed below:

- Lack of proper ventilation and lighting
- In adequate spacing between drums and other storage chemicals.
- Fire extinguishers were not placed inside the storage area (fire hydrant was present ouside the yard)
- No sign boards indicating "Hazardous Chemicals Storage Area", "No Smoking Within 50 Feet" and "Authorized Personnel Only"
- Containers were not labelled with property of the chemicals stored.
- No provision for spill/leak management

Figure. 3.1 Chemicals storage yard in MFL a) chemicals in PVC containers b) Lubricating oil

3.4.1 Ammonia storage (Manufacture, Storage and Import of Hazardous chemical rules, 1989)

The ammonia produced in MFL is stored in two cylindrical storage tanks of capacity 5000 T each shown in Fig 1.7 . The maximum value that MFL usually maintains is around 5000 T at a peressure of 20 inches of water column.

According to the manufacture, storage and import of hazardous chemical rules, 1989 given by Ministry of Environment & Forests, the unit should have an onsite emergency plan and help the concerned authorities in framing an off site emergency plan by giving essential details required for devising it.

The onsite plan at MFL includes the provision of valve inside the storage tanks that will vent the ammonia gas automatically incase of any increase in the pressure above 20 inches of water column. The unit is also conducting a training session for the workers once in 6 months making sure that they are well aware about the precautions that are to be taken incase of an ammonia leak. Besides onsite emergency planning, MFL is also carrying out offsite training for the local residents along with the concerned authorities.

3.5 Hazardous waste storage facility

The hazardous waste storage area is located close to the south gate of MFL as shown in Figure.3.2. The hazardous wastes were stored in a shed with concrete flooring and berm concrete walls on three sides as shown in Figure.3.2. The shed receives spent catalysts from the ammonia plant and used/waste oil from all process of the unit stored in PVC containers.

The spent catalyst generated at MFL includes zinc-copper, nickel, zinc oxide, cobalt- molybdenum. The Zn-Cu generation was the highest (58%), followed by ZnO (20%), Ni (15%), and Co-Mo mix (7%). The lubricating oil (used oil) and residue oil generation is around 6.67 MT/month and 1 MT/month respectively. Table 3.3 shows the details of the hazardous waste generated upto March 2020 in MFL.

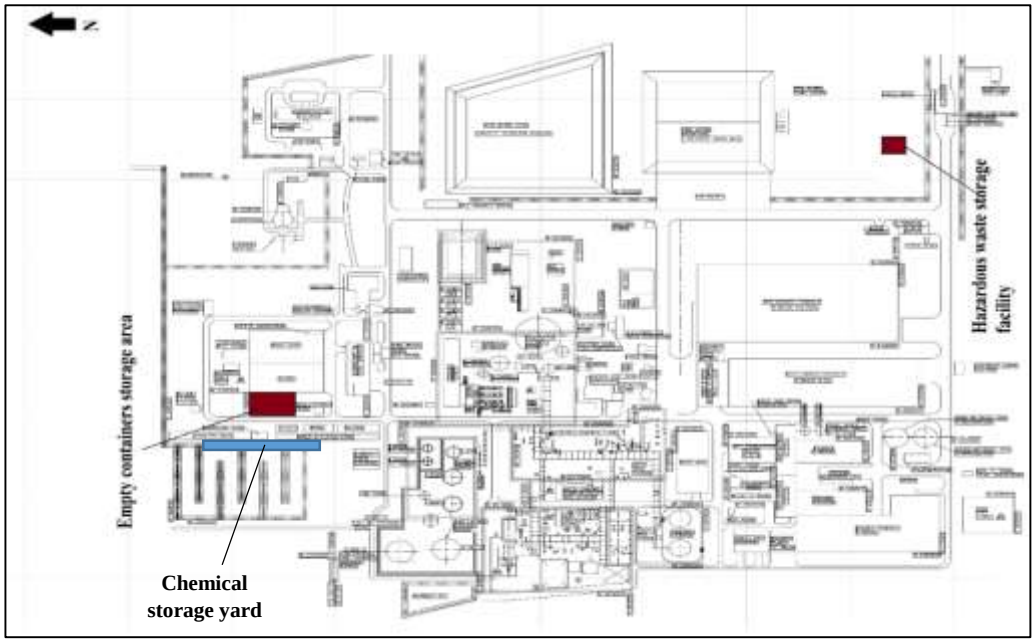

Figure. 3.2 Location of hazardous waste storage facility and empty containers storage area at MFL

Table 3.3 Details of hazardous waste generated in MFL

S NO	Hazardous waste	Quantity (Metric tons)
1.	Lubricating oil	20
2.	Residue containing oil	3
3.	Spent catalyst	166.77
4.	PVC empty chemical drums	350

Besides, spent catalysts and oil, empty containers contaminated with chemicals were stored near to the chemical warehouse in a open area as shown in Figure.3.4 b). Containers with spent catalysts were also found in a open area close to the hazardous shed.

The wastes were classified as hazardous based on the Schedule-1 (category.5.2 – lubricant oil and residues containing oil, category.18.1- spent catalyst, category.33.3- empty containers contaminated with chemical) (Hazardous waste rules, 2016). Table.3.4 presents hazardous waste storage requirements and their compliance at MFL hazardous storage area.

Figure 3.3 a) MFL hazardous waste storage facility b) sealed containers with used oil and spent catalyst

Figure 3.4 a) Containers with spent catalyst stored in open area b) Empty containers storage area

Table.3.4 Hazardous waste storage requirements and their compliance at MFL hazardous storage area.

Requirements	Action item	Compliance (Y/N)	Remarks
Storage	Hazardous wastes are stored for not more than 90 days	Yes	
	Containers are labelled with the words "Hazardous waste"	No	The containers were labelled only with waste name and category.
	Containers Labels clearly show the contents of the hazardous waste, hazardous property of the waste, physical state of the waste, full date, and arrival date.	No	
	If oil is stored, containers are labelled with used oil	Yes	
	All containers that store hazardous waste are in good physical condition and are compatible with the type of waste.	Yes	
	Storage do not exceed the allowable storage quantity of 10 tons	Yes	

	Containers of hazardous waste are closed at all times	Yes	
Usage of sign boards	The following signs are displayed in the permitted storage area: “Hazardous Waste Storage Area” “No Smoking Within 50 Feet” “Authorized Personnel Only”	No	
Emergency equipment	Internal communications equipment or alarm system	No	
	Telephone	No	
	Portable fire extinguishers and other fire control equipment (foam, dry chemicals, etc.)	No	
	Fire hydrants	No	
	Spill control equipment	No	
Aisle space	Adequate aisle space is provided.	No	

Emergency contacts	The following information is posted next Contacts to the telephone: 1) Name and telephone number of emergency contact 2) Location of fire extinguisher 3) Telephone number of the local fire department	No	
Empty containers	Containers are adequately emptied of hazardous waste prior to disposal.	Yes	
	Emptied containers are sealed at all times	No	There were small openings at the top of the empty containers through which water can enter.

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Chapter 4

DISPERSION MODELLING

4.1. Model Description

Atmospheric dispersion modelling system incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts. It includes both surface and elevated sources in both simple and complex terrain. It integrates three modules:

i. Steady-state dispersion model for up to 50 km for the dispersion of pollutants from industrial, vehicular, domestic and other sources.

ii. A meteorological data pre-processor that accepts surface meteorological data, upper air soundings, and also data from on-site instrument towers which is optional. The atmospheric parameters necessary for the dispersion model such as mixing height, turbulence characteristics, etc.

iii. A terrain data pre-processor that incorporates complex terrain using elevation data into the dispersion model. The processing is not necessary if the terrain is assumed to be flat.

The inputs necessary are as follows:

Source types: Multiple point, line, area, and volume sources.

Source releases: Surface, near surface and elevated sources.

Source locations: Urban or rural locations. Urban effects are scaled by population.

Plume types: Continuous, buoyant plumes

Plume deposition: Dry or wet deposition of particulates and/or gases.

Plume dispersion treatment: Gaussian model treatment in horizontal and in vertical for stable atmospheres. Non-Gaussian treatment in vertical for unstable atmospheres.

Terrain types: Simple or complex terrain. Building effects: Handled by PRIME downwash algorithms.

Meteorological data profiles: Vertical profiles of wind, turbulence and temperature are created.

Receptor Types: Receptors could be specified as points or grids.

Atmospheric dispersion modeling describe the contaminant transport in the atmosphere through the combination of diffusion (due to turbulent eddy motion) and advection (due to the wind) that occurs within the air. The concentration of a contaminant released into the air may therefore described by the advection-diffusion equation which is a second-order partial differential equation of parabolic type. The advection- diffusion equation is given by

$$u\frac{\partial C}{\partial x} = K_y\frac{\partial^2 C}{\partial y^2} + K_z\frac{\partial^2 C}{\partial z^2} \tag{4.1}$$

where C is the steady-state contaminant concentration in x,y,and z direction, K_y and K_z are the diffusion coefficient in y and z direction assuming that advection is the dominant term along x direction and u is the wind which is constant and steady. The simplest analytical solution for the above equation is called gaussian plume, corresponding to a continuous point source that emits contaminant into a uni-directional wind in an infinite domain. The solution is given by

$$C(x,y,z) = \frac{Q}{2\pi u\sigma_y\sigma_z}\exp\left(-\frac{y^2}{2\sigma_y^2}\right)\left[\exp\left(-\frac{(z-H)^2}{2\sigma_z^2}\right) + \exp\left(-\frac{(z+H)^2}{2\sigma_z^2}\right)\right] \tag{4.2}$$

where Q is the pollutant released at a constant rate (g/s), H is the effective height of plume centre-line, z is the coordinate measured vertically from the ground to a point in the plume (m), σ_i^2 is the standard deviation which is depend on the atmospheric stability.

The unstable conditions have standard deviations that rapidly increase downwind and stable conditions have standard deviations that stay small downwind. Hence, in stable conditions the pollutant may travel long distances before dispersion.

Gaussian plume model for this study has been implemented in MATLAB programming language. The model was ran for calm wind conditions (November to January). It was observed that 40% of the winds were under calm conditions during this period which is the critical for dispersion of the pollutants. The meteorological parameter during this period is listed in the table.4.1

Table.4.1 Average meteorogical parameter during calm condition at Manali industrial complex.

Temperature	Wind speed	Relative humidity	Solar radiation	Cloud cover	
				Night	Day
26.3℃	0.84m/s	78.97%	50 W/mt^2	41%	57%

The model was ran to predict ground level pollutant concentration up to 5km (both downwind and crosswind) from the industry. All three vertical stability (stable, neutral, and unstable) were tested to understand the effect of vertical stability of the atmosphere on the ground level concentrations. The effect of terrain-influence height was not considered as the terrain is plain at Manali. The effect of humidity, multi stacks were considered during the run. The Carson and Moses method was used to calculate plume rise for unstable and neutral stability and Briggs method was used for stable condition.

4.2. Results and discussion

4.2.1 Modeling of PM concentration

The 24-hr averaged PM concentrations varied between 10-80 µg/m^3 under unstable class (during the day) with the maximum concentration of 80 µg/m^3 predicted at a distance of approximately 500m from the industry as shown in figure.4.1. The 24-hr average PM levels under stable and neutral stability (during the night) varied between 2-22 µg/m^3 and 0.5-3 µg/m^3 respectively as shown in figure.4.2 and figure.4.3. The maximum PM under stable and neutral condition occurred at a distance of 5km from the industry. Under stable and neutral condition, pollutants travel long distance before dispersion.

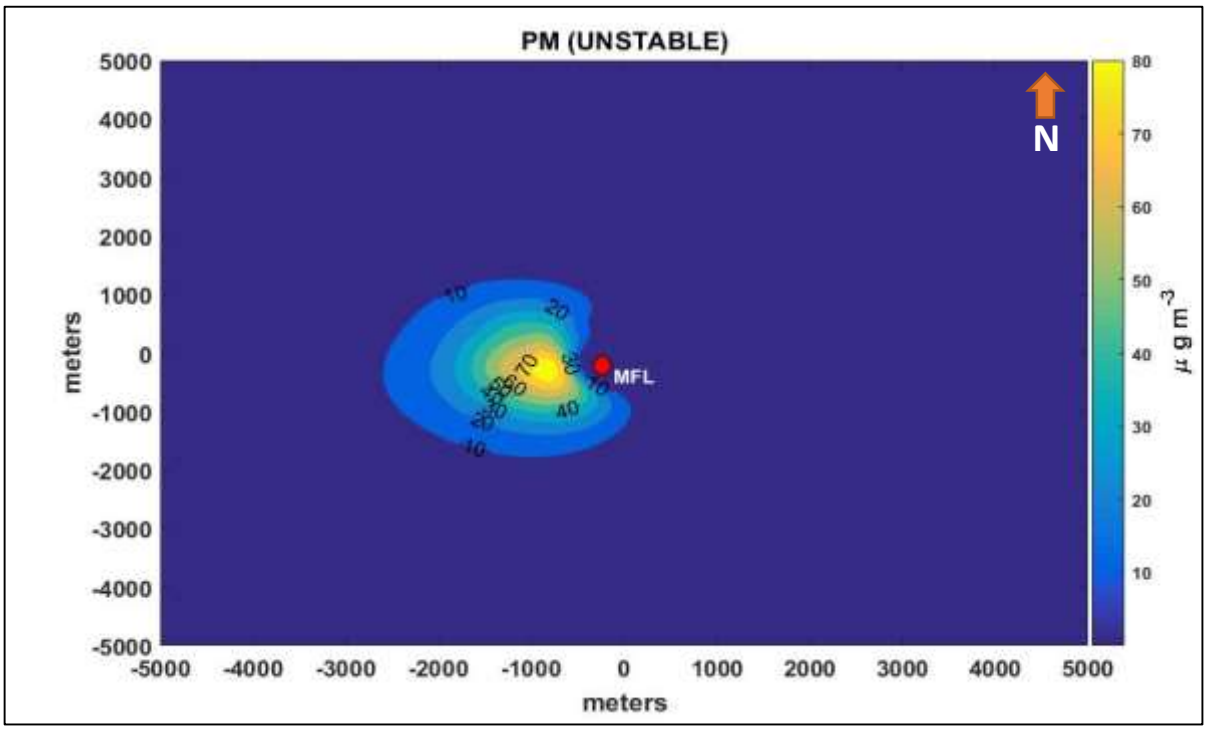

Figure.4.1. Dispersion of 24-hr average PM concentration during unstable condition from MFL.

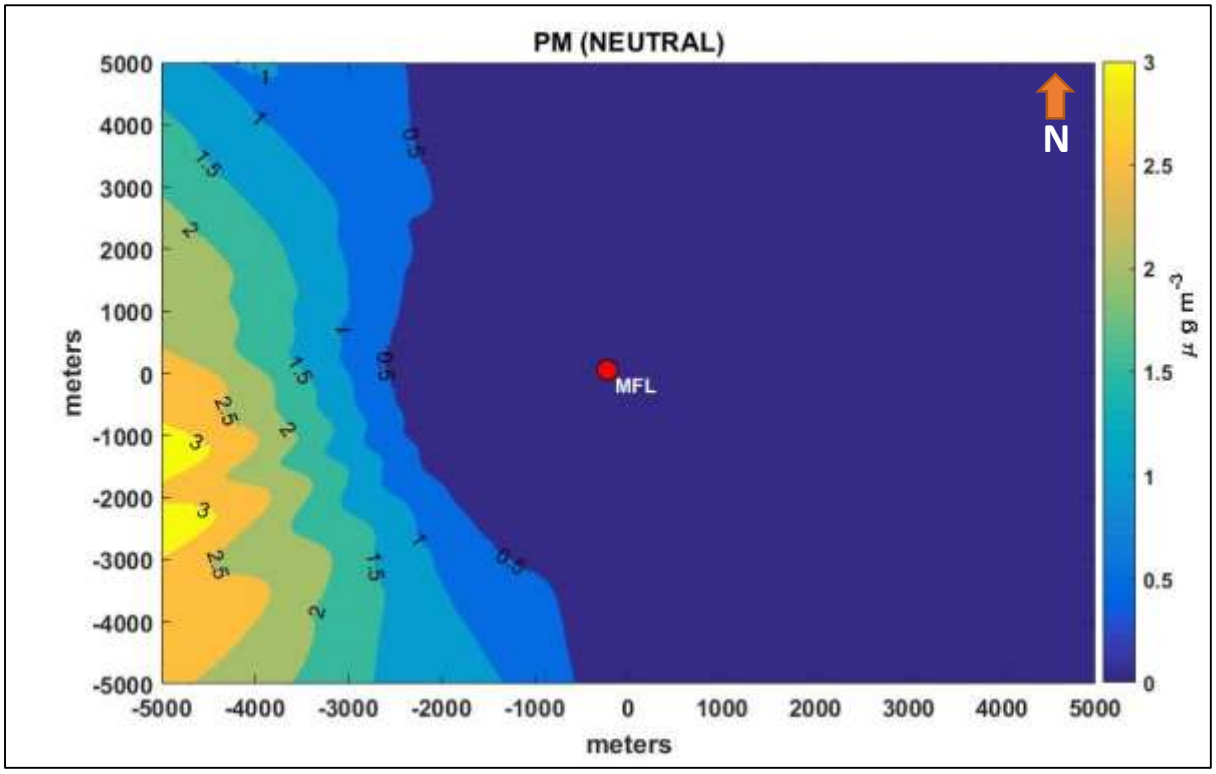

Figure.4.2. Dispersion of 24-hr average PM concentration during neutral condition from MFL.

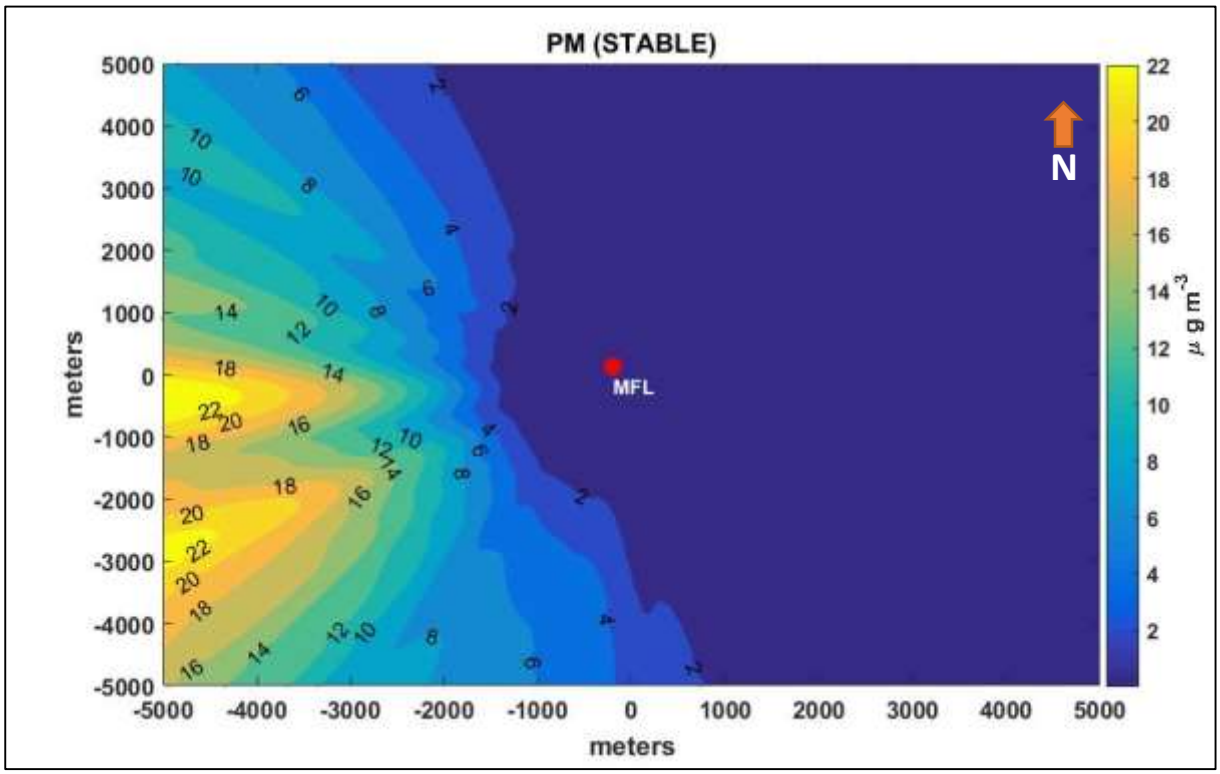

Figure.4.3. Dispersion of 24-hr average PM concentration during stable condition from MFL.

4.2.2 Modeling of ammonia concentration

The 24-hr averaged ammonia concentrations varied spatially between 0.05-0.55 µg/m^3 under unstable condition with a maximum concentration occurred at a distance of 500m from the MFL as shown in figure.4.4. The 24-hr average ammonia levels under stable and neutral stability varied spatially between 0.005-0.035 µg/m^3 and 0.005-0.045 µg/m^3 respectively as shown in figure.4.5 and figure.4.6. The predicted values were well within the NAAQS limits. The fastest diffusing rate (K=0.176) of ammonia and less ammonia emission from the stacks are responsible for low ammonia concentrations in the receptors.

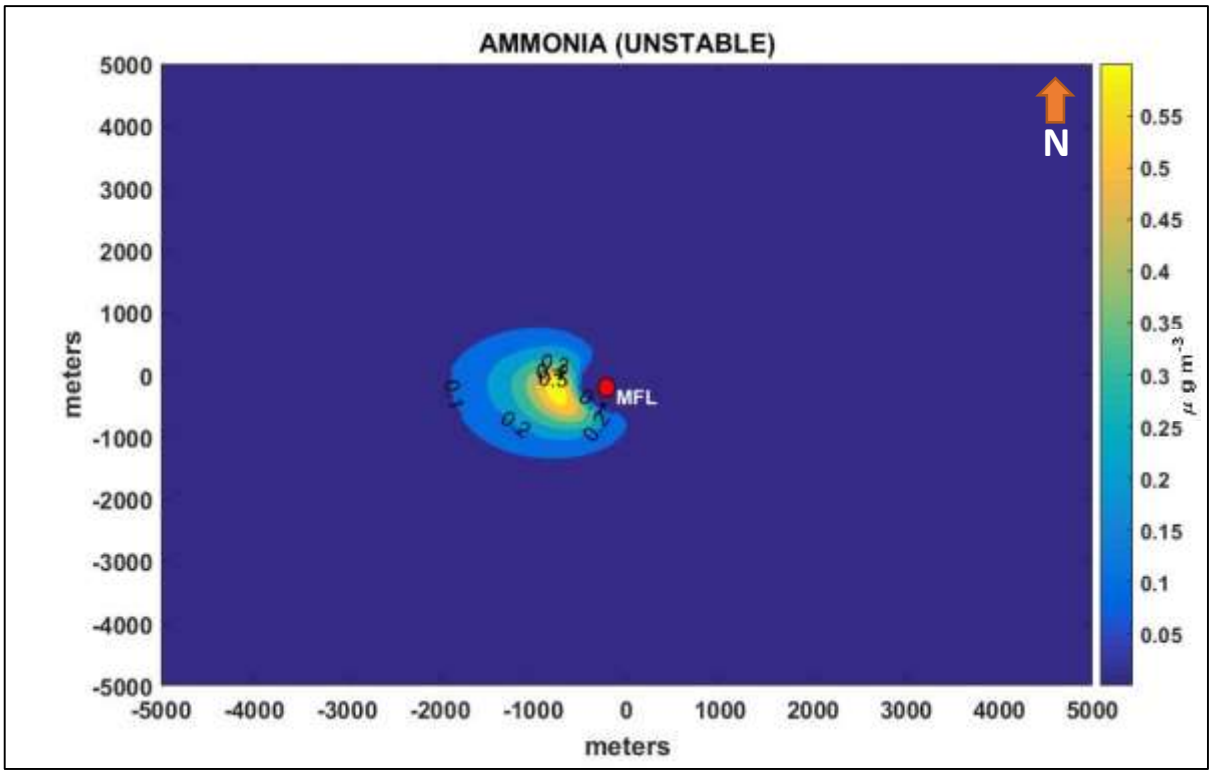

Figure.4.4. Dispersion of 24-hr average ammonia concentration during unstable condition from MFL.

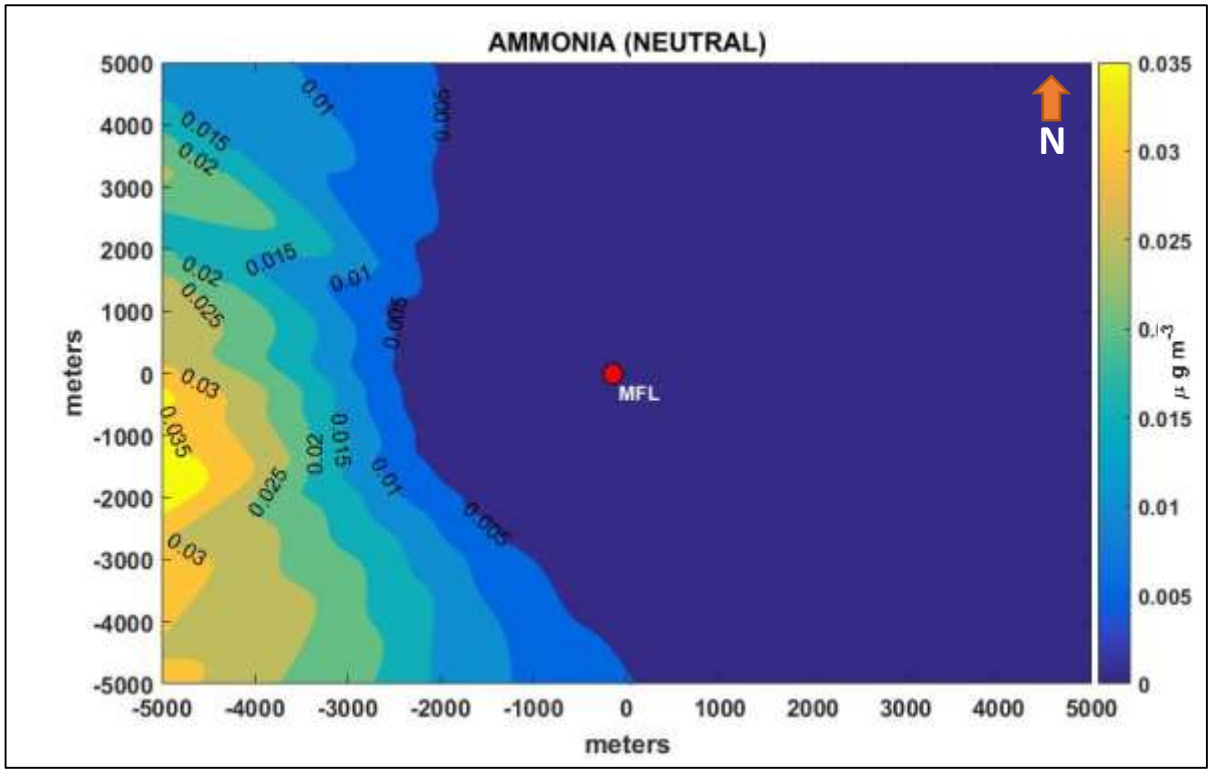

Figure.4.5. Dispersion of 24-hr average ammonia concentration during neutral condition from MFL

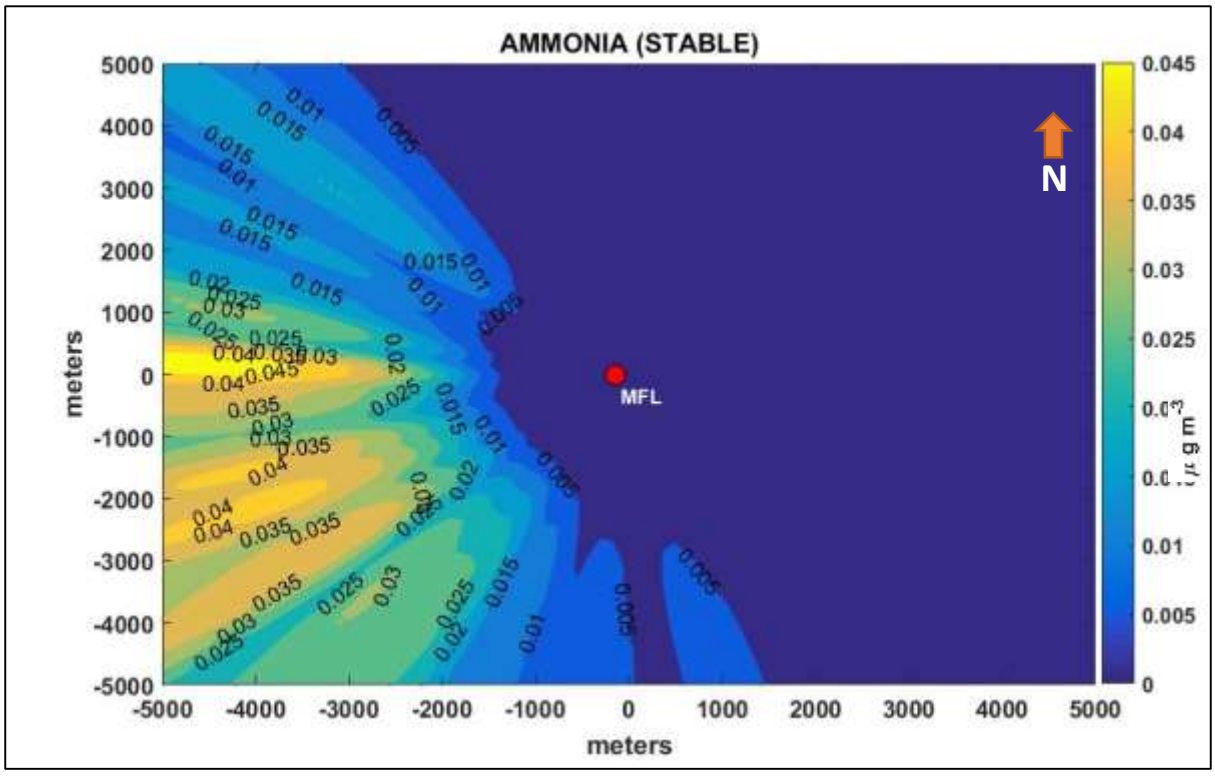

Figure.4.6. Dispersion of 24-hr average ammonia concentration during stable condition from MFL

4.2.3 Modeling of SO_2 concentration

The 24-hr averaged SO_2 concentrations varied spatially between 0.5-2.5 µg/m^3 under unstable condition with a maximum concentration observed for a distance of 1km from the MLF as shown in the figure.4.7. The very low 24-hr averaged SO_2 concentration was observed under neutral class in the study domain as shown in the figure.4.8. This is because the maximum SO_2 concentration may occurred after 5km. The 24-hr average SO_2 levels under stable condition varied spatially between 0.1-0.5 µg/m^3 as shown in the figure.4.9. The predicted concentrations were found well within the NAAQS limits.

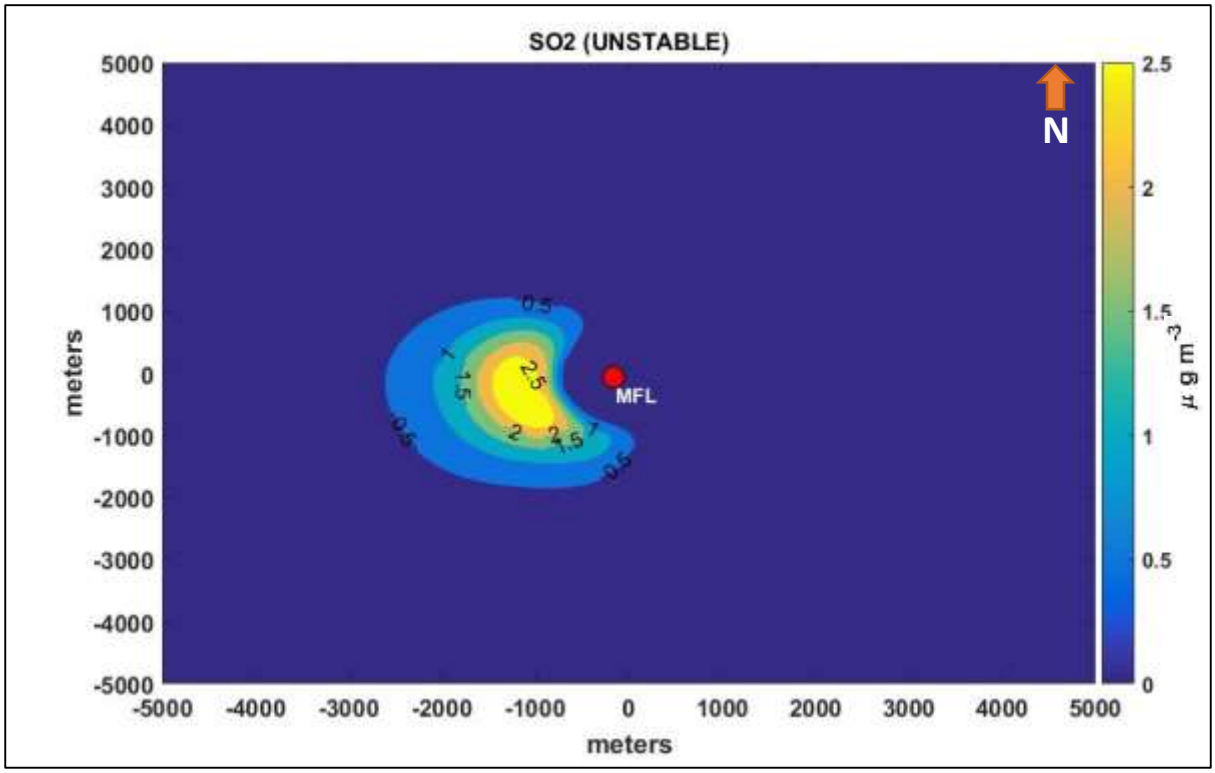

Figure.4.7. Dispersion of 24-hr average SO_2 concentration during unstable condition from MFL.

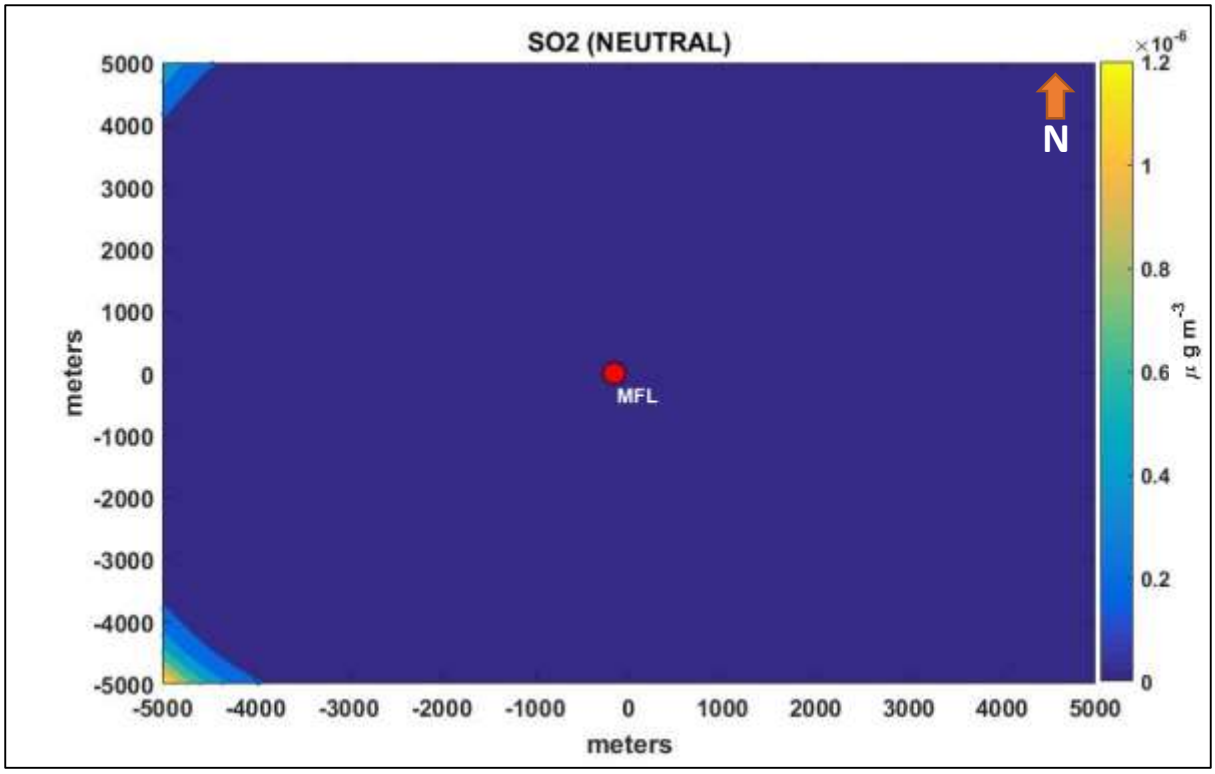

Figure.4.8. Dispersion of 24-hr average SO_2 concentration during neutral condition from MFL.

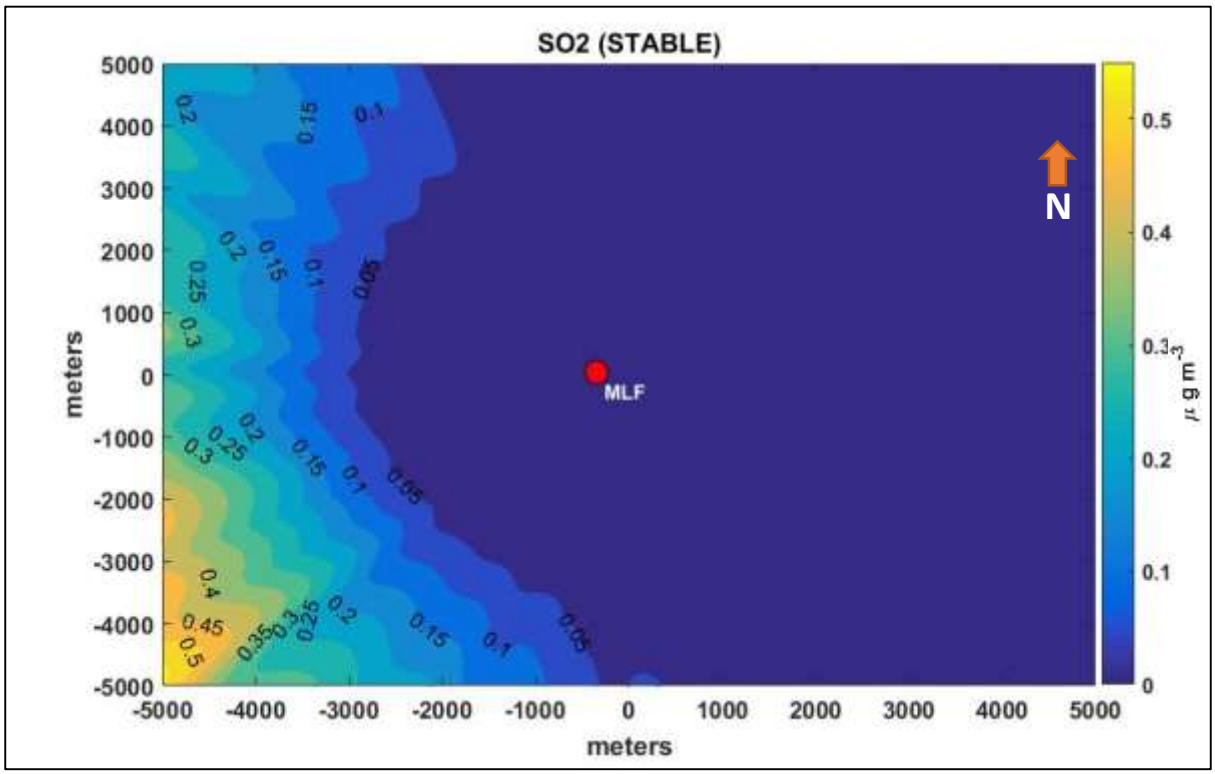

Figure.4.9. Dispersion of 24-hr average SO_2 concentration during stable condition from MFL.

4.2.4 Modeling of NO_X concentration

The 24-hr averaged NO_X concentrations varied spatially between 2-14 µg/m^3 under unstable condition with a maximum concentration observed at a distance of 1km from the MLF as shown in the figure.4.9. Similar to SO_2, NOx concentration was found very low in the study domain as shown in figure.4.10. The 24-hr average NOx levels under stable condition varied spatially between 0.2-1.4 µg/m^3 as shown in the figure.4.11. The predicted concentrations were found well with the NAAQS limits.

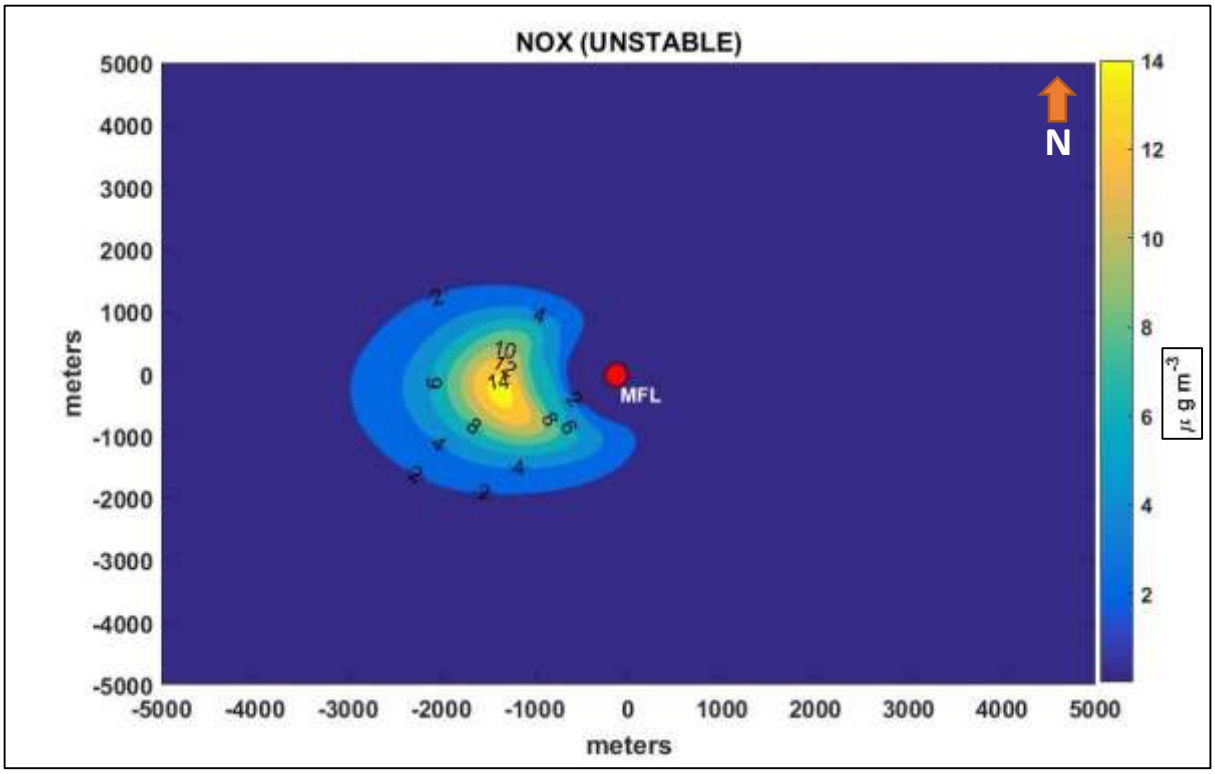

Figure.4.10. Dispersion of 24-hr average NO_x concentration during unstable condition from MFL.

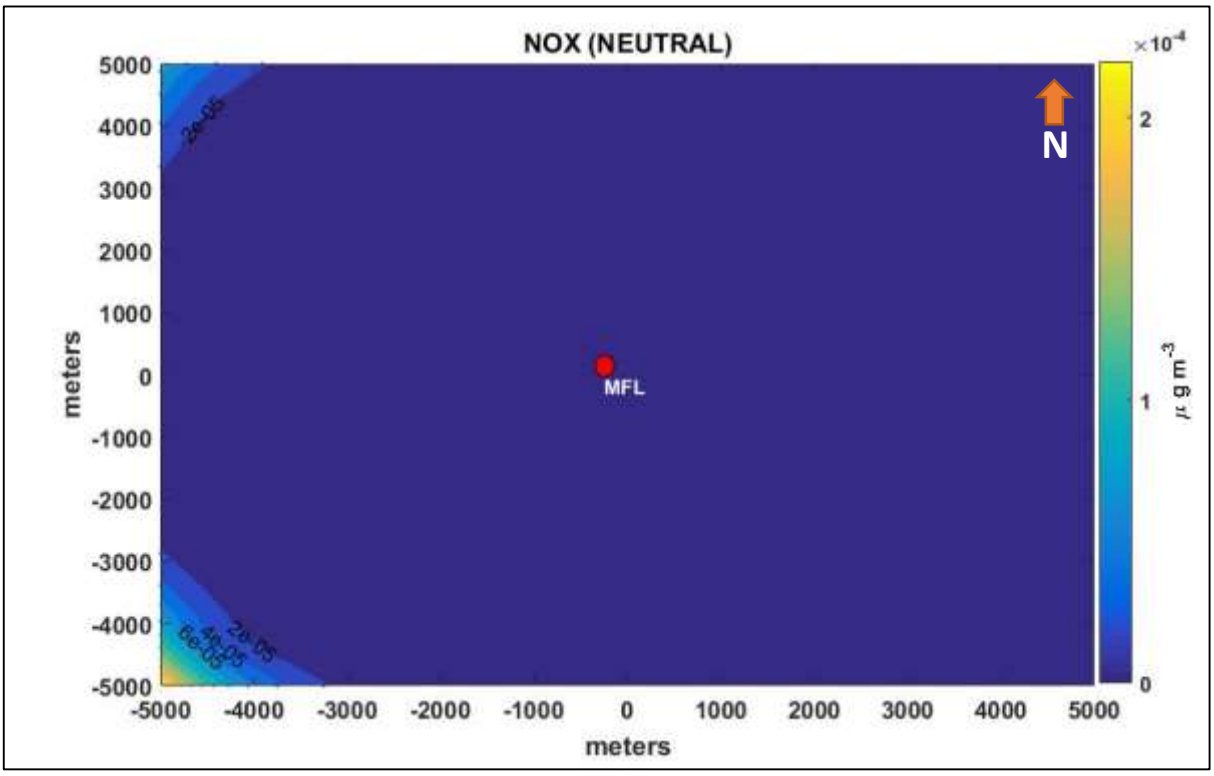

Figure.4.11.Dispersion of 24-hr average NO_x concentration during neutral condition from MFL.

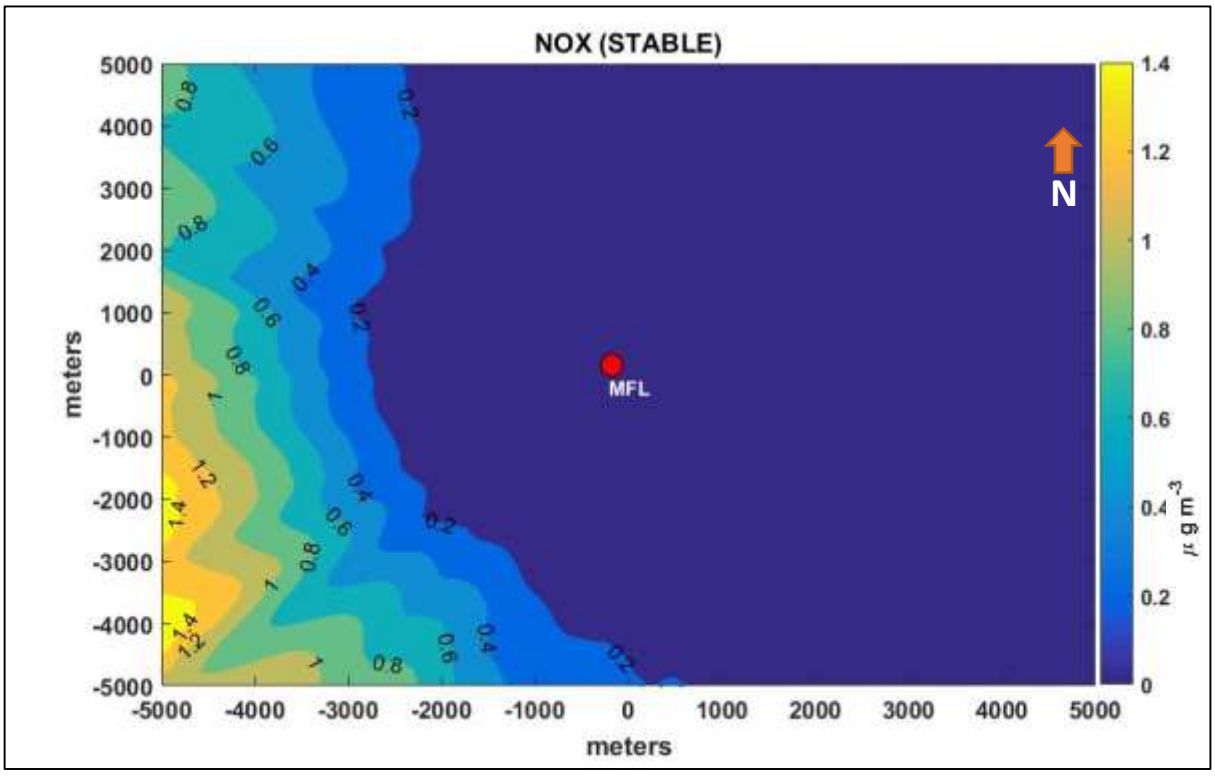

Figure.4.12. Dispersion of 24-hr average NO_x concentration during stable condition from MFL.

Chapter 5

SUMMARY AND CONCLUSION

5.1 Summary

Air quality and hazardous waste management assessment were carried out for MFL during 26th - 28th August 2020. The ambient, workspace, and point source monitoring was performed to assess the air quality and field inspection was carried out to assess the adequacy of hazardous waste and chemical storage facility. Eleven locations were chosen for ambient monitoring which covers the entire boundary of MFL. The locations were chosen based on the pre-dominant wind direction and physical observance of the location.

The results of monitoring showed the PM_{10} and $PM_{2.5}$ values were exceeding the NAAQS limits at 4 and 3 monitored locations repectively, while ammonia levels were exceeding at all the sampling points. Besides ambient monitoring, stationary monitoring was also carried out for utility, ammonia, urea and NPK stacks. PM and NOx emissions were exceeding the standards prescribed by CPCB for utility boiler stack. However, other pollutants (including ammonia) monitored for the above stacks were within the limits prescribed by CPCB. Pollutants from urea and NPK stacks were well within the CPCB limits. For, 110 ATA & PCB boiler stack, it has met the stack height criteria notified *vide* G.S.R. 176(E), dated the 2nd April 1996.

Work place monitoring was carried out to assess the ammonia levels in the work environment. Ammonia concentrations were found well within the limit given by NIOSH in all the sampling points. The hazardous waste and chemical storage yard was examined to check its compliance with specifications given by CPCB. Major categories of waste generated includes spent catalyst, residual oil and oil containing sludge.

5.2 Conclusions

5.2.1.Ambient monitoring

- The measured 24-hr PM_{10} concentration varied between 55.3 to 143.6 µg/m^3 and 24-hr $PM_{2.5}$ concentration varied between 27.8 to 86.4 µg/m^3. The measured PM concentrations were found within the NAAQS limit except at few locations ((PM_{10} = New DM plant, RO plant, LPG bullet area, and stripping plant) & ($PM_{2.5}$ = RO plant, LPG bullet area, and stripping plant)). The high PM concentrations at these points may

be attributed to location of these points in the direction of predominant winds which brings prominent emission from the plant stacks. Also, emissions from vicinity industry (SRF) and vehicles movement might have also contributed to the PM exceedance.

- The 24-hr NO_2 and SO_2 concentrations varied in the range of 35.4-38.9 and 23.7-26.7 $\mu g/m^3$ respectively and were found below the NAAQS limit at all the measured locations. Similarly, 24-hr HF and 1-hr CO concentrations (except LPG bullet area) were found below the detection level at all the measured points.
- The 24-hr ammonia concentration varied between 833.4 to 2977.3 $\mu g/m^3$. The ammonia levels were exceeding the NAAQS limits at all the monitored locations. At an average, the ammonia concentration was exceeding 4.3 times the National standard at MFL. The fugitive leaks from stripping plant, ammonia plant and, urea plant and liberation of ammonia from process water near LPG bullet area were responsible for high ambient ammonia concentration besides the emission from the plant stacks.
- Though the ammonia concentrations in ambient were exceeding the National standard but it is found within the standard of 25 ppm prescribed by NIOSH.

5.2.2 Stationary monitoring

- The PM and NOx emission from utility boiler stacks (PM =487.4 mg/Nm^3 & NOx = 429.57 mg/Nm^3 at 3% dry O_2) was exceeding the CPCB emission standard by 3.24 and 1.4 times respectively. Other pollutants (CO & SO_2) from utility boiler were below the CPCB norms. The use of furnance oil for combustion in utility boiler emits PM significantly. The high amount of excess air (utility boiler, O_2 =15.4% & ammonia boiler, O_2 =8.6%) used during the combustion process is responsible for high NO_X formation in the utility boilers.
- The PM emission from 110 ATA & PCB common stack were within the CPCB norms, CO and NH_3 were found within the below detection limit. There is no standard specified for sulphur dioxide and oxides of nitrogen for boilers using natural gas, it is required to meet stack height criteria notified *vide* G.S.R. 176(E), dated the 2nd April 1996. The 110 ATA & PCB common stack have height greater than the prescribed height of 11m.
- The NH_3 and PM emissions measured from the urea demister were found well below the CPCB emission norms and CO, NOx, and SO_2 were below the detection limit.
- The PM, NOx, CO, and NH_3 emission complied with the CPCB emission standards at the NPK stack. The SO_2 and HF were below the detection limit.

5.2.3.Workspace ammonia monitoring

- The 8-hr ammonia levels at workspace varied between 2.97 to 4.90 ppm and were found well below the NIOSH limit.

5.2.4 Hazardous waste storage adequacy

- Wastes were labelled and categorized according to the classification given by CPCB.
- Majority of the storage requiremnts prescribed by CPCB were not met with respect to spacing of storage containers, fire extinguishers etc.

5.2.5 Dispersion Modelling

Dispersion model was used to understand the spatial dispersion of emission from the stationary sources of MFL. The model was ran to predict 24-hr average pollutant concentration (SO_2, NO_X, PM and NH_3) during the calm condition of the year.

- The highest 24-hr average pollutant levels (PM= 80µg/m^3, NH_3= 0.55µg/m^3, SO_2 =2.5µg/m^3, NO_X =14µg/m^3) under unstable condition occurred at a distance between 0.5-1km from the MFL.
- The highest 24-hr average pollutants levels (PM= 3µg/m^3, NH_3= 0.035µg/m^3) under neutral condition occurred at a distance between 4-5km from the MFL.
- The highest 24-hr average pollutants levels (PM= 22µg/m^3, NH_3= 0.045µg/m^3, SO_2 =0.5 µg/m^3, NO_X =1.4µg/m^3) under stable condition occurred at a distance between 4-5km from the MFL.
- All the predicted pollutants concentration (SO_2, NO_X, PM and NH_3) under different vertical stability were found within the NAAQS limits.

Chapter 6

RECOMMENDATIONS

- The Natural gas shall be used in place of furnance oil in utility boiler to keep down the emissions.
- On-line monitoring at critical emission points shall be installed to provide information about the effect of malfunctions in the process and consequently the process conditions can be corrected.
- Proper fuel to air combustion ratio should be maintained to keep down the NOx production in the boiler.
- All liquid wastes (water in the gutter) should be properly treated and recycled into the process, so that stripping of ammonia from the process water can be minimized.
- The unit must take continuous effort on monitoring the plant and carrying out periodical inspection of the valves, gaskets, and pipelines of the ammonia and urea plant to avoid ammonia leakages in the plant.
- The plant shall revamp the equipment and re-design the process to abate the pollution problem.
- The hazardous waste facility should be provided with leak/spill management systems to avoid any accidents that may occurr due to spillage.
- The spacing beween the containers can be increased as per the provision given by CPCB.
- Additional shed can be constructed to accommodate the hazardous waste containers and spent catalyst accumulated in the hazardous waste shed so that storage of these chemicals in open space can be avoided.
- The waste containers must also be named along with the characteristics of the hazardous waste stored so that the safety protocols can be followed accordingly during transportation and handling of the waste.

Annexure – I (Observations of Air Quality Monitoring)

Report No : **EN20080049-01** **Report Date** : **18 Sep 2020**

SAMPLE DRAWN BY LABORATORY

Customer Name : Centre for Industrial Consultancy & Sponsored Research,
Indian Institute of Technology
Madras
(C/O Madras Fertilizers Limited)

Customer Address : Chennai,Tamilnadu- 600 036

Sample Name	:	Ambient Air Quality			
Sample Description	:	Ambient Air Quality	**Sampling Date & Time**	:	27 to 28 Aug 2020
Sample No	:	EN20080049-01			4.00 pm to 4.00 pm
Sampling Location	:	Back side of the MFL 110 Boiler Area-Up wind	**Sample Received on**	:	31 Aug 2020
Sample Condition	:	Fit for Analysis	**Test Started on**	:	31 Aug 2020
Relative Humidity	:	56 %	**Test Completed on**	:	08 Sep 2020
Sampling Procedure	:	IS 5182 Part V & XIV	**Ambient Temperature**	:	34°C
Latitude & Longitude	:	N 13°10.422, E 080°15.858			

Test Results

Sl.No	Test Name	Test Method	Results	Units	Requirement as per NAAQS Specification
1	Sulphur Dioxide as SO_2	IS 5182 (Part 2):2001	25.7	µg/m^3	80
2	Nitrogen Dioxide as NO_2	IS 5182 (Part 6):2006	38.9	µg/m^3	80
3	Particulate Matter (PM 10)	IS 5182 (Part 23):2006	74.3	µg/m^3	100
4	Particulate Matter (PM 2.5)	GL/EN/SOP/062	31.7	µg/m^3	60
5	Carbon Monoxide as CO (1 hour)	IS 5182 (Part 10):1999	BDL(DL:1.14)	mg/m^3	4
6	Ammonia as NH_3	GL/EN/SOP/057	1699.7	µg/m^3	400
7	Hydrogen Fluoride as HF	IS 5182 (Part 13):2004	BLQ(LOQ:0.02)	mg/m^3	-
8	Hydrocarbon as HC	IS 5182 (Part 17):2004	BLQ(LOQ:0.1)	mg/m^3	-

Remarks : The above Sample does not comply as per NAAQS limit which is provided in the environmental protection Rule 3 (3B) Nov.2009, against the above tested parameter.

Report No	**:**	**EN20080049-02**	**Report Date**	**:**	**18 Sep 2020**

SAMPLE DRAWN BY LABORATORY

Customer Name	**:**	Centre for Industrial Consultancy & Sponsored Research, Indian Institute of Technology Madras (C/O Madras Fertilizers Limited)
Customer Address	**:**	Chennai,Tamilnadu- 600 036

Sample Name	**:**	Ambient Air Quality			
Sample Description	**:**	Ambient Air Quality	**Sampling Date & Time**	**:**	27 to 28 Aug 2020
Sample No	**:**	EN20080049-02			3.40 pm to 3.40 pm
Sampling Location	**:**	MFL-ETP-Up Wind	**Sample Received on**	**:**	31 Aug 2020
Sample Condition	**:**	Fit for Analysis	**Test Started on**	**:**	31 Aug 2020
Relative Humidity	**:**	59 %	**Test Completed on**	**:**	08 Sep 2020
Sampling Procedure	**:**	IS 5182 Part V & XIV	**Ambient Temperature**	**:**	34°C
Latitude & Longitude	**:**	N 13°10.4131, E 080°15.911			

Test Results

Sl.No	Test Name	Test Method	Results	Units	Requirement as per NAAQS Specification
1	Sulphur Dioxide as SO_2	IS 5182 (Part 2):2001	26.0	µg/m^3	80
2	Nitrogen Dioxide as NO_2	IS 5182 (Part 6):2006	36.4	µg/m^3	80
3	Particulate Matter (PM 10)	IS 5182 (Part 23):2006	66.8	µg/m^3	100
4	Particulate Matter (PM 2.5)	GL/EN/SOP/062	29.8	µg/m^3	60
5	Carbon Monoxide as CO (1 hour)	IS 5182 (Part 10):1999	BDL(DL:1.14)	mg/m^3	4
6	Ammonia as NH_3	GL/EN/SOP/057	1582.8	µg/m^3	400
7	Hydrogen Fluoride as HF	IS 5182 (Part 13):2004	BLQ(LOQ:0.02)	mg/m^3	-
8	Hydrocarbon as HC	IS 5182 (Part 17):2004	BLQ(LOQ:0.1)	mg/m^3	-

Report No	**:**	**EN20080049-03**	**Report Date**	**:**	**18 Sep 2020**

SAMPLE DRAWN BY LABORATORY

Customer Name	**:**	Centre for Industrial Consultancy & Sponsored Research, Indian Institute of Technology Madras (C/O Madras Fertilizers Limited)
Customer Address	**:**	Chennai,Tamilnadu- 600 036

Sample Name	**:**	Ambient Air Quality			
Sample Description	**:**	Ambient Air Quality	**Sampling Date & Time**	**:**	27 to 28 Aug 2020 12.40 pm to 12.40 pm
Sample No	**:**	EN20080049-03			
Sampling Location	**:**	MFL-Labour Canteen-Down Wind	**Sample Received on**	**:**	31 Aug 2020
Sample Condition	**:**	Fit for Analysis	**Test Started on**	**:**	31 Aug 2020
Relative Humidity	**:**	58 %	**Test Completed on**	**:**	08 Sep 2020
Sampling Procedure	**:**	IS 5182 Part V & XIV	**Ambient Temperature**	**:**	35°C
Latitude & Longitude	**:**	N 13°10.4184, E 080°15.998			

Test Results

Sl.No	Test Name	Test Method	Results	Units	Requirement as per NAAQS Specification
1	Sulphur Dioxide as SO_2	IS 5182 (Part 2):2001	26.4	µg/m^3	80
2	Nitrogen Dioxide as NO_2	IS 5182 (Part 6):2006	35.7	µg/m^3	80
3	Particulate Matter (PM 10)	IS 5182 (Part 23):2006	82.1	µg/m^3	100
4	Particulate Matter (PM 2.5)	GL/EN/SOP/062	54.8	µg/m^3	60
5	Carbon Monoxide as CO (1 hour)	IS 5182 (Part 10):1999	BDL(DL:1.14)	mg/m^3	4
6	Ammonia as NH_3	GL/EN/SOP/057	2336.7	µg/m^3	400
7	Hydrogen Fluoride as HF	IS 5182 (Part 13):2004	BLQ(LOQ:0.02)	mg/m^3	-
8	Hydrocarbon as HC	IS 5182 (Part 17):2004	BLQ(LOQ:0.1)	mg/m^3	-

Report No	**:**	**EN20080049-04**	**Report Date**	**:**	**18 Sep 2020**

SAMPLE DRAWN BY LABORATORY

Customer Name	**:**	Centre for Industrial Consultancy & Sponsored Research, Indian Institute of Technology Madras (C/O Madras Fertilizers Limited)
Customer Address	**:**	Chennai,Tamilnadu- 600 036

Sample Name	**:**	Ambient Air Quality			
Sample Description	**:**	Ambient Air Quality	**Sampling Date & Time**	**:**	27 to 28 Aug 2020 11.55 pm to 11.55 pm
Sample No	**:**	EN20080049-04			
Sampling Location	**:**	MFL-SOS Building-Cross Wind	**Sample Received on**	**:**	31 Aug 2020
Sample Condition	**:**	Fit for Analysis	**Test Started on**	**:**	31 Aug 2020
Relative Humidity	**:**	60 %	**Test Completed on**	**:**	08 Sep 2020
Sampling Procedure	**:**	IS 5182 Part V & XIV	**Ambient Temperature**	**:**	35°C
Latitude & Longitude	**:**	N 13°10.187, E 080°16.103			

Test Results

Sl.No	Test Name	Test Method	Results	Units	Requirement as per NAAQS Specification
1	Sulphur Dioxide as SO_2	IS 5182 (Part 2):2001	26.0	µg/m^3	80
2	Nitrogen Dioxide as NO_2	IS 5182 (Part 6):2006	35.4	µg/m^3	80
3	Particulate Matter (PM 10)	IS 5182 (Part 23):2006	92.0	µg/m^3	100
4	Particulate Matter (PM 2.5)	GL/EN/SOP/062	49.4	µg/m^3	60
5	Carbon Monoxide as CO (1 hour)	IS 5182 (Part 10):1999	BDL(DL:1.14)	mg/m^3	4
6	Ammonia as NH_3	GL/EN/SOP/057	833.4	µg/m^3	400
7	Hydrogen Fluoride as HF	IS 5182 (Part 13):2004	BLQ(LOQ:0.02)	mg/m^3	-
8	Hydrocarbon as HC	IS 5182 (Part 17):2004	BLQ(LOQ:0.1)	mg/m^3	-

Report No	**:**	**EN20080049-05**	**Report Date**	**:**	**18 Sep 2020**

SAMPLE DRAWN BY LABORATORY

Customer Name	**:**	Centre for Industrial Consultancy & Sponsored Research, Indian Institute of Technology Madras (C/O Madras Fertilizers Limited)
Customer Address	**:**	Chennai,Tamilnadu- 600 036

Sample Name	**:**	Ambient Air Quality			
Sample Description	**:**	Ambient Air Quality	**Sampling Date & Time**	**:**	27 to 28 Aug 2020 11.20 pm to 11.20 pm
Sample No	**:**	EN20080049-05			
Sampling Location	**:**	MFL-RO Plant Effluent top-Cross Wind	**Sample Received on**	**:**	31 Aug 2020
Sample Condition	**:**	Fit for Analysis	**Test Started on**	**:**	31 Aug 2020
Relative Humidity	**:**	58 %	**Test Completed on**	**:**	08 Sep 2020
Sampling Procedure	**:**	IS 5182 Part V & XIV	**Ambient Temperature**	**:**	35°C
Latitude & Longitude	**:**	N 13°10.324, E 080°16.117			

Test Results

Sl.No	Test Name	Test Method	Results	Units	Requirement as per NAAQS Specification
1	Sulphur Dioxide as SO_2	IS 5182 (Part 2):2001	26.2	$\mu g/m^3$	80
2	Nitrogen Dioxide as NO_2	IS 5182 (Part 6):2006	36.5	$\mu g/m^3$	80
3	Particulate Matter (PM 10)	IS 5182 (Part 23):2006	143.6	$\mu g/m^3$	100
4	Particulate Matter (PM 2.5)	GL/EN/SOP/062	86.4	$\mu g/m^3$	60
5	Carbon Monoxide as CO (1 hour)	IS 5182 (Part 10):1999	BDL(DL:1.14)	mg/m^3	4
6	Ammonia as NH_3	GL/EN/SOP/057	2211.5	$\mu g/m^3$	400
7	Hydrogen Fluoride as HF	IS 5182 (Part 13):2004	BLQ(LOQ:0.02)	mg/m^3	-
8	Hydrocarbon as HC	IS 5182 (Part 17):2004	BLQ(LOQ:0.1)	mg/m^3	-

Report No	**:**	**EN20080049-06**	**Report Date**	**:**	**18 Sep 2020**

SAMPLE DRAWN BY LABORATORY

Customer Name	**:**	Centre for Industrial Consultancy & Sponsored Research, Indian Institute of Technology Madras (C/O Madras Fertilizers Limited)
Customer Address	**:**	Chennai,Tamilnadu- 600 036

Sample Name	**:**	Ambient Air Quality			
Sample Description	**:**	Ambient Air Quality	**Sampling Date & Time**	**:**	26 to 27 Aug 2020
Sample No	**:**	EN20080049-06			2.35 pm to 2.35 pm
Sampling Location	**:**	MFL-LPG Bullet area-Up Wind	**Sample Received on**	**:**	31 Aug 2020
Sample Condition	**:**	Fit for Analysis	**Test Started on**	**:**	31 Aug 2020
Relative Humidity	**:**	65.9 %	**Test Completed on**	**:**	08 Sep 2020
Sampling Procedure	**:**	IS 5182 Part V & XIV	**Ambient Temperature**	**:**	34.1°C
Latitude & Longitude	**:**	N 13°10.581, E 080°15.883			

Test Results

Sl.No	Test Name	Test Method	Results	Units	Requirement as per NAAQS Specification
1	Sulphur Dioxide as SO_2	IS 5182 (Part 2):2001	26.7	µg/m^3	80
2	Nitrogen Dioxide as NO_2	IS 5182 (Part 6):2006	37.2	µg/m^3	80
3	Particulate Matter (PM 10)	IS 5182 (Part 23):2006	112.3	µg/m^3	100
4	Particulate Matter (PM 2.5)	GL/EN/SOP/062	63.4	µg/m^3	60
5	Carbon Monoxide as CO (1 hour)	IS 5182 (Part 10):1999	1.67	mg/m^3	4
6	Ammonia as NH_3	GL/EN/SOP/057	2190.3	µg/m^3	400
7	Hydrogen Fluoride as HF	IS 5182 (Part 13):2004	BLQ(LOQ:0.02)	mg/m^3	-
8	Hydrocarbon as HC	IS 5182 (Part 17):2004	BLQ(LOQ:0.1)	mg/m^3	-

Report No	**:**	**EN20080049-07**	**Report Date**	**:**	**18 Sep 2020**

SAMPLE DRAWN BY LABORATORY

Customer Name	**:**	Centre for Industrial Consultancy & Sponsored Research, Indian Institute of Technology Madras (C/O Madras Fertilizers Limited)
Customer Address	**:**	Chennai,Tamilnadu- 600 036

Sample Name	**:**	Ambient Air Quality			
Sample Description	**:**	Ambient Air Quality	**Sampling Date & Time**	**:**	26 to 27 Aug 2020
Sample No	**:**	EN20080049-07			2.20 pm to 2.20 pm
Sampling Location	**:**	MFL-New DM plant-Down Wind	**Sample Received on**	**:**	31 Aug 2020
Sample Condition	**:**	Fit for Analysis	**Test Started on**	**:**	31 Aug 2020
Relative Humidity	**:**	61.2 %	**Test Completed on**	**:**	08 Sep 2020
Sampling Procedure	**:**	IS 5182 Part V & XIV	**Ambient Temperature**	**:**	34.9°C
Latitude & Longitude	**:**	N 13°10.416, E 080°16.089			

Test Results

Sl.No	Test Name	Test Method	Results	Units	Requirement as per NAAQS Specification
1	Sulphur Dioxide as SO_2	IS 5182 (Part 2):2001	23.7	µg/m^3	80
2	Nitrogen Dioxide as NO_2	IS 5182 (Part 6):2006	35.8	µg/m^3	80
3	Particulate Matter (PM 10)	IS 5182 (Part 23):2006	105.9	µg/m^3	100
4	Particulate Matter (PM 2.5)	GL/EN/SOP/062	59.2	µg/m^3	60
5	Carbon Monoxide as CO (1 hour)	IS 5182 (Part 10):1999	BDL(DL:1.1.4)	mg/m^3	4
6	Ammonia as NH_3	GL/EN/SOP/057	1416.3	µg/m^3	400
7	Hydrogen Fluoride as HF	IS 5182 (Part 13):2004	BLQ(LOQ:0.02)	mg/m^3	-
8	Hydrocarbon as HC	IS 5182 (Part 17):2004	BLQ(LOQ:0.1)	mg/m^3	-

Report No	**:**	**EN20080049-08**	**Report Date**	**:**	**18 Sep 2020**

SAMPLE DRAWN BY LABORATORY

Customer Name	**:**	Centre for Industrial Consultancy & Sponsored Research, Indian Institute of Technology Madras (C/O Madras Fertilizers Limited)
Customer Address	**:**	Chennai,Tamilnadu- 600 036

Sample Name	**:**	Ambient Air Quality			
Sample Description	**:**	Ambient Air Quality	**Sampling Date & Time**	**:**	26 to 27 Aug 2020 11.00 am to 11.00 am
Sample No	**:**	EN20080049-08			
Sampling Location	**:**	MFL-Top of the admin building-Cross Wind	**Sample Received on**	**:**	31 Aug 2020
Sample Condition	**:**	Fit for Analysis	**Test Started on**	**:**	31 Aug 2020
Relative Humidity	**:**	56.5 %	**Test Completed on**	**:**	08 Sep 2020
Sampling Procedure	**:**	IS 5182 Part V & XIV	**Ambient Temperature**	**:**	36.2°C
Latitude & Longitude	**:**	N 13°10.523, E 080°16.191			

Test Results

Sl.No	Test Name	Test Method	Results	Units	Requirement as per NAAQS Specification
1	Sulphur Dioxide as SO_2	IS 5182 (Part 2):2001	24.4	$\mu g/m^3$	80
2	Nitrogen Dioxide as NO_2	IS 5182 (Part 6):2006	34.8	$\mu g/m^3$	80
3	Particulate Matter (PM 10)	IS 5182 (Part 23):2006	55.3	$\mu g/m^3$	100
4	Particulate Matter (PM 2.5)	GL/EN/SOP/062	27.8	$\mu g/m^3$	60
5	Carbon Monoxide as CO (1 hour)	IS 5182 (Part 10):1999	BDL(DL:1.1.4)	mg/m^3	4
6	Ammonia as NH_3	GL/EN/SOP/057	1431.5	$\mu g/m^3$	400
7	Hydrogen Fluoride as HF	IS 5182 (Part 13):2004	BLQ(LOQ:0.02)	mg/m^3	-
8	Hydrocarbon as HC	IS 5182 (Part 17):2004	BLQ(LOQ:0.1)	mg/m^3	-

Report No	**:**	**EN20080049-09**	**Report Date**	**:**	**18 Sep 2020**

SAMPLE DRAWN BY LABORATORY

Customer Name	**:**	Centre for Industrial Consultancy & Sponsored Research, Indian Institute of Technology Madras (C/O Madras Fertilizers Limited)
Customer Address	**:**	Chennai,Tamilnadu- 600 036

Sample Name	**:**	Ambient Air Quality			
Sample Description	**:**	Ambient Air Quality	**Sampling Date & Time**	**:**	26 to 27 Aug 2020
Sample No	**:**	EN20080049-09			10.40 am to 10.40 am
Sampling Location	**:**	MFL-Mechanical workshop-Cross Wind	**Sample Received on**	**:**	31 Aug 2020
Sample Condition	**:**	Fit for Analysis	**Test Started on**	**:**	31 Aug 2020
Relative Humidity	**:**	59 %	**Test Completed on**	**:**	08 Sep 2020
Sampling Procedure	**:**	IS 5182 Part V & XIV	**Ambient Temperature**	**:**	36.2°C
Latitude & Longitude	**:**	N 13°10.545, E 080°16.085			

Test Results

SI.No	Test Name	Test Method	Results	Units	Requirement as per NAAQS Specification
1	Sulphur Dioxide as SO_2	IS 5182 (Part 2):2001	25.2	$\mu g/m^3$	80
2	Nitrogen Dioxide as NO_2	IS 5182 (Part 6):2006	37.2	$\mu g/m^3$	80
3	Particulate Matter (PM 10)	IS 5182 (Part 23):2006	93.7	$\mu g/m^3$	100
4	Particulate Matter (PM 2.5)	GL/EN/SOP/062	43.6	$\mu g/m^3$	60
5	Carbon Monoxide as CO (1 hour)	IS 5182 (Part 10):1999	BDL(DL:1.1.4)	mg/m^3	4
6	Ammonia as NH_3	GL/EN/SOP/057	1199.4	$\mu g/m^3$	400
7	Hydrogen Fluoride as HF	IS 5182 (Part 13):2004	BLQ(LOQ:0.02)	mg/m^3	-
8	Hydrocarbon as HC	IS 5182 (Part 17):2004	BLQ(LOQ:0.1)	mg/m^3	-

Report No	**:**	**EN20080049-10**	**Report Date**	**:**	**18 Sep 2020**

SAMPLE DRAWN BY LABORATORY

Customer Name	**:**	Centre for Industrial Consultancy & Sponsored Research, Indian Institute of Technology Madras (C/O Madras Fertilizers Limited)
Customer Address	**:**	Chennai,Tamilnadu- 600 036

Sample Name	**:**	Ambient Air Quality			
Sample Description	**:**	Ambient Air Quality	**Sampling Date & Time**	**:**	26 to 27 Aug 2020 12.40 am to 12.40 am
Sample No	**:**	EN20080049-10			
Sampling Location	**:**	MFL-Ammonia Plant-Up Wind	**Sample Received on**	**:**	31 Aug 2020
Sample Condition	**:**	Fit for Analysis	**Test Started on**	**:**	31 Aug 2020
Relative Humidity	**:**	61.7 %	**Test Completed on**	**:**	08 Sep 2020
Sampling Procedure	**:**	IS 5182 Part V & XIV	**Ambient Temperature**	**:**	32.9°C
Latitude & Longitude	**:**	N 13°10.312, E 080°15.863			

Test Results

Sl.No	Test Name	Test Method	Results	Units	Requirement as per NAAQS Specification
1	Sulphur Dioxide as SO_2	IS 5182 (Part 2):2001	25.6	µg/m^3	80
2	Nitrogen Dioxide as NO_2	IS 5182 (Part 6):2006	36.4	µg/m^3	80
3	Particulate Matter (PM 10)	IS 5182 (Part 23):2006	89.6	µg/m^3	100
4	Particulate Matter (PM 2.5)	GL/EN/SOP/062	40.3	µg/m^3	60
5	Carbon Monoxide as CO (1 hour)	IS 5182 (Part 10):1999	BDL(DL:1.1.4)	mg/m^3	4
6	Ammonia as NH_3	GL/EN/SOP/057	1387.8	µg/m^3	400
7	Hydrogen Fluoride as HF	IS 5182 (Part 13):2004	BLQ(LOQ:0.02)	mg/m^3	-
8	Hydrocarbon as HC	IS 5182 (Part 17):2004	BLQ(LOQ:0.1)	mg/m^3	-

Report No	**:**	**EN20080049-11**	**Report Date**	**:**	**18 Sep 2020**

SAMPLE DRAWN BY LABORATORY

Customer Name	**:**	Centre for Industrial Consultancy & Sponsored Research, Indian Institute of Technology Madras (C/O Madras Fertilizers Limited)
Customer Address	**:**	Chennai,Tamilnadu- 600 036

Sample Name	**:**	Ambient Air Quality			
Sample Description	**:**	Ambient Air Quality	**Sampling Date & Time**	**:**	26 to 27 Aug 2020 11.55 am to 11.55 am
Sample No	**:**	EN20080049-11			
Sampling Location	**:**	MFL-Stripper Plant-Cross Wind	**Sample Received on**	**:**	31 Aug 2020
Sample Condition	**:**	Fit for Analysis	**Test Started on**	**:**	31 Aug 2020
Relative Humidity	**:**	67 %	**Test Completed on**	**:**	08 Sep 2020
Sampling Procedure	**:**	IS 5182 Part V & XIV	**Ambient Temperature**	**:**	33.5°C
Latitude & Longitude	**:**	N 13°10.494, E 080°15.951			

Test Results

Sl.No	Test Name	Test Method	Results	Units	Requirement as per NAAQS Specification
1	Sulphur Dioxide as SO_2	IS 5182 (Part 2):2001	24.6	µg/m^3	80
2	Nitrogen Dioxide as NO_2	IS 5182 (Part 6):2006	37.8	µg/m^3	80
3	Particulate Matter (PM 10)	IS 5182 (Part 23):2006	123.4	µg/m^3	100
4	Particulate Matter (PM 2.5)	GL/EN/SOP/062	65.2	µg/m^3	60
5	Carbon Monoxide as CO (1 hour)	IS 5182 (Part 10):1999	BDL(DL:1.1.4)	mg/m^3	4
6	Ammonia as NH_3	GL/EN/SOP/057	2977.3	µg/m^3	400
7	Hydrogen Fluoride as HF	IS 5182 (Part 13):2004	BLQ(LOQ:0.02)	mg/m^3	-
8	Hydrocarbon as HC	IS 5182 (Part 17):2004	BLQ(LOQ:0.1)	mg/m^3	-

Wind Direction: Predominant wind direction is from West 57% and from South 39%

STACK MONITORING

Report No : **EN20080049-12** **Report Date** : **18 Sep 2020**

SAMPLE DRAWN BY LABORATORY

Customer Name : Centre for Industrial Consultancy & Sponsored Research, Indian Institute of Technology Madras (C/O Madras Fertilizers Limited)

Customer Address : Chennai,Tamilnadu- 600 036

Sample Description : Stack Emission

Sample No : EN20080049-12 **Sampling Date** : 27 Aug 2020

Sampling Location : Utility boiler 1 & 2 **Sample Received on** : 31 Aug 2020

Sample Condition : Fit for Analysis **Test Started on** : 31 Aug 2020

Sampling Procedure : GL/EN/SOP/111 **Test Completed on** : 08 Sep 2020

Test result

S.No	Test Name	Test Method	Results	Units	Limit as per CPCB Standard
1	Stack Temperature	IS 11255 (Part – 3):2008	408	K	-
2	Velocity	EPA Method 1-3	5.6	m/sec	-
3	Volume of Gas Discharge	IS 11255 (Part – 3):2008	281146	Nm^3/hr	-
4	Oxygen as O_2	GL/EN/SOP/149	15.4	%	-
5	Carbon Monoxide as CO	GL/EN/SOP/149	2	mg/m^3	-
6	Carbon Dioxide as CO_2	GL/EN/SOP/149	3.2	%	-
7	Particulate Matter	GL/EN/SOP/113	487.4	mg/Nm_3	150
8	Sulphur Dioxide as SO_2	EPA Method 6	68.2	mg/m^3	-
9	Oxides Of Nitrogen as NO_2	GL/EN/SOP/149	132	mg/m^3	-

Report No : **EN20080049-13** **Report Date** : **18 Sep 2020**

SAMPLE DRAWN BY LABORATORY

Customer Name : Centre for Industrial Consultancy & Sponsored Research,
Indian Institute of Technology
Madras
(C/O Madras Fertilizers Limited)

Customer Address : Chennai,Tamilnadu- 600 036

Sample Description : Stack Emission

Sample No : EN20080049-13 **Sampling Date** : 28 Aug 2020

Sampling Location : Ammonia Boiler (110 ATA & PC attached chimney) **Sample Received on** : 31 Aug 2020

Sample Condition : Fit for Analysis **Test Started on** : 31 Aug 2020

Sampling Procedure : GL/EN/SOP/111 **Test Completed on** : 08 Sep 2020

Test result

S.No	Test Name	Test Method	Results	Units	Limit as per CPCB Standard
1	Stack Temperature	IS 11255 (Part – 3):2008	398	K	-
2	Velocity	EPA Method 1-3	4.79	m/sec	-
3	Volume of Gas Discharge	IS 11255 (Part – 3):2008	390611	Nm^3/hr	-
4	Oxygen as O_2	GL/EN/SOP/149	8.6	%	-
5	Carbon Monoxide as CO	GL/EN/SOP/149	BDL(DL:1.14)	mg/m^3	-
6	Carbon Dioxide as CO_2	GL/EN/SOP/149	7.0	%	-
7	Particulate Matter	GL/EN/SOP/113	6.2	mg/Nm_3	150
8	Sulphur Dioxide as SO_2	EPA Method 6	13.4	mg/m^3	-
9	Oxides Of Nitrogen as NO_2	GL/EN/SOP/149	228	mg/m^3	-
10	Ammonia as NH3	IS 11255 (Part – 6):2008	BDL (DL:0.02)	mg/Nm^3	-

Report No	**:**	**EN20080049-14**	**Report Date**	**:**	**18 Sep 2020**

SAMPLE DRAWN BY LABORATORY

Customer Name	**:**	Centre for Industrial Consultancy & Sponsored Research, Indian Institute of Technology Madras (C/O Madras Fertilizers Limited)
Customer Address	**:**	Chennai,Tamilnadu- 600 036

Sample Description	**:**	Stack Emission			
Sample No	**:**	EN20080049-14	**Sampling Date**	**:**	28 Aug 2020
Sampling Location	**:**	Urea - Demister area	**Sample Received on**	**:**	31 Aug 2020
Sample Condition	**:**	Fit for Analysis	**Test Started on**	**:**	31 Aug 2020
Sampling Procedure	**:**	GL/EN/SOP/111	**Test Completed on**	**:**	08 Sep 2020

Test result

S.No	Test Name	Test Method	Results	Units	Limit as per CPCB Standard
1	Stack Temperature	IS 11255 (Part – 3):2008	314	K	-
2	Velocity	EPA Method 1-3	3.44	m/sec	-
3	Volume of Gas Discharge	IS 11255 (Part – 3):2008	510664	Nm^3/hr	-
4	Oxygen as O_2	GL/EN/SOP/149	20.7	%	-
5	Carbon Monoxide as CO	GL/EN/SOP/149	BDL(DL:1.14)	mg/m^3	-
6	Carbon Dioxide as CO_2	GL/EN/SOP/149	0.1	%	-
7	Particulate Matter	GL/EN/SOP/113	30.2	mg/Nm_3	150
8	Sulphur Dioxide as SO_2	EPA Method 6	BDL(DL:3.0)	mg/m^3	-
9	Oxides Of Nitrogen as NO_2	GL/EN/SOP/149	BDL(DL:2.0)	mg/m^3	-
10	Ammonia as NH3	IS 11255 (Part – 6):2008	11.1	mg/Nm^3	-
11	Hydrogen Fluoride as HF	GL/EN/SOP/154	BDL(DL:0.02)	mg/m^3	-

Report No	**:**	**EN20080049-15**	**Report Date**	**:**	**18 Sep 2020**

SAMPLE DRAWN BY LABORATORY

Customer Name	**:**	Centre for Industrial Consultancy & Sponsored Research, Indian Institute of Technology Madras (C/O Madras Fertilizers Limited)
Customer Address	**:**	Chennai,Tamilnadu- 600 036

Sample Description	**:**	Stack Emission			
Sample No	**:**	EN20080049-15	**Sampling Date**	**:**	28 Aug 2020
Sampling Location	**:**	NPK Stack	**Sample Received on**	**:**	31 Aug 2020
Sample Condition	**:**	Fit for Analysis	**Test Started on**	**:**	31 Aug 2020
Sampling Procedure	**:**	GL/EN/SOP/111	**Test Completed on**	**:**	08 Sep 2020

Test result

S.No	Test Name	Test Method	Results	Units	Limit as per CPCB Standard
1	Stack Temperature	IS 11255 (Part – 3):2008	319	K	-
2	Velocity	EPA Method 1-3	11.71	m/sec	-
3	Volume of Gas Discharge	IS 11255 (Part – 3):2008	191255	Nm^3/hr	-
4	Oxygen as O_2	GL/EN/SOP/149	20.6	%	-
5	Carbon Monoxide as CO	GL/EN/SOP/149	132	mg/m^3	-
6	Carbon Dioxide as CO_2	GL/EN/SOP/149	0.2	%	-
7	Particulate Matter	GL/EN/SOP/113	29.8	mg/Nm_3	150
8	Sulphur Dioxide as SO_2	EPA Method 6	BDL(DL:3.0)	mg/m^3	-
9	Oxides Of Nitrogen as NO_2	GL/EN/SOP/149	2	mg/m^3	-
10	Ammonia as NH3	IS 11255 (Part – 6):2008	13.7	mg/Nm^3	-
11	Hydrogen Fluoride as HF	GL/EN/SOP/154	BDL(DL:0.02)	mg/m^3	-

WORL PLACE MONITORING

Report No : **EN20080049-16** **Report Date** : **04 Sep 2020**

SAMPLE DRAWN BY LABORATORY

Customer Name : Centre for Industrial Consultancy & Sponsored Research, Indian Institute of Technology Madras (C/O Madras Fertilizers Limited)

Customer Address : Chennai,Tamilnadu- 600 036

Sample Description : Fugitive Emission

Sample No : EN20080049-16 **Sampling Date** : 28 Aug 2020

Sampling Location : Ammonia Plant - MFL **Sample Received on** : 31 Aug 2020

Sample Condition : Fit for Analysis **Test Started on** : 31 Aug 2020

Test Completed on : 08 Sep 2020

Test result

S.No	Test Name	Test Method	Results	Units
1	Ammonia as NH3	NIOSH - 6015	3.3	mg/m3

Report No : **EN20080049-17** **Report Date** : **04 Sep 2020**

SAMPLE DRAWN BY LABORATORY

Customer Name : Centre for Industrial Consultancy & Sponsored Research, Indian Institute of Technology Madras (C/O Madras Fertilizers Limited)

Customer Address : Chennai,Tamilnadu- 600 036

Sample Description : Fugitive Emission

Sample No : EN20080049-17 **Sampling Date** : 28 Aug 2020

Sampling Location : Urea Plant - MFL **Sample Received on** : 31 Aug 2020

Sample Condition : Fit for Analysis **Test Started on** : 31 Aug 2020

Test Completed on : 08 Sep 2020

Test result

S.No	Test Name	Test Method	Results	Units
1	Ammonia as NH3	NIOSH - 6015	2.4	mg/m3

Report No : **EN20080049-18** **Report Date** : **04 Sep 2020**

SAMPLE DRAWN BY LABORATORY

Customer Name : Centre for Industrial Consultancy & Sponsored Research, Indian Institute of Technology Madras (C/O Madras Fertilizers Limited)

Customer Address : Chennai,Tamilnadu- 600 036

Sample Description : Fugitive Emission

Sample No : EN20080049-18 **Sampling Date** : 31 Aug 2020

Sampling Location : Utility control room(opp) - MFL **Sample Received on** : 31 Aug 2020

Sample Condition : Fit for Analysis **Test Started on** : 31 Aug 2020

Test Completed on : 08 Sep 2020

Test result

S.No	Test Name	Test Method	Results	Units
1	Ammonia as NH3	NIOSH - 6015	2.0	mg/m3

Report No : **EN20080049-19** **Report Date** : **04 Sep 2020**

SAMPLE DRAWN BY LABORATORY

Customer Name : Centre for Industrial Consultancy & Sponsored Research, Indian Institute of Technology Madras (C/O Madras Fertilizers Limited)

Customer Address : Chennai,Tamilnadu- 600 036

Sample Description : Fugitive Emission

Sample No : EN20080049-19 **Sampling Date** : 31 Aug 2020

Sampling Location : Urea A & B Packing backside - MFL **Sample Received on** : 31 Aug 2020

Sample Condition : Fit for Analysis **Test Started on** : 31 Aug 2020

Test Completed on : 08 Sep 2020

Test result

S.No	Test Name	Test Method	Results	Units
1	Ammonia as NH3	NIOSH - 6015	2.2	mg/m3

Note : BDL: Below Detection Limit., DL: Detection Limit / NAAQS: National Ambient Air Quality Standard

BLQ-Below Limit of Quantification, LOQ-Limit of Quantification

Annexure 2

Docments related to contract made by MFL for Handling Hazardous Waste

(1) With MSTC limited

தமிழ்நாடு तमिलनाडु TAMILNADU BH 583481

MSTC LTD

SELLING AGENCY AGREEMENT

1.0 THIS AGREEMENT made this day of 20th December, 2018 between **M/s. MADRAS FERTILIZERS LTD,** a government of India Company incorporated under the companies Act, 1956 and having its registered office at Manali, Chennai 600068, hereinafter called "the Principal" (which expression shall unless excluded by or repugnant to the context be deemed to include its successors and assigns) on the ONE PART;

AND

M/s. *MSTC LIMITED* (A Govt. of India Enterprise) incorporated under the Companies Act, 1956 and having its registered office at 225-C, Acharya Jagadish Chandra Bose Road, Kolkata-700 020, represented by its regional office at 3rd floor, Ispat Bhavan, No.5 Kodambakkam High Road, Chennai - 600 034 hereinafter called "MSTC" (which expression shall unless excluded by or repugnant to the context be deemed to include its successors and assigns) on the Other part.

2.0 WHEREAS the Principal has viewed the contents as displayed in the web site of MSTC and is desirous of engaging MSTC as its Selling Agents for disposal of movable items such as Scrap, rejected/condemned/obsolete, secondary arising (ferrous and non-ferrous), surplus obsolete stores, equipment, misc items such as Trees, Wood etc through MSTC's Auction web site.

Page 1 of 6

For MSTC LTD.

Regional Manager

3.0 AND WHEREAS the Principal has agreed to engage MSTC as Selling Agent for the above purpose on the terms and conditions displayed in the Auction web site Viz., www.mstcecommerce.com and also the Terms and Conditions mentioned hereinafter;

4.0 NOW it is hereby agreed and declared by the parties hereto as follows:

4.1 This Agreement covers disposal of all movable items such as scraps, secondary arising, surplus stores and equipment, misc. items , and also immovable properties etc. as mentioned in clause-2.0 above;

4.2 In addition to the above, add-ons to the category of disposals may be effected through this agreement on mutual consent.

4.3 MSTC shall act as Selling Agent for disposal of all items covered under Clauses 4.1 & 4.2 hereof in the home/indigenous market by way of public auction over the Internet through www.mstcecommerce.com based on this agreement.

5.0 DURATION OF CONTRACT:

The Contract will remain valid for the period of TWO years from December 20, 2018 thru November 20, 2020. Either party can terminate the agreement by giving notice of 3 (Three) months to the other party.

6.0 QUANTUM OF BUSINESS:

If the volume of business is anticipated to be below Rs.5 lakhs (Rupees five lakhs), MSTC will request the Principal for accumulation of disposal items till disposal becomes economically viable. This contract by itself does not commit the Principal as to the quantum of business to MSTC.

7.0 NATURE & SCOPE OF SERVICE & RESPONSIBILITY OF MSTC:

7.1 MSTC shall conduct auction sale directly and in no case the appointment of any dealer/trader/auctioneer for the purpose will be considered.

7.2 MSTC will offer guidance in regard to making of lots for the purpose of Auction and will act on the basis of the list of disposable land/plots received from the Principal.

7.3 MSTC may arrange publicity for disposal through E-auctions by way of MSTC Websites and other Internet Tools. In addition the system shall notify automatically to all the buyers who are registered with the auction website i.e. www.mstcecommerce.com regarding all the forthcoming E-auctions specifying therein all relevant details about the materials / Lots / date & time of opening & closing of auctions etc. In addition to the above, advertisements in Local or National Newspapers may be arranged by the Principal and payment to the advertisement agency may be made directly by the Principal.

For MSTC LTD.

Regional Manager

(2) With TNWML Hazardous waste contract

भारतीय गैर न्यायिक

एक सौ रुपये Rs. 100

रु. 100 ONE HUNDRED RUPEES

भारत INDIA

INDIA NON JUDICIAL

தமிழ்நாடு तमिलनाडु TAMILNADU

BT 195382

16 APR 2019

Madras Fertilizers Limited
Chennai

R. LAKSHMANAN
STAMP VENDOR
L. C. No: 6/772/B3/95
No: 261, E.V.R. ROAD,
AMINJIKARAI, CHENNAI-29

SERVICE AGREEMENT

This Service Agreement is made at **Manali** on this the **28th day of May, 2019**, BY AND BETWEEN

Madras Fertilizers Limited, a Public Sector Undertaking, having its registered office at **Manali, Chennai 600 068** represented by its **Occupier, Mr. U. Saravanan** (hereinafter referred as "Generator" which expression shall unless repugnant to the subject or context include its successors and assigns);

AND

TAMILNADU WASTE MANAGEMENT LIMITED, Company registered under the Companies Act, 1956 and having its registered office at Ramky Grandiose, 12th & 13th floor, Ramky Tower's complex, Gachibowli, Hyderabad – 500 032, represented by its AUTHORISED SIGNATORY (herein after called ("TNWML") of the FIRST PART (which expression include their successors and assigns, unless such inclusion is inconsistent with the context of meaning thereof)

Hereinafter in this Agreement Generator and Operator shall collectively be referred to as 'Parties' and individually as 'Party'.

U. SARAVANAN
निदेशक - तकनीकी / Director - Technical

Page 1 of 17

4 USER CHARGES & TERMS OF PAYMENT

4.1 The Generator shall pay monthly user charges to Operator for its services as per the slab agreed, which is based upon the declaration given by the Generator as per Annexure. In addition, the Generator shall also be liable for payment of applicable taxes, levies, ESCROW Charges etc., if any, on the user charges.

4.2 The user charges are subject to revision on the basis of Government of India wholesale price index and also in every event of escalation of fuel costs, power tariff, change in disposal technologies and/or method, wage hike and others. Any revision shall be done as per guidelines arising out of discussion between TNWML and IWMA

4.3 Operator shall collect the waste as per the declaration and send the monthly waste disposal and shall send the monthly user charges invoice to the Generator on or before 5th of every succeeding month and the bill amount shall be payable by the Generator on or before 5th of the subsequent month.

4.4 Any object and/or clarification on the waste disposal invoices and monthly bills submitted by Operator to Generator shall be communicated to Operator within seven (7) working days from the date of the invoices. In

U. SARAVANAN
Director - Technical

मद्रास फ़र्टिलाइज़र्स लिमिटेड
Madras Fertilizers Limited

case of non-receipt of any clarification or objection it shall be deemed that the invoices are acceptable and shall fall due for payment as per clause 4.3 of this Agreement.

4.5 In case of delayed payments Generator shall be liable to pay interest at the rate of 1.5 % per month on the outstanding amount during the default period. In the event of any bill amount along with interest is due for more than three (3) months, Operator reserves the right to refuse to extend its services to Generator and even to terminate this Agreement with immediate effect upon giving a prior written notice of fifteen (15) days.

5 TERM OF AGREEMENT

This Agreement shall be valid for a period of Two Years effective from **May 28, 2019**, subject to early termination by either party in accordance with this Agreement.